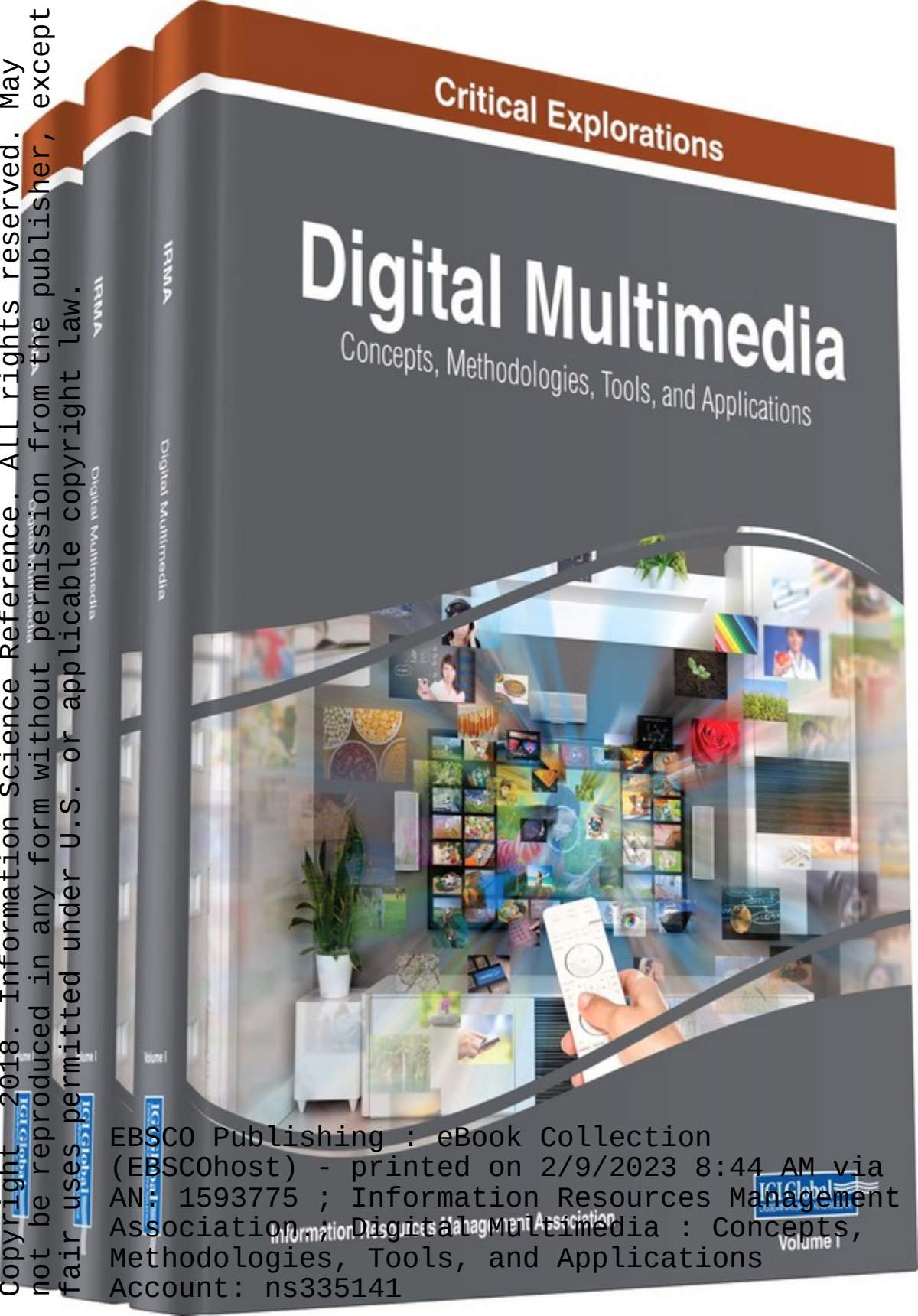

Digital Multimedia:

Concepts, Methodologies, Tools, and Applications

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Preface

The constantly changing landscape of Digital Multimedia makes it challenging for experts and practitioners to stay informed of the field's most up-to-date research. That is why Information Science Reference is pleased to offer this three-volume reference collection that will empower students, researchers, and academicians with a strong understanding of critical issues within Digital Multimedia by providing both broad and detailed perspectives on cutting-edge theories and developments. This reference is designed to act as a single reference source on conceptual, methodological, technical, and managerial issues, as well as to provide insight into emerging trends and future opportunities within the discipline.

Digital Multimedia: Concepts, Methodologies, Tools, and Applications is organized into six distinct sections that provide comprehensive coverage of important topics. The sections are:

1. Fundamental Concepts and Theories;
2. Development and Design Methodologies;
3. Tools and Technologies;
4. Utilization and Applications;
5. Organizational and Social Implications; and
6. Emerging Trends.

The following paragraphs provide a summary of what to expect from this invaluable reference tool.

Section 1, "Fundamental Concepts and Theories," serves as a foundation for this extensive reference tool by addressing crucial theories essential to the understanding of Digital Multimedia. Introducing the book is "Terms of the Digital Age: Realities and Cultural Paradigms" by Kimberly N. Rosenfeld, a great foundation laying the groundwork for the basic concepts and theories that will be discussed throughout the rest of the book. Section 1 concludes, and leads into the following portion of the book, with a nice segue chapter, "Security in Digital Images: From Information Hiding Perspective" by Mohammed A. Otair.

Section 2, "Development and Design Methodologies," presents in-depth coverage of the conceptual design and architecture of Digital Multimedia. Opening the section is "Media Literacy in the Digital Age: Literacy Projects and Organizations" by Amir Manzoor. Through case studies, this section lays excellent groundwork for later sections that will get into present and future applications for Digital Multimedia. The section concludes with an excellent work by Regner Sabillon, Jordi Serra-Ruiz, Victor Cavaller, and Jeimy J. Cano, "Digital Forensic Analysis of Cybercrimes: Best Practices and Methodologies."

Section 3, "Tools and Technologies," presents extensive coverage of the various tools and technologies used in the implementation of Digital Multimedia. The first chapter, "Making It for the Screen: Creating Digital Media Literacy" by Paul Chilsen, lays a framework for the types of works that can be

found in this section. The section concludes with "Video Authentication: An Intelligent Approach" by Saurabh Upadhyay, Shrikant Tiwari, and Shalabh Parashar. Where Section 3 described specific tools and technologies at the disposal of practitioners, Section 4 describes the use and applications of the tools and frameworks discussed in previous sections.

Section 4, "Utilization and Applications," describes how the broad range of Digital Multimedia efforts has been utilized and offers insight on and important lessons for their applications and impact. The first chapter in the section is "Young Children and Digital Media in the Home: Parents as Role Models, Gatekeepers, and Companions" written by Patricia Dias. This section includes the widest range of topics because it describes case studies, research, methodologies, frameworks, architectures, theory, analysis, and guides for implementation. The breadth of topics covered in the section is also reflected in the diversity of its authors, from countries all over the globe. The section concludes with "Digital Media Affecting Society: Instruction and Learning" by Terry Cottrell, a great transition chapter into the next section.

Section 5, "Organizational and Social Implications," includes chapters discussing the organizational and social impact of Digital Multimedia. The section opens with "What Does Digital Media Allow Us to 'Do' to One Another?" by Donna E. Alvermann, Crystal L. Beach, and George L. Boggs. This section focuses exclusively on how these technologies affect human lives, either through the way they interact with each other or through how they affect behavioral/workplace situations. The section concludes with "Reflecting Emerging Digital Technologies in Leadership Models" by Peter A. C. Smith and Tom Cockburn.

Section 6, "Emerging Trends," highlights areas for future research within the field of Digital Multimedia, opening with "Trends in Managing Multimedia Semantics" by Roberto Poli, Achilles Kameas, and Lambrini Seremeti. This section contains chapters that look at what might happen in the coming years that can extend the already staggering amount of applications for Digital Multimedia. The final chapter of the book looks at an emerging field within Digital Multimedia, in the excellent contribution, "Media Synchronization Control in Multimedia Communication" by Mya Sithu and Yutaka Ishibashi.

Although the primary organization of the content in this multi-volume work is based on its six sections, offering a progression of coverage of the important concepts, methodologies, technologies, applications, social issues, and emerging trends, the reader can also identify specific contents by utilizing the extensive indexing system listed at the end of each volume. As a comprehensive collection of research on the latest findings related to using technology to providing various services, *Digital Multimedia: Concepts, Methodologies, Tools, and Applications* provides researchers, administrators, and all audiences with a complete understanding of the development of applications and concepts in Digital Multimedia. Given the vast number of issues concerning usage, failure, success, policies, strategies, and applications of Digital Multimedia in countries around the world, *Digital Multimedia: Concepts, Methodologies, Tools, and Applications* addresses the demand for a resource that encompasses the most pertinent research in technologies being employed to globally bolster the knowledge and applications of Digital Multimedia.

Section 1

Fundamental Concepts and Theories

Chapter 1
Terms of the Digital Age:
Realities and Cultural Paradigms

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ABSTRACT

This chapter defines terms of the digital age as they relate to digital media literacy. The changing landscape of society is demonstrated through the recalibration occurring in media processes and the cultural forms they generate. These conditions have fostered cultural paradigms unique to the digital age: paradigms aligned with either humanistic or capitalist perspectives, and marketing playing a role with respect to this tension. An analysis of two policies in the form of new curricula reveals that more must be done to prepare, protect, and empower a digitally literate citizenry. The chapter closes with an argument that the first step in this direction must involve both establishing digital media literacy as a discipline as well as deepening and extending current media literacy frameworks.

INTRODUCTION

As we entered the second decade of the twenty-first century, digital technology reached capabilities that opened a new era with its own ecosystem: an ecosystem that is dynamic by nature constantly rearranging, restructuring, expanding, and where new ideas sprout into startups that turn concepts into products. The unceasing innovation, shape-shifting, expansion of possibilities, and excitement around all things digital defines the digital age.

The frenetic rapidity of the information revolution has made defining digital-age terms an endless task. As soon as concepts are clarified, new ones emerge and others become obsolete. Therefore, it would be futile to concretize such terms. Instead, this chapter presents definitions as snapshots of the current times, acknowledging that the terms of the digital age can only be captured as they presently stand. In addition to clarifying ideas that are often confusing, this chapter will also engage the tangible, the intangible, and the barely perceptible aspects of digital life, with the goal of defining terms as they directly relate to digital media literacy. This will involve a journey that begins by establishing several foundational definitions and then moves on to discuss tangible artifacts and the cultural forms they en-

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able. Next, the chapter critiques the monetization and manipulation efforts underway to push the digital media environment into becoming an integral part of capitalism, and it provides a response in the form of various theoretical frameworks designed to equip the digital citizenry. The chapter also explores the education policies that have been put into practice to implement digital media literacy through a comparison and analysis of two broad-scale curriculum changes in England and the United States. The chapter concludes with the recommendation that digital media literacy be recognized as a discipline as well as a set of skills and offers suggestions for strengthening digital media literacy frameworks.

DIGITAL MEDIA DEFINITIONS

Before defining *digital media literacy*, the notions of a *term* and of *digital media* require clarification. At the most fundamental level, a *term* is a word or phrase used to describe a thing or express a concept. The word *term* will be used here more broadly to refer to various phenomena of the digital age such as changes to culture, identity, and ontology. In *The Medium is the Massage* (1967/2005), McLuhan and Fiore define a *medium* as an extension of some human faculty, either psychic or physical. Their definition recognizes that media extend beyond physical artifacts and products to the less tangible realm of the mind and culture, areas that are examined in this chapter. The definition of *digital media* must begin with an understanding of the unique advantages of their digital nature. One advantage of *digital media* is their flexibility in communication due to their scalability: For example, digital media can be accessed with ease across devices and contexts through *video streaming*. Another advantage is the manner in which they are stored, either as encoded files (MP3 for sound or MP4 for multimedia), on servers (in the cloud), or streamed directly over the Web. Each of these methods provides for a more enduring medium and also makes the portable device a more entrenched actor in virtual life.

Digital environments, however, cannot be accurately characterized without paying careful attention to the multiple, overlapping realities in which the denizens of high-tech societies reside. *Real-life reality* is the world we live in when we are not logged in to cyberspace, while *virtual reality* is the reality associated with interacting in and through cyberspace. In its original conception, *virtual reality* referred to a virtual experience requiring the donning of equipment for moving within 3D virtual environments. This use of the term has largely evolved into references to cyberspace experiences. The idea of reality is further complicated by various interpretations of reality emerging from experiences in the virtual. Such interpretations are different in nature, as illustrated by *augmented reality* and *hyperreality*. Augmented reality is a composite presentation of real life augmented by virtual overlays, usually through a smartphone or tablet. Whereas, hyperreality is a psychological state involving virtual experiences that are perceived to be better than real life (Rosenfeld, 2015).

Conceptually, *digital media literacy* is approached quite differently among scholars; its conceptions vary from instrumental to psychological and sociocultural. In the following, multiple perspectives on the subject are introduced, drawing from important digital and media literacy thinkers, policy makers, and scholars. The Royal Society,[1] an independent body of research scholars composed of the UK's most renowned scientific thinkers (Stephen Hawking and Tim Berners-Lee are fellows) serves as a logical starting point, due to the work they have done on digital literacy. Since its inception in 1660, the Society's mission has been to recognize, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity. It is not surprising that these scholars use a

scientific perspective to present a definition of digital literacy in terms of instrumental computer skills rather than with reference to an academic discipline. Thus, for the Royal Society advisory group, digital literacy is analogous to the ability to read and write: As they report, it is a "basic skill or ability to use a computer confidently, safely and effectively, including: the ability to use office software such as word processors, email and presentation software, the ability to create and edit images, audio and video, and the ability to use a web browser and Internet search engines. These are the skills that teachers of other subjects at secondary school should be able to assume that their pupils have, as an analogue of being able to read and write" (2012, p. 17). Here digital literacy is described as a fundamental skill that is necessary for accessing all subjects across the curriculum. However, the group argues that digital literacy is not a "subject" in itself: "Neither are reading and writing—but [digital literacy] is an essential skill for all in the modern age" (2012, p. 24). In contrast, computer science is defined as a rigorous subject and discipline, just like mathematics and physics.

The Royal Society's Computing at School group characterizes a "discipline" as a subject that has five distinct attributes. First, it includes a body of knowledge, with widely applicable ideas and concepts as well as a theoretical framework into which these ideas and concepts fit. Second, it uses a set of rigorous techniques and methods to solve problems and to advance knowledge. Third, a discipline has a way of thinking and working that provides a perspective on the world that is distinct from the perspectives of other disciplines. Fourth, it has a stable set of concepts, meaning that a discipline does not "date" quickly. Although the subject advances, the underlying concepts and processes remain relevant and enlightening. Finally, a discipline exists independently of specific technologies, especially those that have a short shelf life (2012). Whether digital literacy counts as a discipline is largely dependent on the lens through which it is viewed. For example, cultural studies theorists take another approach and treat digital media literacy as both a skill and a discipline and add the word "media" to the discussion. Thereby, they refer to digital media literacy as opposed to digital literacy.

On another point, there is no clear agreement among scholars on the use of the term in a singular sense, *digital media literacy* versus a plural sense, *digital media literacies*. Nevertheless, all agree that digital literacy must include media and is therefore more than the ability to use a computer and access the Internet. Furthermore, some scholars discuss digital media literacy in the broader context of media literacy (see Gee, 2010; Pérez Tornero & Varis, 2010), while others draw a distinction between the two (see Buckingham, 2007; Hobbs, 2010). All agree, however, that there is an overlap. Media literacy scholars study how people can become more aware, critical, and mindful of the meanings they give to and get from media (Gee, 2010). They also believe that people can be manipulated by media messages and can use media to manipulate others. To decode messages, it is important to ask whose vested interests are represented and who we are led to believe benefits from the message (Gee, 2010). For Hoechsmann and Poyntz (2012), media literacy is "a set of competencies that enable one to interpret media texts and institutions, to make media of their own, and to recognize and engage with the social and political influence of media in everyday life" (p. 1). According to the National Association for Media Literacy Education (NAMLE),[2] media literacy is intended "to help individuals of all ages develop the habits of inquiry and skills of expression that they need to be critical thinkers, effective communicators, and active citizens in today's world" (2009, p. 1).

Media literacy theorist Douglas Kellner (1998) argues that to foster literacy in the technocultures of the past and the future, a postmodern pedagogy that involves developing multiple literacies in the interrelated areas of critical media literacy, print literacy, computer literacy, and multimedia literacy is needed. Kellner and Share (2007) use the term *critical media literacy* in a way that "expands the notion

of literacy to include different forms of mass communication and popular culture as well as deepens the potential of education to critically analyze relationships between media and audiences, information and power" (p. 4). Thus, for Kellner and Share, digital media literacy must also include a critical component.

Media scholar Henry Jenkins (2008) defines media literacies as "a set of cultural competencies and social skills that young people need in the new media landscape…. These skills build on the foundation of traditional theory, research skills, technical skills, and critical analysis skills taught in the classroom" (p. 6). Jenkins further explains that the traditional approach to media literacy is to address the politics of representation by teaching how to read through media-constructed stereotypes about race, class, sex, ethnicity, religion, and other forms of cultural differences (Jenkins, 2009). However, he acknowledges that in today's media landscape, students must also be taught awareness in relation to "participation" in media environments. Such skills are related specifically to the ability to listen and to respond to a range of different perspectives, defined in two ways: "first, as the ability to negotiate between dissenting perspectives, and second, as the ability to negotiate through diverse communities" (2009, p. 99). The work of Jenkins illustrates that digital media literacy training must also consider training in the area of audience participation.

Renee Hobbs, a prolific and well-regarded American media literacy scholar, defines digital and media literacy as "a constellation of life skills that are necessary for full participation in our media saturated, information-rich society" (2010, p. viii). For Hobbs, these skills include being able to make responsible choices and access information by locating and sharing materials, to analyze messages and create content in a variety of forms, to reflect on one's own conduct, and to take social action. Unique to Hobbs is the addition of "reflection" and "social action" as important elements of digital media literacy.

One of England's most renowned media literacy scholars, David Buckingham, emphasizes broad conceptual aspects of media literacy such as representation, language, production and audience. Although these were initially specific to the pre-Internet television era, Buckingham makes the case that they continue to be relevant in the digital age. For Buckingham, digital media literacy is one type of literacy added to an ever-growing list of other modern "literacies," including economic literacy, emotional literacy, and spiritual literacy (2007). He further argues that digital media literacy goes well beyond the basics of access and technical skill and must include the ability to critically evaluate and use information with the aim of transforming it into knowledge. For Buckingham, this means asking questions about "the source of that information, the interests of its producers, and the ways in which it represents the world; and understanding how these technological developments are related to broader social, political and economic forces" (2006, p. 267). Buckingham brings an acute knowledge of media grounded in his background in traditional media effects. Thus, he highlights the consideration of media sources and the interests of those producing it as components of digital media literacy.

A global, humanist perspective was brought to the digital media literacy discussion by a 2010, UNESCO study titled *Media Literacy and New Humanism*, by José Manuel Pérez Tornero and Tapio Varis. The study asserts that media literacy (which for the authors includes digital media literacy) should be grounded in a new critical media awareness that fosters use of the instruments, codes, and languages that enable information to be received, created, and disseminated. To accomplish this, instruction in media literacy should provide systems for evaluating and selecting information and foster critical views of technological development and media messages as well as their technological contexts. Furthermore, such media awareness must promote citizens' free expression with the goal of strengthening social communication and the right to make decisions autonomously. Finally, they argue that media awareness should foster exchange and mutual understanding among cultures and should stimulate the achievement of universal

rights as well as the acceptance of universal responsibilities. Clearly, digital media scholars view literacy to encompass a variety of practical, critical, and analytical skills.

This chapter uses "digital media literacy" in reference to the development of a unified set of critical, cultural competencies. This chapter also sets out to demonstrate that digital media literacy is both an academic discipline and a skill, as will be explained at the close of this chapter. In this fast paced digital age, media is taking on different forms, thus a discussion of how the digital has changed both media and society is in order to identify the relevance of digital media literacy skills.

Traditionally, the creation of any type of "media" required an exclusive infrastructure that encompassed all the necessary steps from its creation to its consumption. The news, movies, or TV series that were streamed into the home via radio waves were the result of a mechanism that needed to pass through codified stages of a highly bureaucratic process. The creation of content was accomplished using the tools of production under the watchful eye and control of studios, then the distribution step required affiliated local stations located across the country that could diffuse the program, and finally, access to and consumption of these programs were enabled by the television set itself an artifact positioned at the center of the home, the living room. The digital age has changed this infrastructure, rewriting the process from media creation to consumption with both simplicity and multiplicity. Shows are more simply distributed directly to the audience's cable box or modem via the Web. Additionally, the audience can now watch their favorite shows on multiple devices and in various contexts. What was once confined to the living room has extended to people watching at the park, in a car, on the street, at a restaurant, at sporting events, the contexts are endless. This transformation calls for a look at some of the ways that all things digital have affected production, distribution, and consumption habits.

MEDIA LITERACY CONSTRUCTS ALIGNED WITH THE DIGITAL WORLD

Production

The Internet cannot be accessed without tangible artifacts. These artifacts include the devices themselves (e.g., smartphones, laptops, tablets, gaming devices of various forms, and smartwatches) and the infrastructure that allows them to work (including cell towers, fiber optic cables, satellites, and computer programs such as Codec to encode and decode images and sound signals sent over digital data streams). The tangible also extends to sounds and design, for example, ringtones and computer user interfaces. To understand the nature and conditions of these twenty-first century artifacts, it is necessary to analyze their social, cultural, economic, environmental, aesthetic, global, and personal effects. In a book titled *The Ringtone Dialect: Economy and Cultural Form*, Sumanth Gopinath (2013) examines the cultural implications of the seemingly benign ringtone industry. Gopinath highlights important social and cultural issues related to the mobile industry including the musical labor force, ringtones as representations, the geographic dispersion of the political ringtone, as well as the ringtone's narrative functions in cinematic and televisual media. Similarly, Lisa Parks, professor of Film and Media Studies at the University of California, Santa Barbara, examines satellites as they relate to society and culture, including satellite economy, satellite espionage, and satellite images as an extension or another form of the televisual world. Parks recognizes that an entire field of satellite studies is possible, one that would examine satellites as exerting agency in a system of global power relations (Parks, 2005). Gopinath's and Parks' work point to the reality that artifacts of the digital age are tied to institutions, places, people, and agendas (Parks,

2005). The fact that the digital age includes unnoticed aspects of digital life, or, as Parks puts it, "barely perceptible" (2005, p. 5) features of the digital world, illustrates that the tangible and the intangible are not mutually exclusive. The relationship between tangible and intangible aspect of digital society is perhaps one area for which digital media literacy training is most needed.

As David Buckingham (2006) observed, digital media are not just about information hardware and software but also provide new ways of mediating and representing the world and of communicating. In essence, participation in the digital age also involves active engagement in the production process, for which the virtual world has provided a new terrain. The ease of use associated with recent iterations of the portable camera along with the availability of editing software and the ability to upload the result to a global audience have shifted a large part of media production from professionals to amateurs. Production now extends to the tools of the audience thereby changing both production and distribution practices.

Distribution

Social media provide an organic network for distribution to the mass population. As Jenkins noted, "if it doesn't spread, it is dead" (2013, p. 2) largely because social media tools have changed the nature of information dissemination from distribution to circulation. This represents a paradigm shift from pre-constructed message distribution to communities of people who shape, share, reframe, and remix media content in novel ways. Jenkins (1992, 2009) uses the term *participatory culture* to describe a culture in which fans and other consumers are invited to actively participate in the creation and circulation of new content. In essence, social media are self-propagating and provide an extreme level of exposure to a maximum number of global audiences in minimal time. The idea that media are now "spreadable" (Jenkins, 2013) also means that new social logics and cultural practices have enabled and popularized the new platforms.

Social media sites come in different shapes and forms: *Twitter, Vine, Instagram, and YouTube*. No two of these are alike; they are singular in their distinctive formats and use very specific types of medium as their forms of distribution: short texts for *Twitter,* short-form video clips for *Vine,* pictures for *Instagram,* and video clips of all forms for *YouTube.* Each, however, speaks to a particular audience and yields its own individual power in the war for viewership within an increasingly saturated media landscape. Such sites enable community building to the point that the passive consumer cannot help but be transformed into an active producer. Traditional models of production and marketing have had to respond to this change, as they are no longer able to control and manipulate public response as they once did. One area where the audience has taken the reins in influencing distribution is evident in the phenomenon known as *going viral*.

Going viral has been defined in many ways. Nahon and Hemsley (2013) describe going viral as "that which stands out as remarkable in a sea of content" (p. 2). Additionally, Boynton (2009) offers several ways to understand the term. On one interpretation, it applies to videos that are viewed many times, such as any video that has been viewed more than 100,000 times—although it should be noted that there is no exact number of views that determine virality. Another interpretation compares this phenomenon to the biological process behind an epidemic, where infection is spread through contact. In the digital age, this dissemination is triggered through posting to a social network. It starts with a few who are infected coming into contact with others and infecting them, and so on. A third interpretation of *going viral* is a

functional one described in terms of a sigmoid curve, which is a mathematical function having an "S" shape. Something that is going viral begins small and expands over time, such as videos or images that are initially shared among a few individuals and then expand to wider audiences (Boynton, 2009). At the heart of virality lie both the ability and the decision to share information (Nahon & Hemsley, 2013). The act of sharing has also changed the nature of oppositional movements, as seen in the cases of the activist group Anonymous (Olson, 2012), the 2010 Arab Spring Movement (Aday, Farrell, Lynch, Sides, & Freelon, 2012), and the 2014 Hong Kong Protests (Cohen, 2014).

With the empowerment of the masses, as illustrated through the concept of *going viral*, the notion of *audience* has changed into a participant-recipient role. Therefore, the concept of an audience must include consideration of which "audience" along with each audience's unique perspective.

Audience

The ability to disseminate information to an individual site or to entire groups of people with the push of a single button has not only changed consumption, it has also changed the nature of business, marketing, politics, and a myriad of other social functions. The practice of "likes" and online "reviews" demonstrates that audience members are also influencers. A positive or negative rating on *Yelp* can make or break a business, just as a positive *Twitter* review of the Koji food truck in California ignited a food truck frenzy. The practice of rating turns social roles on their heads by creating a new breed of influencers, where not only is the customer a reviewer, but the provider is one as well. For example, drivers for the company *Uber* rate customers on a 1–5 scale. Customers with a score of 4.0, say, might find that drivers are not willing to pick them up (Ephron, 2014). Likewise, the site *Rate My Professor* allows students to rate their college professors on a 1–5 scale in the categories of easiness, helpfulness, clarity, and looks (called *hotness*). The site is so popular that students across the nation use the ratings as a factor in planning their college schedules (Robertson, 2006). Indeed, *The New York Times* reminds users that *Rate My Professor* has its own vocabulary, values, and idiosyncrasies and that success on the site is not necessarily a badge of honor; the top-rated professors on the site are not the top-rated professors in the nation, but only the top-rated professors on *Rate My Professor* (Heffernan, 2010).

The virtual world of likes and reviews has made the digital citizenry subject to both private and public comments as well as their dissemination, regardless of the citizen's social roles and perceived status. This same citizenry needs training in how to contribute to and take from such sites, beyond their face value. They need to understand the composition of a site's users, the complexity or simplicity on which they base their reviews, and the very abstract nature of "good" and "bad." They also need to understand the reality that such reviews can legally be manipulated, as happened during a case against *Yelp* when a federal appeals court ruled that *Yelp* could move or change ratings (The Associated Press, 2014). The idea of review bias applies not just to "likes," but also to the intentions and manipulations embedded within the communication itself.

The empowerment of individuals through digital media is an integral part of the digital landscape. Henry Jenkins (2008) discussed the agency exerted by online fan communities whose acts of sharing and recommending have created a new form of social and economic power. Jenkins aptly noted that "as soon as the conversation shifts to participation, cultural protocols and practices come to mind" (2008, p. 23). These shifts can best be understood through an analysis of modern-day cultural forms.

CULTURAL FORMS, CAPABILITIES, AND HABITS

Cultural Forms

The term *cultural forms* is used across numerous disciplines, including anthropology, cinema/film, literature, ethnic studies, feminist studies, and more, yet most writers use ostensive definitions (examples or demonstrations) rather than direct articulations of the concept. Thus, cultural forms will first be defined, then, they will be explained in the context of the digital age in general and digital media literacy in particular, and finally, their articulation with how they relate to understandings of digital media literacy will be clarified.

The idea of cultural forms can be traced back to the work of English anthropologist Edward Burnett Tylor. His landmark study *Primitive Culture: Researches into the Development of Mythology, Philosophy, Religion, Language, Art and Custom* (1871/2010) begins with the observation that "culture or civilization, taken in its wide ethnographic sense, is that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society" (2010, p. 1). Although Tylor did not use the term *cultural forms*, his description alludes to cultural forms as the components that make up the whole of a culture, including physical artifacts such as art but also extending to capabilities and habits that contribute to the creation of cultural norms and mores: knowledge, beliefs, morals, laws, and customs. Today, the term *cultural forms* is used to describe and represent numerous ideas and tangible artifacts of architecture, prose, verse, music, art, cinema, television, theater, novels, dance, and even food (MacGregor, 2012; Miller, 2002; Minett, 2014; Tietchen, 2014; Wee, 2012). The term has also been used in reference to diverse concepts such as modes of cultural practice (McLeod, 2012), species-specific behaviors (Sahlins, 2010), sites of struggle (Brooks, 1997), and cultural identifications and infrastructures (Danesi, 2013; Yamashiro, 2012).

Furthermore, cultural forms have been identified as polysemic vehicles for familial, economic, political, and cultural relationships and processes (Miller, 2002). For instance, modern-day gift giving now includes digital donations. The website *i-give* enables individuals to enroll in a program that allows a small portion of their payments for online purchases to be donated to a community of their choosing. The vision behind the website is to make all customer transactions benefit social causes that are close to home. Thus, the meaning of gift giving has shifted from something done between close friends and family members to a communal act of philanthropy. Similarly, college students are moving beyond the traditional methods of college funding (i.e., family, government, self) and using crowdsourcing software to fund tuition. Through sites like *GoFundMe*, individuals, as opposed to just recognized charities, can create profiles, explain what they are collecting funds for, and then spread the word through social networks. This brings new meaning to college funding, charity, and storytelling as a vehicle of persuasion (Carrns, 2014).

Tangible digital artifacts themselves are also polysemic, as perhaps best illustrated through the smartphone. The smartphone was initially intended to be solely a communication device, yet today it is a stand-alone game platform, a surrogate TV screen, an e-reader, and a payment device, to name just a few of its uses. The meaning of the smartphone has been extended so as to be associated with each of these new capabilities, whether professional or personal. Another layer of meaning that is projected to others concerns the type of smartphone one owns. The device can convey meanings associated with socioeconomic status, preferences in logic, and lifestyle.

Twentieth-century Welsh philosopher Raymond Williams reminds us "taking the theory of culture as a theory of relations between elements is a whole way of life. We need also, in these terms to examine the idea of an expanding culture, and its detailed processes. For we live in an expanding culture, yet we spend much of our energy regretting the fact, rather than seeking to understand its nature and conditions" (1958/1983, p. viii). This is the very idea that is captured in David Buckingham's recent suggestion that there is a whole range of contemporary forms of communication that require literacies (2006). Thus, to be clear, cultural forms of high-tech societies include not only the tangible artifacts of the digital world, but also the intangible areas of capabilities and habits. Furthermore, ideologies, struggles, polysemic interpretations, and symbol manipulations are embedded within each tangible artifact. Thus, cultural forms represent unsettled territory where meanings are created, changed, and fought over, especially as they relate to longstanding cultural practices that embody values, norms, and mores.

Capabilities and Habits

Turning now to the capabilities and habits of the digital age, it becomes clear that high-tech culture is changing cultural practices as well. With the expansion of communication outlets comes a broadening of real-life reality. For instance, representations now include high-resolution amateur videos captured using small wearable cameras (e.g., the GoPro). Such cameras allow individuals to capture life like never before by rigging a camera directly on the subject. This enables viewers to move beyond a spectator point of view and actually participate in an experience such as skydiving, surfing, or rising to the edge of space. Furthermore, drone images, as seen during the numerous US-led wars in the Middle East, have been dubbed *drone porn* for their wide-view detached shots of bombings as well as the startling graphic close-ups. These images have affected both civilian and military perceptions and experiences of war (Thompson, 2009). Televisual war spectacles also include Google Earth satellite images, where representations of global conflicts and crises are transforming views of these events (Parks, 2009). Such images extend to terrorist groups as well who regularly use the Internet to disseminate graphic videos of prisoner beheadings to incite fear and global intimidation.

The culture of the digital is creating a new form of personhood and multiculturalism, yet the changes are not the same for everyone. In order to map the impact of digital culture on individual identity, it is essential to understand levels of *digital immersion*, which is the breadth and depth of an individual's digital use and time spent in cyberspace. The present moment in history represents perhaps the greatest range with respect to immersion, as a Luddite may still be able to function without entering cyberspace (however, this possibility has been slowly dwindling and will soon be an impossibility). Therefore, the spectrum today begins with nonusers and slowly crescendos. There is the superficial user, one who enters cyberspace mainly to get things done (e.g., checking email, texting, light Internet surfing, shopping, and banking). The intermediate user is one who maintains a stronger presence in cyberspace such as hosting a blog, posting online reviews, and maintaining accounts on several social network sites. A deep user is one who builds and maintains online relationships (e.g., through multiplayer games, online interest groups, dating sites) and may even engage in cyberspace-enabled activities such as hacking or activism. These levels of digital immersion are ephemeral, as technology is moving at such a steady pace that most citizens will eventually find themselves intermediately or deeply immersed. It is not surprising that great strides are being made in the "Internet of Things," where home devices learn about and adapt to humans for their convenience, security, and energy saving. For example, there are thermostats that adjust based on the time one gets up in the morning and clothes dryers that adjust to cooler, slower drying cycles

during times of peak energy use (Lohr, 2014). There are also children's toys such as Crayola's Virtual Design Pro that combine the physical and virtual worlds by allowing children to physically create a car through drawing and coloring and then use a mobile app to import the car into cyberspace and then drive it in the virtual world ("Virtual Design," 2014).

Digital tools allow for new capabilities with direct social implications. A quick snapshot of behaviors around and through digital devices at the time of this chapter's writing reveals several rapidly changing cultural forms, such as *sexting* and the *selfie*. The practice of *sexting*[3] brings to light both the breadth and depth of new cultural practices. It should be noted that although adults and minors alike are implicated in the practice (Brown, Keller, & Stern, 2009; Chen & Hernandez, 2013; Linsey, 2013; Walker, Sanci, & Temple-Smith, 2011), sexting is primarily associated with minors (Brown et al., 2009; McEachern, McEachern-Ciattoni, & Martin, 2012), and it is practiced globally (e.g., in the United States, Australia, Canada, and Papua New Guinea). Sexting is so pervasive that it has reshaped thoughts, policies, and expert opinions about what constitutes normal sexual experimentation and development in the digital age (Brown et al., 2009). For instance, sex education in the digital world now includes smartphone apps that help youth resist sexting requests (Brown et al., 2009; Smith, 2014). Sexting has also expanded and reshaped what constitutes cyberbullying (Siegle, 2010), exploitation and self-objectification, especially of women (Brown et al., 2009), human rights ("PNG Constitutional," 2014), as well as child pornography and sex offender laws (Maddocks, 2014).

Sexting can be considered as a subphenomenon of a larger one known as the *selfie*, as sexting involves self-portraits that are shared online. In 2013, the Oxford Online Dictionary designated *selfie* as the word of the year, defining it as "a photograph that one has taken of oneself, typically one taken with a smartphone or webcam and uploaded to a social media website" ("Selfie Named," 2013). The concept of the selfie and the generation it represents is an "old practice" rediscovered: the control of one's own image. In an interview with the *Sunday Star-Times*, Rex Armstrong, the director of a New Zealand art gallery featuring a selfie exhibit, noted that "selfies might seem like an immediate snapshot of reality but they were as much a deliberate piece of storytelling and fiction, as a self-portrait painted 500 years ago…. We all want to portray ourselves as we would [like to] be seen. The selfie is the subject in control of the image" (Walters, 2014, p. A7). The power of selfies is further evidenced by apps that allow doctoring digital photos to achieve flawlessness ("LINE Launches," 2014; "New Update," 2014) and even extending to "selfie surgery" (Harris & Vega, 2014). Visual imagery can now be manipulated with much more ease and much less expertise than were previously possible. This is also true of videos that are edited to alter reality either through strategic cuts or the use of visual effects. The selfie has also been linked to law enforcement and geopolitics. Burglars revealed their identities to law enforcement officials when they snapped selfies using their victim's smartphone, which unbeknownst to them, was set to automatically upload to the victim's cloud account (Robach, 2014); and in the midst of an international crisis generated by the presence of Russian troops in Ukraine, which was denied by the Russian government, a Russian soldier posted online selfies that were geo-tagged with GPS coordinates—thus giving away his true geographical location (Murphy, 2014).

These new cultural forms expand personal and cultural capabilities, yet they are not without risks. New vulnerabilities are emerging that once again require a digitally literate citizenry; a citizenry taught how to navigate the land mines of the digital age. As Jenkins (2008) noted, it is important to keep in mind that "the interests of producers and consumers are not the same" (p. 58). We are currently in the midst of cultural wars over who will capture the attention and respect of audiences and who will control and influence their behavior through new media: the traditional outlets of show creators and producers,

marketing experts, and corporate gatekeepers (publishers, television networks, and so on) or the convergent fan communities often led by unlikely sorts such as 16-year-old girls who like to shop, males who collect and follow the production and distribution of Air Jordan shoes, or—in the case of Perez Hilton—a blogger with an interest in celebrity culture and a sense of humor. These examples illustrate the rise of the "pro-am," defined by Leadbeater and Miller (2004) as an innovative, committed, and networked amateur working to professional standards. Amidst the flood of original and remixed content from amateur and pro-am users, the marketing community has been working to appropriate this public.

A CONFLUENCE OF TOOLS, CULTURAL FORMS, AND MARKETING

Since large, global audiences have shifted from being accessible only to a very small group of elites to being accessible by the masses, the professional production and distribution industry is at odds with, but also collaborates with, these same amateurs and their communities—as amateurs can help promote or destroy a project, a person, a product, or an event. This has posed a new challenge to the marketing world: to find the formula for influencing a network of web communities with the ultimate goal of making ideas, products, and corporate brands "go viral." The confluence of tools, cultural forms, and marketing constitute a perfect storm for the commodification of the Internet. The target of marketers' new efforts is *earned influence*, a term used to describe positive perceptions achieved through efforts made in such realms as social media (Elliott, 2014). In fact, the Public Relations Society of America has updated the definition of public relations to reflect such changes: "Public relations is a strategic communication process that builds mutually beneficial relationships between organizations and their publics" (Elliott, 2014). The notion of relationship building with a public illustrates the shift from a focus on appealing to individual wants and desires to a focus on earned influence.

Marketing was famously practiced throughout the early twentieth century based on the work of Edward Bernays, who is largely recognized as the father of modern public relations; and now the race is on to use any means (psychology, guile) to create associations in the minds of consumers that provoke them not only to take personal action but also to distribute the decision to do so across their personal networks. As Bernays wrote in his book *Propaganda* (1928/2005), "The conscious and intelligent manipulation of the organized habits and opinions of the masses is an important element in democratic society. Those who manipulate this unseen mechanism of society constitute an invisible government which is the true ruling power of our country" (2005, p. 37). The advertising industry has clearly turned its attention and efforts to power building through cyberspace leaving citizens vulnerable to novel forms of manipulation. Geoffrey Moore, marketing professional and author, noted that "we have embarked upon the world's largest and longest cocktail party, and every issue imaginable is up for grabs." (Moore, 2007, p. vii). This frenzy is not overt rather it is happening through seemingly benign, yet insidious acts.

In an ongoing frenzy to earn influence by capturing viewers, media corporations are inserting themselves into exchanges of grassroots cultural videos and images in the form of inconspicuous product placement and paid endorsements by unlikely agents. In doing so, they are perverting the original intent of this new media while providing a novel doorway to fame. This practice can be seen in the advent of theAudience, a social media publishing company whose business is to manipulate means of cultural discovery over the Web. Their service is to create content that taps into the values and passions a brand shares with its consumers, then amplify it through a network of influencers ("TheAudience," 2014). Culled from various sources such as *Vine* actors, *YouTube* singers, and *Instagram* models, *influencers*

are young, relatable, Internet-popular microcelebrities who are willing to use products and talk about them for a fraction of the traditional celebrity's cost, yet together they reach the same number of fans (Brodesser-Akner, 2014). TheAudience employs a cadre of 6,000 influencers who are all paid for their sponsorship (Brodesser-Akner, 2014). The marketing profession considers this practices to be a new discipline called "conversation marketing," (Gillin, 2007, p. xiii) the creation of a dialog with customers where useful information is exchanged, trust is built and brand loyalty established. In essence, it involves understanding who one's customers are, who influences them and how to engage with those influencers (Gillin, 2007). Conversation marketing is another example of Bernaysian manipulation applied to the Internet. Just as women of the early twentieth century were duped into thinking that smoking cigarettes was an expression of women's liberation as described in the documentary *Century of the Self* (Curtis, Kelsall, & McKinnell, 2002), fans of the twenty-first century are duped into thinking that their favorite Internet microcelebrity is free from hidden agendas.

At the same time, established celebrities such as actors have moved from brand endorsements to branding themselves in the form of online lifestyles and shopping companies, thereby using their star status as a vehicle for associating their values with products (V. Friedman, 2014). The Web serves as another form of mass entertainment, and as with older forms, advertising has become an active agent in the genre. This is also true of the entire entertainment industry, which now has agents and managers representing *You Tube* talent (Barnes & Atkins, 2014). These efforts pose a unique problem, as today's users are living at a time when it is commonly believed that social sharing within the digital world is altruistic, free, and authentic.

A quick overview of the free software (a.k.a. open source) movement can shed some light on this belief. Richard Stallman, a former programmer at the M.I.T. Artificial Intelligence Laboratory, hacker, programmer, and political activist, is also author of the "GNU Manifesto" (2002), a treatise calling for software to remain open and free for programmers to modify, improve, share, and even "cannibalize" parts to make a new program. Stallman's main argument was that "computer users should be free to modify programs to fit their needs, and free to share software, because helping other people is the basis of society" (p. 18). Stallman's work represents another side of two camps existing today, one espousing proprietary ownership of not only software but also the Internet and users' access to it and the other espousing the belief that the Internet was created by the people[4] for the people and should remain open and free. The struggle between the two camps can be seen not only in the advertising world but also in "net neutrality" debates, which concern treating all Internet data equally as opposed to allowing some data to move at faster speeds based on user, site, and platform. The movement of data whether fast or slow has led to another concern: data collection and privacy. Another practice linked to advertising is the collection of huge data sets containing information about all aspects of the citizenry's lives. In other words, any piece of information shared over the cyberspace network is open to collection and analysis. As noted in *The Atlantic,* "Nearly every transaction or interaction leaves a data signature that someone somewhere is capturing and storing" (Furnas, 2012, p. 2). The information captured is known as *big data* and is used in the practice of data mining, which is a repetitive, iterative process in which specialized analytical methods (e.g., classification, regression, and clustering) are employed for pattern discovery and extraction (Fayyad, Piatetsky-Shapiro, & Smyth, 1996). The key component of data mining is *knowledge discovery in databases* (KDD), which is the process of converting data into knowledge that is for sale. One use of data mining is to formulate descriptions and predictions for practices such as the IRS's detection of atypical tax returns on a more sophisticated level, or for traditional companies' targeted

marketing purposes such as sending coupons based on the consumer's most likely time to shop (e.g., just after they are paid). Additionally, tech companies use information gleaned across social networking sites to guide designers in writing programs that encourage more engagement on the sites (Furnas, 2012). A reaction to rampant data collection has inspired the creation of a social network called *Diaspora* that mirrors the original design of the Internet, a network of networks. In the spirit of Richard Stallman's work, *Diaspora* gives its code away for free and invites other programmers to improve it. The goal of the site is to free users' data from the hands of big business (Dwyer, 2014). Magnus Enzensberger (1974) argued that one of the main interests of mass media is to expand and train consciousness in order to exploit it. For him, what was being abolished in today's affluent (high-tech) societies is not exploitation, but the citizenry's awareness of it. It is with Enzensberger's ideas in mind that this chapter argues that there is an urgent need for policymakers and other stakeholders to take bold steps toward producing a digitally literate citizenry.

A DIGITALLY LITERATE CITIZENRY

A digitally literate citizenry is a citizenry that is trained for conscious and critical participation in digital life, a participation that centers on cultural forms related to tangible artifacts, ontologies, and democratic expression. Concrete guidelines must take into consideration the issues raised in the following subsections.

Tangible Artifacts

To be most effective, digital media literacy must address both the conspicuous and the inconspicuous aspects of digital life. To unpack the conspicuous elements of design, user interface, and programming, all students must be taught computational thinking skills. "By computational thinking, I am referring to the "if, then" axiomatic thinking tradition that is characteristic of today's computer programmers" (Rosenfeld, 2015, p. 160). Although media scholars like Sherry Turkle (2009) argue for teaching programming skills, and the national curriculum in England now requires more rigorous computer science training (Department for Education, 2013), there is much more work to be done in tandem with computational thinking skills. Perhaps even more urgent is the need for advanced training in perceiving the barely perceptible. This includes imparting an understanding of how worldviews are shaped through new devices in a form of exposure ranging from highly manipulated selfies and "peer reviews" to raw, unfiltered images of war and terrorism. The citizenry needs to cultivate skills for reading these media in relation to truth, perceptions, social justice, and ethics, as well as rights and responsibilities in a digital, globalized world.

Another tangible reality is the information society's impact on the environment. There is an urgent need for ecopedagogy training, which focuses on how environmental degradation results from sociocultural, political, and economic inequalities, on the intrinsic value of all species, on the need to care for and live in harmony with the planet, and on human aesthetic experiences of nature (Kahn, 2010). However, there is also a need for an ecopedagogy that includes the problems of digital waste and its impact on the environment, countries, communities, and individuals. These problems include biological risks associated with varying levels of exposure for both the high-tech workforces of developing nations and their consumers. Finally, there is a need to weave training in globalization throughout an ecopedagogy,

and all digital media literacy, curriculum. New forms of waste and planetary abuses of both people and resources call for training in globalization in all its forms as well as its impact on the individual, social, cultural, and planetary level.

Ontologies

The very nature of how a person in high-tech society functions is shifting. Those living in a state of deep digital immersion might begin their day checking social networks and reading their news online while simultaneously texting and reading incoming emails and texts. They are accustomed to short communication bites in the form of tweets and texts devoid of visual and audio cues. This has in turn modified conversational skills, even moving some to experience discomfort in face-to-face or telephone conversations, and to a cultural shift in meaning, where the levity of a situation is signified by the method of communication (e.g., texting for less serious topics and face-to-face conversations for more serious topics).

The general population is now exposed to a different way of existing, through digital capabilities and the representations they project. The notion and images of war through satellite and social media capabilities (e.g., war footage uploaded to *You Tube* channels) has already been discussed, and the change is confirmed by the disturbing images of beheadings and other heinous activities disseminated by terrorist organizations. Beyond war and terrorism, a myriad of online communities such as those following extreme sports, politics, or various forms of fandom similarly expose users to new experiences. Virtual reality gear is also changing lived experiences, as personal computer users are able to utilize virtual reality devices to plunge into fully immersive computer-generated experiences such as space exploration and deep examination of the Egyptian pyramids, experiences that seem so real that users almost forget that these are virtual worlds (Goel, 2014). Virtual reality devices have the strong potential to alter storytelling, with the experience of a story shifting from a static, two-dimensional experience to a dynamic, three-dimensional ride (Suellentrop, 2014).

These new capabilities also pose risks such as flawed code that can subject users to great personal and financial risk, for example, the Heartbleed software bug that was used to steal passwords or the Shellshock software bug that could be used to take over a user's entire machine (Perlroth, 2014). Likewise, national and international hacking efforts pose a risk to both corporations and citizens as seen in the data compromise at Sony studios as well as at Anthem Blue Cross, a major health insurance provider in the US (Schmidt & Shear, 2014; Abelson & Goldstein, 2015). Furthermore, smartphones and other GPS devices subject everyday citizens to a variety of forms of privacy infringement, data mining, and tracking by various entities. As one example, car loan lenders can now remotely disable vehicles when buyers are late on a payment. This practice is used for subprime borrowers, who are required to have a "starter interrupt device" put in their car, which allows lenders to track the car's location and movements as well as initiate a digital repossession by disabling the car before the payment is legally deemed delinquent (Corkery & Silver-Greenberg, 2014).

Ideology is another aspect of online life that is not often discussed or readily recognized. The term was coined in 1796 by Destutt de Tracy to refer to the science of ideas. In the twentieth century, "the term has often been employed in a purely descriptive and non-pejorative sense, being used simply to refer to the set of beliefs, attitudes, standards of rationality, etc. that embody the basic values of some social group and that group's conception of the political order appropriate to those values" (Backhurst, 2010, p. 192). Although "ideology" has many meanings, this chapter refers to a form of consciousness caused by a presentation of reality by either those representing dominant interests (tech and corporate

capitalists) or egalitarian interests (open source movement). The ideology behind "free" in cyberspace has many interpretations. For those espousing democratic values, championed by Richard Stallman and the open source movement as previously described, *free* does not imply ownership for the user but rather indicates a genuine expectation of community contribution. In contrast, in connection with the proprietary values supported by most tech companies, *free* is understood as a trade. By consenting[5] to a tech company's terms of use, the user is allowed to make use of the software, application, or platform without paying. This consent, in turn, allows the company unfettered access to and ownership of users' data.

Bullying and exploitation also have new formats in virtual life. Cyberbullying, a term used to describe intentional and repeated harm inflicted through the use of computers, cell phones, and other electronic devices (Hinduja & Patchin, 2014), has received a great deal of attention in recent years due to the number of adolescents who have both reported such harassment and committed suicide over it (Collins, 2008; Hinduja & Patchin, 2010; O'Shaughnessy, 2011). According to a 2014 Pew Research Center report on US Internet users, 40% of all Internet users surveyed have personally experienced online harassment and 73% have witnessed it happen to others (Duggan et al., 2014). This phenomenon is not limited to the United States; the U.S. National Institute of Health studied the prevalence of bullying and victimization across 40 countries and found that although it varies in rate and intensity, cyberbullying occurs in all of them. Thus, the Institute deemed cyberbullying to be a universal public health problem that impacts large numbers of adolescents (Craig et al., 2009). Although bullying is not new among adolescents, its nature has advanced within cyberspace: It can happen "anywhere, anytime, among lots of different children who may never actually meet in person. It is inescapable and often anonymous" (Maag, 2007). The problem is aggravated by apps appropriated in order to harass others, such as *Ask.fm*, a website that lets people anonymously ask questions and leave comments. In 2013, nine teenager suicides were linked to bullying on the site (Bilton, 2014a). *Yik Yak*, another website that lets people post anonymously, has banned middle and high school students from using the site and has disabled its services around schools. Further, the selfie site *Shots* does not allow comments to be posted due to the cyberbullying problem (Bilton, 2014a). Some school districts have taken action against cyberbullying by hiring companies or using online tools to comb the Internet for signs that students are engaging in such behavior. However, the social and legal systems have not yet caught up with the problem, leading to debates about freedom of speech and the right to privacy (Sengupta, 2013). The cyberbullying problem has prompted social media sites to take steps to address this new reality. On *Facebook*, for instance, users can click on an icon to ask for the removal of a harmful post or photo and then provide information about what is happening in the post, how they feel about it, and how sad they are. In addition, they are provided with a text box containing a polite prewritten response that they can send to the person who hurt their feelings. The leader of this project, Arturo Bejar, believes that the success of social media largely depends on solving the cyberbullying problem (Bilton, 2014b).

Democratic Expression

New forms of exploitation are also occurring in the digital world. These include personal information being made public through social media, by criminals, and even by law enforcement agencies (Anderson & Rainie, 2010), as well as personal privacy cases involving cyberstalking (Zeller, 2006). Additionally, sexual predators use instant messaging and Web cameras to meet, lure, and digitally stalk children and share pornography (Brockman, 2006). Exploitation also includes *social engineering*, in which Internet users are tricked into downloading malware that can be used to extract financial gain. Social engineer-

ing messages often appear in e-mails that seem to be from friends and associates, greeting cards, and celebrity photos (Sengupta, 2012). Finally, the right to be anonymous is under attack, with individuals having their photos snapped or their behavior videotaped, uploaded, and gone viral without their knowledge or consent (Kaufman, 2014).

Society pushes back against exploitation through cyber-enabled social and political activism and new media tools. One example is FireChat, an app that enables smartphones to communicate with each other directly, without needing a cellular or Wi-Fi connection. This app was created in direct response to communication problems experienced during the Arab Spring,[6] when hours before a massive protest, the Egyptian government shut down the Internet and attempted to block cell phone texting services (Kanalley, 2011). Three years later, during the 2014 protests that erupted in Hong Kong, FireChat enabled continued connections despite challenges brought about by a strained network (Cohen, 2014). Anonymous, a leaderless, shape-shifting, international cyber activist group, and Wikileaks, a non-profit, global, free press journalism organization, further demonstrate empowerment through use of digital tools and the Web. Both are lauded as modern-day freedom fighters (M. Friedman, 2010; Gellman, 2012) and are equally despised as high-tech terrorists (Fogarty, 2011; MacAskill, 2010), regardless they are the expression of democracy in action. Digital media literacy itself also requires structure to build upon; frameworks should reflect democratic principles to address these growing literacy needs of high-tech populations.

Digital Media Literacy Frameworks

Numerous digital media literacy frameworks exist, often using slightly different terminology to describe the same phenomena. This section synthesizes some of the most well-known proposals for digital media literacy, found in the work of David Buckingham, Renee Hobbs, and UNESCO's José Manuel Pérez Tornero and Tapio Varis. Their combined recommendations advocate for digital media literacy to address the areas of use and access, critical understanding, production, the self, and Web citizenship.

Use and access to media stresses the importance of developing skills for finding and sharing relevant information using media texts and technology tools (Hobbs, 2011). Pérez Tornero and Varis (2010) have conceptualized access to include physical access to media and media content as well as the availability of media in a given setting. Pérez Tornero and Varis also include environmental factors: the educational system, the policies handed down by authorities, and the role of media in both of these.

Another key idea, critical understanding, is the ability to find and select information and then analyze the information, its representations, and the potential effects or consequences of messages as they relate to authority, reliability, and bias (Buckingham, 2006; Hobbs, 2011; Pérez Tornero & Varis, 2010). Critical understanding also includes what Pérez Tornero and Varis (2010) describe as "sophisticated" abilities, such as recognizing opportunities that are offered and using critical thinking, personal autonomy, and problem-solving capacities to understand conditions that are set by the media.

Production, which is at the heart of digital media, needs to be understood with respect to the creation, composition, and generation of content, including how messages can be created and produced using different codes and how they can be disseminated through different platforms. Thus, creative, expressive, semiotic, and social competencies must be taught as part of digital media literacy (Pérez Tornero & Varis, 2010). The understanding of production must also include a broader awareness of the global role of advertising, promotion, and sponsorship, and how these influence the nature of the information that is available in the first place (Buckingham, 2006; Hobbs, 2011). For Buckingham, such awareness should extend to noncommercial sources and interest groups, who are increasingly using the Web as a

means of persuasion and influence. It should also include knowledge about how sites are designed and structured as well as the rhetorical functions of links between sites (Buckingham, 2006).

Paramount to literacy, the self focuses on a need to decode how identity is influenced by media messages and technology tools via their impact on thinking and on behavior—for example, how users are guided or encouraged to navigate and how information is gathered about them (Buckingham, 2006; Hobbs, 2011). This area also includes an awareness of one's own position as a user, which requires understanding how media target audiences, the ideological and cultural orientations they promote, and how different audiences use and respond to new media (Pérez Tornero & Varis, 2010).

Finally, Web citizenship focuses on actions that can be taken on the Web to solve problems at the local, regional, national, and international levels (Hobbs, 2011). For Pérez Tornero and Varis (2010), this equates to fostering new values related to the ability to participate in global decision-making concerning the planet, cosmopolitan patriotism, and the dignity of humanity as a whole.

These ideas show that a great deal of work has already been done globally to delineate the area of digital media literacy. While these ideas are a good first step toward this end, they contain some blind spots that will be addressed at the end of this chapter. Theorizing is instrumental to build sound policies and see their implementation. An analysis of education policies will demonstrate how much is currently being done.

EDUCATION POLICIES IN PRACTICE

England's Computing Curriculum and the United States' Common Core

In a race to adapt education curricula to twenty-first century demands, both England and the United States have adopted new curriculum standards, and 2014 was the year of broad-scale implementation. Although both curricula make significant changes across many disciplines, this chapter's analysis concentrates on digital media literacy. Despite the fact that many citizens are simultaneously living in multiple realities (real, augmented, and virtual), neither of these curricula prepares the citizenry to consciously function within these parallel worlds—although, it should be noted, England has made greater strides than the United States toward this end. Thus, this analysis begins with the stronger of the two curricula. According to Michael Gove, England's education secretary, "Our new curriculum teaches children computer science, information technology and digital literacy: teaching them how to code and how to create their own programs; not just how to work a computer, but how a computer works and how to make it work for you" (Dredge, 2014). As outlined in the final draft of England's National Curriculum Framework (Department for Education, 2013), the overarching goal is to "equip pupils to understand and change the world through logical thinking and creativity, by making links with mathematics, science, design and technology" (p. 188). In this curriculum, *digital literacy* is defined as the ability to effectively, responsibly, safely, and critically navigate, evaluate, and create digital artifacts using a range of digital technologies. Digital artifacts can take many forms, including digital images, computer programs, spreadsheets, 3D animation, and other kinds of representations (Kemp, 2014). England's curriculum addresses digital literacy in a very direct, clear, and consistent fashion, yet leaves out one of the most important parts "media," as discussed earlier in this chapter. Likewise, the curriculum introduced in the United States only sparsely relates to digital literacy and also leaves out "media."

The United States Common Core standards were a response to more than a decade of poor performance compared to Japan, Russia, Singapore, and South Korea on a number of international assessments (Garland, 2013), as well as inconsistent curricula across states. As US Secretary of Education Arne Duncan stated, such standards should be "internationally benchmarked and include the knowledge and skills that students must learn to succeed in college and career" (2010, para. 2). The same rationale guided the creation of the Next Generation Science Standards[7], whose website acknowledges that "if the nation is to compete and lead in the global economy and if American students are to be able to pursue expanding employment opportunities in science-related fields, all students must have a solid K–12 science education that prepares them for college and careers" ("Next Generation," 2014). This is reflective of a recurrent position on literacy to promote shaping future workers rather than most importantly encouraging the need of such knowledge for intellectual enrichment and development of the individual as a citizen.

Consistent with Bowles and Gintis' view in *Schooling in Capitalist America* (1976/2011), such efforts are more concerned with meeting labor force demands than fostering personal liberation and equality. Furthermore, these efforts do not move the digital citizenry out of what Paulo Freire would characterize as the "oppressed." Freire notes that "any situation in which 'A' objectively exploits 'B' or hinders his and her pursuit of self-affirmation as a responsible person is one of oppression. Such a situation in itself constitutes violence, even when sweetened by false generosity, because it interferes with the individual's ontological and historical vocation to be more fully human" (1968/2000, p. 55). A comprehensive digital media literacy curriculum should not be adopted for the sole purpose of college and career readiness. Rather, such a curriculum has a democratic responsibility to free the citizenry from manipulation and traumatization within and through the digital world by fostering consciousness, self-reflection, and agency, thereby allowing citizens to be more fully human. For John Dewey, being fully human includes being a citizen and a true participant in the democratic process. Dewey argued that education should be transformative in order to foster a democratic citizenry and that education should progress alongside society (1916/2009). Modern-day progress calls for a Deweyan response in the form of digital media literacy.

Computer science and information technology are a part of digital literacy in both England's and the United States' curricula. England's computing curriculum is largely based on computer science, an argument built on the idea that studying computer science principles will help to ensure students are prepared for the digital world. Such literacy is achieved through three distinct strands of instruction: computer science, information technology, and digital literacy (Kemp, 2014). The rationale is that pupils who can think computationally are better able to conceptualize, understand, and use computer-based technology and are therefore better prepared for today's world and the future. In the United States Common Core curriculum, the focus is not very different, as all standards are anchored to college and career readiness. This becomes evident as one tries to untangle how the Common Core standards are organized.

The United States Common Core standards for English language arts (ELA), for example, comprise three sections: comprehensive K–5 and two content-area-specific sections for grades 6–12: one for ELA and another for history/social studies, science, and technical subjects. Each of these three sections is divided into strands: K–5 and 6–12 ELA have reading, writing, speaking, listening, and language strands, while the second 6–12 section has history/social studies, science, and technical subject sections that focus on reading and writing within these contexts. Each strand is headed by a strand-specific set of college and career readiness (CCR) anchor standards that are identical across all grades and content areas. In brief, a CCR anchor standard is a skill that high school graduates should have in order to be ready for entry into the world of work or postsecondary education. Anchor standards answer the ques-

tion, "What should a twenty-first century diploma holder be able to do in order to flourish?" Whether the context is kindergarten or 12th grade, an anchor standard is the target. Thus, all grade-specific standards map back to the anchor standards translating the broader CCR statement into grade-appropriate end-of-year expectations. It should be noted that none of the anchor standards directly address digital literacy ("Common Core," 2014).

The Common Core English/language arts standards discuss the strategic use of technology and digital media, as well as the incorporation of research and media skills into the standard (Marcoux, 2012). However, neither the Common Core nor the Next Generation Science Standards include a comprehensive curriculum that directly addresses digital literacy in a meaningful way. This is a tremendous oversight in the age of virtualization. Given the paucity of direction, many school districts supplement the Common Core standards with those from the International Society for Technology in Education (ISTE), a non-profit organization designed to help lead the transformation of digital education. Therefore, the ISTE standards are used as a basis for the present analysis and serve as a clear example of an external organization compensating for Common Core's inadequacies.

For the purpose of this chapter's analysis, Table 1 limits the comparison to the first two of four key stages in England's computing curriculum but includes all of the ISTE standards used in the United States, as these are less elaborate. Both standards treat technology as a tool to be used in society rather than as the humanistic reality that it is. However, England's computer science standards should be recognized for their focus on moving users from surface-level use to a behind-the-scenes understanding of how devices are constructed as well as the logic of how they are made to work. MIT scholar Sherry Turkle considers the same idea in her book *Life on the Screen: Identity in the Age of the Internet* (1997), where she discusses the simulation aesthetic by tracing the progression from DOS-based IBM computers that allowed users to "open the hood" and manipulate an operating system to Macintosh computers that replace this function with simulation via attractive and easily used icons that represent programs and documents. For Turkle, the move to simulation was a liability, not an asset. However, it should be noted that such icons represent an intuitive philosophy that enables self-discovery though accessibility, whereas everyday users may never utilize the "open-box" approach. It appears that England is taking a strong step back from the postmodern superficial acceptance of devices to Turkle's more modernist idea of depth. Teaching students how to understand computer algorithms, how to design, write, and debug programs, and how to understand computer networks enables them to answer questions that Turkle highlights, such as "What makes this work?" and "What's really happening in there?" (1997, p. 42). In the United States, the ISTE curriculum standards hint at this when they suggest teaching the concepts underlying hardware, software, and connectivity. However, these standards fail to provide specifics concerning the level at which these will be taught.

Table 1 also illustrates that both curricula call for students to be trained in a variety of applied technology uses. In England's curriculum, this training is described in terms of how to use technology purposefully to create, organize, store, manipulate, and retrieve digital content. It also includes training in the use of search technologies as well as selecting, using, and combining a variety of software applications (including Internet services) on a range of digital devices to create a wide range of programs, systems, and content that accomplish specific goals, including the collection, analysis, evaluation, and presentation of data and information. For ISTE, training in the uses of technology includes teaching students how to use computers and applications as well as how to use technology for research, critical thinking, problem solving, decision-making, communication, collaboration, creativity, and innovation.

Table 1. Comparison between two national computer technology curricula

Britain **Computing Curriculum***	**USA** **ISTE to Support Common Core****
Key Stage 1: **5-6 year old** **Computer Science** Understand what algorithms are; how they are implemented as programs on digital devices; and that programs execute by following precise and unambiguous instructions. Create and debug simple programs. Use logical reasoning to predict the behavior of simple programs. **Information Technology** Use technology purposefully to create, organize, store, manipulate and retrieve digital content. **Digital Literacy** Recognize common uses of information technology beyond school. Use technology safely and respectfully, keeping personal information private. Identify where to go for help and support when there are concerns about content or contact on the Internet or other online technologies.	**Key Stages:** **Scaffolds across age groups** **Computer Usage** Demonstrate proficiency in the use of computers & applications, as well as an understanding of the concepts underlying hardware, software, and connectivity. Demonstrate the responsible use of technology & an understanding of ethics & safety issues in using electronic media at home, in school, and in society. Demonstrate the ability to use technology for research, critical thinking, problem solving, decision making, communication, collaboration, creativity and innovation.
Key Stage 2: **7-10 year old** **Computer Science** Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts. Use sequence, selection, and repetition in programs. Work with variables and various forms of input and output. Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs. Understand computer networks including the Internet; how they can provide multiple services, such as the World Wide Web. Appreciate how [search] results are selected and ranked. **Information Technology** Use search technologies effectively. Select, use and combine a variety of software (including Internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analyzing, evaluating and presenting data and information. **Digital Literacy** Understand the opportunities [networks] offer for communication and collaboration. Be discerning in evaluating digital content. Use technology safely, respectfully and responsibly. Recognize acceptable/unacceptable behavior. Identify a range of ways to report concerns about content and contact.	

*http://www.computingatschool.org.uk/data/uploads/CASPrimaryComputing.pdf
**http://commoncore.fcoe.org/subject/technology

Although England's curriculum is clearly more sophisticated, both are centered on technology use and troubleshooting.

Finally, both curricula should be recognized for the steps they take toward training in digital literacy. England's curriculum teaches students to recognize common uses of technology outside of school as well as how to use technology safely and respectfully. Likewise, the ISTE curriculum requires that students be taught the responsible use of technology, including an understanding of the ethics and safety issues

involved in using electronic media at home, in school, and in society. However, these represent only an initial introduction to some of the most basic tenets of digital media literacy. The next section of this chapter outlines the level of training that is needed in this area.

In the case of both curricula, digital media literacy should extend to the creation, production, and dissemination of texts, images, and videos with special attention to social justice, fairness, and democracy. This chapter has made it clear that marketing strategies are making headway on the Web in areas related to privacy, authenticity, and truth. Brazilian educational theorist Paulo Freire argued that "leaders cannot treat the oppressed as mere activists to be denied the opportunity of reflection and allowed merely the illusion of acting, whereas in fact they would continue to be manipulated—and in this case by the presumed foes of manipulation" (1968/2000, p. 126). Both curricula are presumed foes of manipulation yet neither frees citizens from such manipulation. Similarly, Pérez Tornero and Varis (2010) stress that once the capacity for critical thinking has been acquired, the individual is independent and free to think autonomously without the control and guidance of 'guardians,' the authorities that, according to the definition proffered by Kant, "subjugate people's thinking by requiring them to accept veins of reasoning and points of view that are not theirs as their own" (as cited in Pérez Tornero & Varis, 2010, p. 80). A digital media literacy curriculum must provide users with the basis for sufficient autonomy and train them how to live in an absorbing media and technological environment.

Recommendations

These aims are best achieved by teaching citizens to employ logic, critical thinking, rhetorical analysis, discourse analysis, and dialogical skills to uncover and evaluate all aspects of digital life, including the objects individuals use, how they are used, and their implications for personal and social ontology, and to recognize cyberspace as another reality that is both separate from and embedded within real-life reality. Additionally, the barely perceptible aspects of digital life, such as the roles that satellites and ringtones play in social, economic, and cultural life, must be recognized and evaluated, along with the broader area of new forms of waste and planetary abuses of both people and resources, which calls for training in globalization in all its forms and its impact on the individual, social, cultural, and planetary levels.

As a first step in addressing the quality of training in these areas, it will be useful to revisit the Royal Society's notion of an academic discipline and demonstrate how their criteria for a discipline apply to digital media literacy as defined in this chapter. The five distinctive characteristics of a discipline are that it has: a body of knowledge, rigorous techniques and methods, a perspective on the world, a stable set of concepts, and independence from existing technologies. This chapter has shown that digital media literacy includes a large body of interdisciplinary knowledge grounded in work in philosophy, sociology, media studies, communications, anthropology, and education. Moreover, several national and international organizations, collectives, formal institutions, centers, and institutions are working in the field (Pérez Tornero & Varis, 2010) such as the National Association for Media Literacy Education (NAMLE), the Action Coalition for Media Education (ACME), Media Awareness Network (Canada), and the European Media Literacy Forum. This chapter has also demonstrated that the production of knowledge within this field uses rigorous techniques and methods including critical inquiry, critical ethnography, rhetorical analysis, discourse analysis as well as qualitative and quantitative studies. Through its recognition that digital media literacy addresses the needs of an immersed digital population, it provides a perspective on

the twenty-first-century world. This is corroborated by the work of global organizations such as UNESCO and the Global Alliance for Partnerships on Media and Information Literacy, both devoted to promoting national and global media and information literacy (MIL) policies. Additionally, the field of media literacy has a stable set of concepts centered on the ideas of production, distribution, and consumption of media texts. These concepts can be found in the literature and on the websites of several organizations, including the National Association for Media Literacy Education (NAMLE). Finally, the field of digital media literacy is independent of specific existing technologies. Although the focus of its analysis falls within digital life, its subject and methods adapt to meet the changing digital landscape. Because digital media literacy meets the five characteristics of a discipline, it should be recognized as not only a skill but also as a discipline. Such recognition may spur education policy makers and other stakeholders to push for a more comprehensive and sophisticated digital literacy curriculum. Furthermore, agreement on this point would better ensure the inclusion of digital media literacy in twenty-first-century curricula and would extend its conceptualization beyond a mere collection of skills to include philosophical and humanistic training in how to navigate the land mines of the digital age.

The suggestions provided in this chapter align with the existing digital media literacy frameworks but also provide some new ideas for inclusion. The existing principles of the self and Web citizenship can be augmented in several ways. The recommendations for the area of the self-need further development with respect to critically analyzing digital vulnerabilities, including how digital objects are used, how they implicitly guide behavior, and the ways they shape personal and social ontologies, thoughts, and actions. Web citizenship should better cover the ethical, democratic, and fair creation, production, and dissemination of texts, images, and videos with special attention to social justice, fairness, and democracy. The rampant problems of cyberbullying, exploitation, and images of terrorism and war each call for more concentrated training in this area. Additionally, a stronger case needs to be made for training in social justice related to environmentalism and globalization in connection with new forms of waste and planetary abuses of both people and resources. This, in turn, calls for training in globalization in all its iterations and its impact on the individual, social, cultural, and planetary levels.

Two additional areas, nature of reality and critical consciousness, would bring additional depth to the digital media literacy tenets already presented. Nature of reality should be added because guidance is needed for how to live one's life in complex, dual realities (real and virtual) that are not mutually exclusive—for while some aspects may reside in only one or the other of these realities, other aspects cross over. Because this is a new way of living life, training and theorizing are needed to understand its impact on the human condition, including an examination of empowerment, disenfranchisement, and abuses. Critical consciousness training is needed to combat the fact that all actions and transactions in cyberspace are subject to persuasion, manipulation, and even exploitation in the form of sophisticated, inconspicuous, and carefully targeted marketing, impersonation techniques, and other forms of influence (such as cyberbullying and catfishing[8]). Furthermore, privacy, truth, and authenticity are being recalibrated with a population that implicitly acquiesces to infringements and truth manipulation as a fact of online life. Complacency about privacy violation and misrepresentations of the truth, whether these be in images, video, or text, must be challenged by providing guidance on how to think about and deconstruct such practices. Under these new areas, citizens should be taught to employ logic, critical thinking, rhetorical analysis, discourse analysis, and dialogical skills to uncover and evaluate all aspects of digital life, including its barely perceptible aspects and how they influence social, economic, and cultural life.

CONCLUSION

This chapter set out to clarify digital media terms, map the changing landscape of society due to digital life, explore current digital media literacy frameworks, policies, and practices, and suggest areas in need of strengthening. Examining discrepancies in understandings of digital media literacy related to whether it should be considered a skill, a discipline, or both, this chapter mapped several definitions of digital media literacy. These definitions include those of computer scientists and critical theorists to establish that digital media literacy extends far beyond training in media use. This chapter also established that the need for meaningful, persistent, and sophisticated media literacy education is global, as evidenced by the efforts of UNESCO and other international organizations. The chapter aligned traditional media literacy constructs with the digital world to demonstrate the extent to which society has changed in the digital media landscape, providing the reader with insights into ideologies and ontologies related to twenty-first-century production and distribution practices as well as audience participation. All of this points to the need for comprehensive training in digital media literacy.

An analysis of recent curriculum changes in England and the United States revealed that more must be done to prepare, and in doing so protect and empower, a digitally literate citizenry. Although the current digital media literacy frameworks posited by Buckingham, Hobbs, and Pérez Tornero and Varis represent a strong starting point, this chapter argued that some areas of the frameworks need further depth and that additional areas are needed. A strong step in this direction would be to establish in the minds of stakeholders the idea that—as this chapter has argued—digital media literacy is indeed a discipline.

It is especially troubling that both England and the United States rewrote their national curricula with very little attention paid to media literacy for humanity. This oversight might have been excusable during the first decade of the twenty-first century when capabilities on the Internet were at a less sophisticated level; however, in the second decade it is irresponsible. The training these curricula provide, although valuable, keeps the digital citizenry in the position of users rather than fostering broader dialogues and thinking skills around how to live, navigate, and participate in the digital world. It is particularly disappointing that the United States' Common Core curriculum provides so little guidance in this area that many districts are turning to an outside organization for guidance. All of this is quite inexcusable in the present day, and points to the fact that neither of these high-tech societies fully understands that the information revolution is not just about means of economic production. Rather, the information revolution is about the creation of new and altered cultural forms, new ontologies, new iterations of manipulation and exploitation, and perhaps most importantly, a changed citizenry in need of training. This chapter contributes to formalizing the digital media literacy conversation by presenting criteria that complement and supplements the existing theoretical frameworks. This is only a beginning, with the door just opening to an embedded future where digital media literacy will be at the forefront and center of the digital debate.

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KEY TERMS AND DEFINITIONS

Barely Perceptible: According to Lisa Parks, the unnoticed aspects of digital life.

Conversation Marketing: A strategy that involves understanding who customers are, who influences them and how to engage with those influencers.

Cultural Forms of High-Tech Society: The ideologies, struggles, polysemic interpretations and symbol manipulations associated with tangible artifacts as well as the intangible areas of capabilities, habits, and ontologies.

Cyberbullying: Intentional and repeated harm inflicted through the use of computers, cell phones, and other electronic devices.

Earned Influence: Positive perceptions achieved through efforts made in such realms as social media.

Influencer: A relatable, Internet-popular microcelebrity who sponsors products with the intent of influencing fan followers' buying habits.

Microcelebrity: A person who has established his/her presence on the Internet through blogging or posting original content that has gone viral and generated a fan following.

Pro-Am: An innovative, committed, and networked amateur working to professional standards.

Selfie: Photograph taken of oneself, typically one taken with a smartphone or webcam and uploaded to a social media website.

Sexting: Subset of the selfie, sexually explicit photos of oneself shared through a smartphone.

ENDNOTES

1. The Royal Society's comprehensive 2012 report titled "Shut down or restart? The way forward for computing in UK schools" analyzed the current state of computing education in England's schools and presented recommendations for improving the situation, many of which serve as the basis for England's 2014 computing curriculum.
2. NAMLE's digital literacy standards are used by many US school districts to supplement the Common Core standards.
3. Sexting refers to sending sexually explicit photos of oneself or others via digital electronic devices.
4. The Internet was created by governments (The United States, Great Britain, France) and spearheaded in the US by the Department of Defense, resulting in the creation of the ARPANET, which would become the Internet.
5. Terms of services are so dense and convoluted that most users do not read them.

[6] Beginning in the spring of 2010, a wave of demonstrations and protests spread across several Arab states and eventually toppled governments.

[7] The Next Generation Science Standards (NGSS) were developed by The National Research Council (NRC), the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve (an independent, nonpartisan, nonprofit education reform organization). The NGSS are the science equivalent to the Common Core for English and math.

[8] A catfish is someone who pretends to be someone else by using social media to create a false identity, particularly for pursuing deceptive online romances (Sbacker, 2010).

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Chapter 2
Multimedia Transmission in Wireless Sensor Networks

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ABSTRACT

Wireless sensor networks are an emerging technology that can provide valuable information for a large series of monitoring and control applications. Comprising many monitoring scenarios with different particularities, as industrial management, weather forecasting, home automation, traffic management and rescue operations, just to cite a few, wireless sensor networks bring many possibilities for innovative applications that cannot be addressed by conventional wireless network technologies. When sensors are equipped with cameras or microphones, multimedia data can be retrieved from the monitored field, enriching the perception of the target area. However, the constrained nature of wireless sensor networks imposes many challenges to multimedia transmission, fostering development of optimized protocols. In this chapter, we present the state of the art of multimedia transmission in wireless sensor networks, covering topics as routing, error control, congestion avoidance, real-time delivery, compression and QoS, potentially supporting in the development of wireless multimedia sensor networks.

INTRODUCTION

In the last years, Wireless Sensors Networks (WSN) have been considered for a large series of monitoring and control applications. Employing tiny devices for sensing of some specific information, like temperature, pressure, humidity and luminosity, these networks have fostered the development of innovative ap-

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plications for industry, home automation, healthcare assistance, weather forecasting, traffic management, battlefield surveillance, tracking, among many other monitoring scenarios (Yick, Mukherjee & Ghosal, 2008). Typically, sensor nodes in WSN are disposable electronic devices commonly equipped with a transceiver, a limited energy supply, a sensing unity and memory and processing resources, although additional modules can be found, allowing distributed information monitoring. However, in order to reduce costs for massive deployment and diminish energy consumption, resource-constrained sensors are expected to be deployed, bringing many communication challenges.

One innovative nature of wireless sensor networks is the possibility to retrieve relevant information from regions with absent infrastructure. In such way, wireless sensor networks could be deployed in wide, hostile or even hard access areas. For that, however, sensors will communicate in an ad-hoc manner where data packets will flow through multiple hops from source nodes toward the network gateway (*sink*). As there is no central unit to coordinate and control communications, sensors are also expected to be self-organizing and protocols must be processed in a distributed way. Due to the inherent constraints of sensor nodes, however, protocols requirements must comply with limited processing, memory and energy resources; energy constraints limit the wireless communication range and inflict controlled use of transmission and processing functions.

For a large group of applications, scalar data gathered from wireless sensor networks are insufficient, even if a large number of sensors is deployed. In order to enrich the retrieved information, sensors may be equipped with inexpensive low-resolution CMOS cameras and/or microphones, allowing multimedia data retrieving. The resulting *Wireless Multimedia Sensor Networks* (WMSN) enhance the understanding of the physical world, by improving monitoring and control applications (Almalkawi *et al.*, 2010).

In general, multimedia transmissions in wireless sensor networks are more stringent than transmissions of scalar data as humidity and temperature, imposing many challenges. And although optimized solutions may be employed, processing and memory constraints may impact the use of buffering techniques by communication protocols, as well as the execution of compression and entropy codes. Such complex scenarios have demanded protocols and algorithms that must be optimized for the particularities of multimedia transmissions in these networks (Akan, 2007).

A typical heterogeneous wireless multimedia sensor network is presented in Figure 1. Visual and audio sensors will retrieve information with different particularities, requiring differentiated services to be provided by the network.

Usually, multimedia transmissions in wireless sensor networks must be energy-efficient and scalable. However, some applications may also require timeliness, transmission fairness and error resilience. The monitoring requirements of the sensing applications will typically define the expected transmission services, which will be associated with some general characteristics, as summarized in Table 1.

As discussed before, multimedia sensor applications may have different transmission requirements. And such requirements do not depend exclusively on characteristics of the deployed sensors and of the monitored field, but also on the expected processing that will be done over the retrieved multimedia data.

MULTIMEDIA MONITORING IN SENSOR NETWORKS

Wireless multimedia sensor networks are an emerging ad-hoc network technology that employs autonomous sensors equipped with a low-power camera and/or microphone to wirelessly retrieve multimedia

Figure 1. A typical wireless multimedia sensor network (source: wmsn.tif)

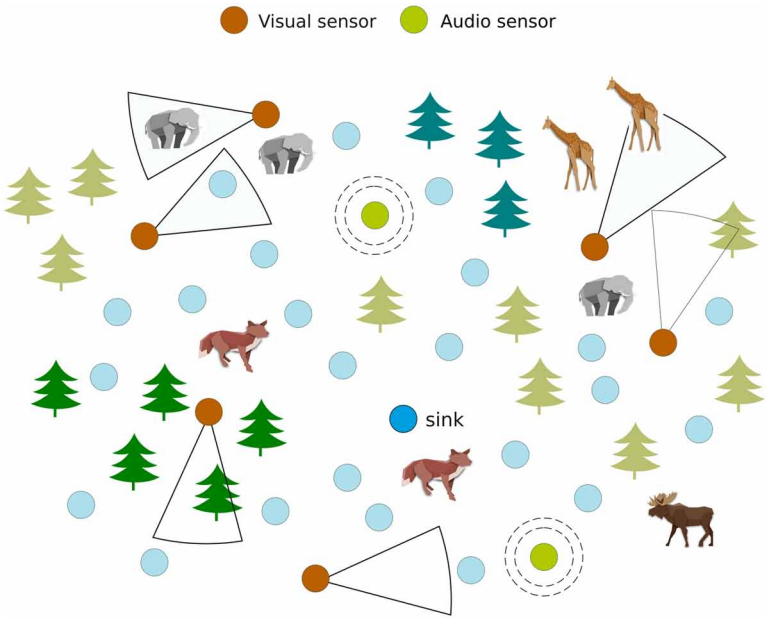

Table 1. Main transmission requirements for WMSN

Transmission Requirement	Short Description
High bandwidth	Some applications many require high transmission bandwidth, especially when visual sources are streaming video. High throughput may severely compromise the energy resources of the network.
Timeliness	Real-time monitoring applications may expect data delivery with time constraints. Critical monitoring applications will often rely on real-time data delivery.
Error resilience	Multimedia sensors may have different relevancies for applications, where high-relevant sources may require error-resilient transmissions. Error recovery may also be required for parts of encoded multimedia data (Costa & Guedes, 2011).
Quality of Experience	The user perceptions of the monitored data depend on many characteristics, but different applications may have different quality thresholds. The network design and operation should try to address such thresholds.

data from the monitored field. The retrieved visual or audio information can be used to compose the monitored information for many surveillance, tracking and control applications. As heterogeneous sensors may be deployed, scalar information, still image, video streams and audio may be available for processing or storage, enlarging the possibilities when developing automatic monitoring and control systems.

There are some general principles of multimedia monitoring, when employing wireless sensor networks. In fact, the way multimedia information is sensed and transmitted will dictate how the network will deal with multimedia data packets. Multimedia data can be roughly divided in three different categories: audio stream, still image and video stream. Audio typically represents human voice or a relevant noise for the application, with transmission rate usually lower than 64kbps. Still images are snapshots of the monitored target or scene, while video represents a continuous viewing created by a greater number

of frames (images), providing a motion sense. In such way, video streams usually demand more communication bandwidth than transmission of still images, turning more stringent video streaming over wireless sensor networks.

Audio Sensing

Sensor nodes may be equipped with a low-power microphone to monitor audio from the monitored field. The retrieved audio may be human voice or some relevant noise for the monitoring application. Generally, the microphone embedded in audio sensors will define an omnidirectional sensing area, resembling scalar sensors. Hence, the sensing and communication ranges are equivalent, which will be, in theory, a circular area.

The sensing paradigm is relevant when computing coverage optimization, sensing redundancy, data compression and localization. Neighbor sensors with omnidirectional sensing areas are likely to retrieve equivalent information, potentially leading to a relation of redundancy. As redundant information may also be exploited for compression and data merging, audio transmission in wireless sensor networks may benefit from the way audio is sensed from the monitored field. Moreover, depending on the network deployment density, transmission errors may be compensated by concurrent transmissions from redundant nodes.

Visual Data Sensing

Camera-enabled sensors retrieve still images or video streams from the monitored field following a directional sensing model. The embedded camera will have a viewing angle, an orientation and a depth of view (Costa & Guedes, 2010), which will define a sector-like area referred as the Field of View (FoV). Thus, visual sensors define a directional sensing of the monitored field, but they communicate according to an omnidirectional communication range.

In practical means, visual sensors will have a unique perception of the deployment area, and two neighbor sensors are likely to retrieve different information. This characteristic changes the perception of sensing vicinity and redundancy, impacting coding, compression and coverage mechanisms. Moreover, the uniqueness of visual sensing makes error resilience a required service, especially when visual sensors are retrieving information from critical monitoring areas.

Data Retrieving

Besides the sensing principles of multimedia data, the application monitoring requirements may also guide the way multimedia will be transmitted in wireless sensor networks. Generally, such monitoring requirements will be associated to characteristics of the deployed sensors and of the monitored field, besides expected uses of the retrieved multimedia data.

While many sensor network applications require passive sensing and reporting, there is a growing need to support real-time streaming. If retrieved information will be used to trigger some action, as for example in an intrusion detection system or in industrial control, multimedia data should reach the network sink as soon as possible, in order to not compromise the effectiveness of the multimedia sensor network. Such applications typically require relatively high bandwidth utilization and impose severe constraints on transmission latency.

Some applications may define a maximal acceptable latency for multimedia data, but such latency may vary according to the type of the sensed data. Zhang *et al.* (2008) propose a mechanism for multipath routing exploiting the relevance of the encoded data for efficient path selection regarding the end-to-end communication delay of transmission paths. In that work, the source stream is split into visual data and audio substreams, giving to each resulting substream a particular priority according to the current monitoring being performed. In other words, the application will have different requirements for transmission latency according to the nature of the retrieved data. For example, in fire monitoring, visual information is more relevant for the application and the audio stream could be transmitted over transmission paths with higher average end-to-end delay (worst paths). Real-time requirements can also be defined concerning scalar data and the network should try to address the transmission requirements in order to keep the monitoring quality in an expected level. In a different perspective, real-time requirements may be set for any source nodes, regardless of the type of sensed data (Costa & Guedes, 2013).

Real-time delivery is not only related to transmissions through paths with lower average end-to-end delay, but also to the processing parameters in intermediate nodes. Sensor nodes may implement some QoS policy when relaying packets, providing faster transmission for high-relevant data. This will be usually performed employing prioritized transmission queues. When facing congestion, such QoS-based queues would be also useful to preserve real-time requirements.

However, for some wireless multimedia sensor networks, real-time transmissions may not be required. For example, some applications may retrieve multimedia data for storage or offline processing. Typically, such applications will be most concerned with energy-efficiency for network lifetime prolonging.

Besides timeliness, the way sensed data is retrieved will directly impact multimedia transmissions. Multimedia sensors may be idle for long periods of time, but they may suddenly start transmission of sensed data when they are requested. Such a behavior can be also expected when an event occurs or when sensors are scheduled for periodic transmission bursts. These three data retrieving paradigms are shortly described as follows:

- **Query-Based:** The sink may request data transmission from source nodes at any time during the network lifetime, and the requested sources will strive to attend the solicitation. For that, some specialized query message should be transmitted to some or all source nodes, requesting data transmission. Of course, query-based transmission may cause congestion in relaying nodes when the transmission rate of source nodes suddenly increases.
- **Triggered-Based:** Multimedia transmissions may be triggered by the occurrence of some relevant event, as fire, an accident or unauthorized penetration into a monitored area. Typically, only source nodes that can sense regions affected by the event will start transmission (or increase current transmission rate), but applications may define any monitoring behavior.
- **Clock-Based:** Sensor nodes may be configured for periodic transmission of multimedia data. For example, some nodes may be scheduled to transmit one image snapshot every second, continuously. In a different way, such schedule may indicate periods of time for transmission of sensed data, interleaved by idle intervals.

All these three paradigms may also impose different demands for real-time transmission, according to the application monitoring requirements. In fact, low transmission latency and jitter may be required for any type of data retrieving paradigm, and even triggered-based transmissions may be performed

without time constraints, in the case a fast response is not required for the monitoring application. Once again, definitions concerning the expected transmission service must always consider the particularities of each monitoring and control application, in order to achieve higher transmission efficiency.

MULTIMEDIA CODING

Wireless multimedia sensor networks may be employed to retrieve any combination of audio, still images, video streams and scalar data from an area of interest. Specialized source nodes may be deployed to retrieve a particular type of data or multipurpose sensor nodes equipped with a low-power camera and a microphone may be employed, resulting in different configurations of homogeneous or heterogeneous networks. Whatever the case, when multimedia information is sensed from the monitored field, the way audio, image and video will be encoded and compressed will impact the transmission rate, the energy consumption and packet relaying over sensor nodes.

Sensed multimedia data have to be digitalized and packetized before transmission through the network. When received at the destination, the media is converted back to its analog form, preferably as close as possible to the original media. This coding process is performed by specialized multimedia codecs.

Different media types require different codecs, which will exploit the particularities of the media to achieve more efficient data compression. As sensor nodes are resource-constrained and battery-operated, the employed codec should not be complex enough to drain the processing, memory and energy resources of source nodes. On the other hand, high compression efficiency will reduce the amount of information to be delivery over relaying sensors, potentially reducing energy consumption for data transmission. However, higher compression efficiency requires higher computational power. This tradeoff should be properly handled in wireless multimedia sensor networks, according to the expected transmission throughput, error resilience, end-to-end delay, energy consumption and quality of reconstructed media at the destination.

In general words, multimedia codecs employed in traditional Internet-based networks should be used carefully in wireless sensor networks, since they are not designed for energy efficiency. In fact, there are three main design issues that should be considered when employing multimedia codecs in sensor networks, as follows:

- **High Compression:** Uncompressed raw multimedia data requires high transmission bandwidth. As energy efficiency will be a major concern in most cases, lossy or lossless compression should be applied over sensed data.
- **Error Resilience:** Wireless links are error-prone, especially in noisy environments. The employed coding technique should provide some error resilience, improving the attainable quality of transmitted multimedia data.
- **Low Complexity:** Multimedia encoding is performed by source nodes, optionally using some additional sensors to share the processing burden. However, sensors are expected to be resource-constrained. High-complex codecs may demand excessive energy consumption or be even prohibitive. Thus, such codecs should be avoided, even if they achieve high compression rates.

For many codecs, processing will be done at the origins, what may rapidly deplete the resources of source nodes. As an alternative, multimedia data may be encoded in a distributed way, employing many

nodes to process an amount of information. An example of how distributed visual data compression may be exploited in wireless sensor networks is described in (Wu & Abouzeid, 2005). That work argues that individual nodes may not have sufficient computational power for source encoding of all collected visual data, especially for large images, turning in-network image compression potentially advantageous. And even if source nodes can satisfactorily handle image compression, distributed in-network processing may provide fairer energy consumption when exploiting idle nodes. Nevertheless, when all or part of raw multimedia data is compressed by nodes other than the source, specialized protocols have to be employed to deliver the tasks among the nodes and coordinate the distributed compression.

Another strategy to reduce energy consumption is shifting the processing burden to the destination (*sink*), which is expected to be resource-full. In the Distributed Video Coding (DVC) technique, the encoders are less complex than the decoders. The main idea of codecs based on distributed video coding is to consider the source statistics at the decoder, exploiting spatiotemporal information in data retrieved by multimedia sensors (Aaron *et al.*, 2004).

Each type of media will require different coding strategies. For example, images may be encoded using progressive or wavelet-based algorithms, while many popular video codecs are based on predictive coding to achieve compression exploiting the motion nature of video streams. For audio coding, the monitoring requirements will indicate what type of audio should be retrieved, since some relevant noises may be outside the frequency that can be discerned by humans (and considered by voice codecs). In such way, codecs for VoIP applications may be not effective for some audio monitoring, unless properly adjusted.

Table 2 lists some of the most popular multimedia codecs that can be employed in wireless multimedia sensor networks.

Besides the employed codec, some coding parameters will also affect multimedia transmission in WSN. Still images may be colored or grayscale, where a pixel may be typically represented by 1, 2, 3, 4 or 8 bytes. Transmission of 64-bit colored images will usually demand much more communication bandwidth and energy than transmission of 8-bit grayscale images. Moreover, visual data may be represented in different resolutions, where images or videos will be typically small due to the resource-constrained nature of wireless sensor networks. Table 3 presents some common formats for images and videos in WSN, that are variations of CIF (Common Intermediate Format) and VGA (Video Graphics Array) resolutions.

Table 2. Some popular multimedia codecs

Codec	Media	Short Description
JPEG	Image	Codec exploiting Discrete Cosine Transform (DCT) for efficient lossy compression.
JPEG2000	Image	Codec exploiting Discrete Wavelet Transform (DWT) for more efficient lossy compression.
H.263	Video	Video transmission for low-bit rate networks.
H.264	Video	Codec very suitable for video streaming, supporting low-bit rate transmission and better error resilience.
G.711	Audio	Uncompressed voice codec for high-quality audio transmission
G.726	Audio	Audio codec for digital telephony with acceptable high quality at low transmission rate.

Table 3. Common resolutions for image and video in WSN

Format	Resolution (Pixels)
SQCIF	128 x 96
QQVGA	160 x 120
QCIF	176 x 144
SCIF	256 x 192
QVGA	320 x 240
CIF	352 x 288
VGA	640 x 480
4CIF	704 x 576
16CIF	1408 x 1152

When streaming video, another relevant coding parameter is the number of frames per second (fps). Higher video quality will be typically achieved for higher values of fps, but more packets will be transmitted over the network when more frames per second are used to encode video. A reasonable value for fps can be borrowed from videoconference systems in Internet, where 15fps is the minimal recommended value for video streaming. However, visual monitoring by sensor networks may have different requirements of video quality, due to the limitations of multimedia transmissions in WSN.

In short, the desired quality of received data by the sink will vary according to the monitoring applications, but it is reasonable to conceive that many applications will only need low-quality versions of audio, image and video, especially when sensed multimedia data is used only to complement scalar information.

TRANSMISSION PROTOCOLS FOR WIRELESS MULTIMEDIA SENSOR NETWORKS

Transmitting multimedia data in WSN is indeed a challenging task, either due to the large amount of data to be transmitted or due to the real-time nature of some multimedia monitoring applications. Nodes are resource-constrained, imposing demands for energy-efficiency and limiting the use of complex algorithms. Therefore, when designing protocols for wireless multimedia sensor networks, there are some principles that must be properly considered, guiding the development of MAC, routing and transport layer protocols.

MAC Protocols

Wireless multimedia transmissions may demand high bandwidth and low latency, which may be accomplished employing appropriate MAC protocols. The natural solution for wireless sensor networks was to use IEEE 802.11 protocol to provide MAC services, especially due to its high transmission rate. In fact, 802.11 standard is suitable for multimedia transmissions, but it is not designed for energy efficiency.

In such way, it is expected that modern wireless sensor nodes will communicate employing protocols whose major concern is energy preservation.

Energy saving is usually achieved alternating active and inactive periods of transmission. A sensor node will periodically sleep to reduce energy consumption, waking up for packet transmission and reception. This behavior is required because energy is consumed even when sensors are in an idle listening state. Of course, such procedure will reduce the network throughput, potentially impacting multimedia transmissions. Protocols as IEEE 802.15.4 (Baronti *et al.*, 2007) and T-MAC (Dam & Langendoen, 2003) define dynamic sleeping periods for wireless sensor networks, but they have no special concern for multimedia content. When images and other multimedia data have to be transmitted using commercial sensor motes, a big challenge is then to adapt the reduced communication bandwidth (IEEE 802.15.4 supports a maximum transmission rate of 250 kbps) to the transmission requirements of multimedia sensing.

When multimedia transmissions became a design challenge for wireless sensor networks, MAC protocols were extended to copy with the new presented requirements. For example, IEEE 802.15.4 standard defines a TDMA GTS (Guaranteed Time Slot) for fast transmission without previous request for transmission slots. For multimedia transmissions, these slots could be exploited to assure some level of real-time data delivery and there are some investigation works that propose extensions on GTS for higher throughput (Koubâa *et al.*, 2008).

Routing

There are many issues related to packet relaying and routing in wireless sensor networks that may particularly affect multimedia transmissions. Source nodes will transmit packets through single or multiple multihop paths toward the sink. A relevant issue for multimedia transmission is to select the best transmission paths, concerning throughput and latency. In general, there are two different types of transmission paths available for WMSN. First, one intermediate node may belong to more than one path, depending on the nodes position after deployment and the available paths discovered by the routing protocol. In such case, nodes will process traffic from more than one source, composing braided-paths. A different approach is to model node-disjoint paths, where intermediate nodes will be dedicated to a specific traffic. Some specialized protocols are used to define transmission paths, following different approaches (Abazeed *et al.*, 2013). And each of these paths will have different impacts on multimedia delivery in sensor networks.

For multimedia transmissions, multiple node-disjoint paths are a reasonable option to achieve high throughput in wireless sensor networks. In (Zhang *et al.*, 2008), the proposed algorithm finds the best paths for multimedia streaming in WSN, considering a set of available node-disjoint paths, where the best paths are those with lower end-to-end transmission delay. Doing so, efficient load balancing is performed to increase the attainable transmission bandwidth. In a different way, when employing braided-paths, prioritizations algorithms may be used to guarantee efficient multimedia transmissions, acting in relaying nodes that receive traffic from more than one source node.

In this context, a very relevant issue is packet prioritization. In short, prioritization approaches may be based on local or global QoS. In local QoS, the relevance is valid for a limited scope. For example, some parts of encoded multimedia data may have higher relevance for the reconstruction process, as in DWT-based images. When regarding global QoS, however, the defined levels of relevance have significance that is valid for the network as a whole, as for example when sensors are differentiated by their potentials to retrieve significant data for the monitoring functions of the considered application (Costa &

Guedes, 2013). Whatever the case, the QoS of transmitted packets may be considered in relaying queues of intermediate nodes, for prioritized transmissions. Such a prioritization would then benefit transmissions with time constraints or even avoid congestion and subsequent packet dropping.

Transport Protocols

In a different way of transport protocols in Internet, transport protocols for wireless multimedia sensor networks must be designed for energy-efficiency and, optionally, for error-resilient transmissions with low delay and jitter. Moreover, well defined concepts as end-to-end transport-layer communication should be revised in order to achieve higher efficiency. Transport protocols in WSN may operate in a hop-by-hop basis, where intermediate nodes can process packets during transmission.

Transport protocols for wireless multimedia sensor networks are mainly designed to support congestion control, loss recovery or both services, according to the applications monitoring requirements. Congestion control may be performed only on congested nodes or over an entire communication path to face the cause of congestion or even to relieve congested nodes dropping excessive packets. In some cases, the dropping policy may regard the relevance of data packets, firstly choosing to discard lower relevant packets. Furthermore, loss recovery by transport protocols may be available to compensate packet losses during transmissions. In short, transport protocols may retransmit corrupted packets, may send redundant duplicated packets or employ correction codes.

When intermediate nodes or wireless links get congested, multimedia communications may experience packet dropping, transmission delay and energy depletion. In WSN context, congestion mitigation may be classified in three categories (Costa & Guedes, 2012): (1) Rate adjustment, (2) load distribution and (3) congestion avoidance. In rate adjustment, the transport protocol tries to reduce the current transmission rate in order to relieve congested nodes or the communication path(s), probably reestablishing the original rate after congestion. In a different way, the load distribution approach may increase the transmission rate over paths that are not congested, decreasing the load at congested path(s). At last, congestion avoidance strategies try to anticipate a congestion situation, changing the current transmission configuration. A practical way to predict or detect congestion is checking the relaying queue of intermediate nodes (Yaghmaee & Adjeroh, 2008).

Typically, packets are dropped when the network faces congestion, when bit-errors occur during packet transmission over wireless links or when intermediate nodes fail or run out of energy. After loss detection, error recovery may be employed through retransmission, redundancy or correction codes. When packets are dropped, the sink or intermediate nodes can request the retransmission of the packets carrying the lost data, in an end-to-end or hop-by-hop fashion. In WSN, hop-by-hop retransmissions may reduce energy consumption avoiding undesired transmissions through some multihop links. In a different way, redundancy will add information in advance, either into data packets (as an additional header) or creating replicated packets. Replicated packets increase the probability of successful packet reception, but they also increase energy consumption (Naderi *et al.*, 2012). When redundancy is implemented adding information into data packets, correction codes are employed in different levels of complexity, where corrupted packets may be recovered processing the codes (employing, for example, Reed-Solomon algorithms).

Camera-enabled sensors are likely to have a unique view of the monitored field, turning error recovery into a desired service in order to preserve sensed information. Moreover, motion compensated video coding is especially sensitive to loss because of temporal error propagation. Thus, visual monitoring will be usually more concerned with error recovery than audio streaming in wireless sensor networks,

since neighbor audio nodes may often retrieve equivalent information and many audio codecs provide some error resilience.

Whatever are the provided services, transport protocols for multimedia transmissions in wireless sensor networks will have to deal with the stringent requirements of multimedia monitoring applications, along with the resource-constrained nature of sensor nodes.

MULTIMEDIA-BASED OPTIMIZATIONS

Multimedia data sensed by source nodes have to be digitalized and transmitted to the sink over one or more multihop transmission paths. The energy and processing constraints of the sensor nodes, as well as the nature of the wireless links that interconnect them, restrict the attainable bandwidth of the communication path(s) and impose a considerable packet loss rate. Hence, in wireless multimedia sensor networks, it is crucial to optimize communications in order to minimize energy consumption and to maintain an acceptable quality for the application.

An efficient way to optimize multimedia transmissions in WSN is to exploit the characteristics of multimedia coding techniques. When following a cross-layer design, such characteristics may alter the operation in transport, networking, MAC and physical layers, influencing procedures for congestion control, error recovery, multipath selection and energy preservation. In short, protocols following cross-layer design disrupt the concept of modularized layers, which reduce the overhead and optimize the jointly design of network protocols (Costa & Guedes, 2011).

Multimedia coding techniques are used to compress the original data, reducing the required transmission rate. In spite of that, some characteristics of multimedia coding may be exploited to optimize the network operation. As an example, DWT coding technique defines different relevancies for the encoded data, since original images are decomposed into separate subbands. As these subbands have different importance for reconstruction of original images, packets may be prioritized according to their payload.

In fact, the expected optimizations may be performed in source nodes or over intermediate nodes of transmission paths. In source nodes, for example, more relevant data may be transmitted through the best transmission paths, while low relevant data may be silently discarded in source nodes when network faces congestion. On the other hand, in-network optimizations may be concerned with packet relaying, assuring higher priority to most relevant packets.

Table 4 presents some common multimedia-based optimization approaches.

Table 4. Some common multimedia-based optimizations

Optimization Approach	Example
Transmission rate adjustment	When necessary, source nodes may avoid transmitting packets containing less relevant encoded data, decreasing the current transmission rate.
Congestion control	Less relevant packets may be discarded in congested queues, reducing the negative impact in the perceptual quality of the received media.
Error recovery	A correction code can be employed to protect only the most relevant parts of the encoded data.
Differentiated MAC transmission	Based on the relevance of multimedia data after encoding, MAC protocols may provide a differentiated treatment in terms of reliability and channel access.
Multipath routing	Prioritized packets can be routed through the best paths or the multipath routing facility may be used to transmit redundant high-relevant packets to protect them from errors during transmission.

Wireless multimedia sensor networks are strongly influenced by the adopted coding technique. The source transmission rate, the energy consumption over transmission path and the error resilience of the communication depend on the way multimedia data is encoded and decoded. In fact, audio, images and video streams have different coding characteristics. Hence, multimedia-based optimizations must properly consider the particularities of the employed media, in order to attain higher efficiency.

Although some quality loss may be experienced in multimedia-based optimizations, when lower-relevant information is not of much concern, data retrieving is somehow improved, enhancing the overall efficiency of multimedia transmissions.

Audio Optimizations

Audio typically represents human voice or some noise relevant for the application, with transmission rates usually lower than 64 kbps. When applications are only concerned to human speech, typical VoIP codecs can be borrowed to process audio data. However, some relevant noises may be outside the frequency range that can be heard by humans, requiring proper audio codecs. Whatever the case, there are some particularities of the coding process that can benefit multimedia transmissions.

Audio sensors may be continuously transmitting audio data sensed from the monitored field. In this context, even silent periods may be transmitted, consuming energy resources of the network. For some applications, however, some silent periods and "comfort" noises may be spared and source sensors or intermediate nodes may choose to discard packets containing this type of information.

Other relevant issue is loss compensation. Some algorithms for VoIP applications allow parts of reconstructed audio at destination to be recovery from some packet losses, employing interpolation techniques over successfully received data. In the wireless sensor network context, such algorithms could allow low or moderate packet discarding at source nodes to reduce energy consumption, at the cost of some quality loss that can be tolerable by some monitoring applications.

Image Optimizations

Images are snapshots retrieved by camera-enabled sensors. Typically, image transmissions require less bandwidth than video streaming, but it still requires proper treating especially when dealing with error resilience and real-time delivery. Monitoring applications designed for snapshot retrieving may impose different demands for image quality, which may range from highly-compressed SQCIF grayscale images to high-quality large colored images. Moreover, some applications may be designed to sense infrared or ultraviolet images, with specific visual coding requirements.

Most image encoding algorithms for WSN will be classified in progressive or wavelet-based categories (Costa & Guedes, 2011). In the first case, images are compressed through multiple scans with progressively increasing details. The first scan shows the image at the equivalent of a very low quality setting, and following scans gradually improve the quality. Progressive coding based on DCT can reduce spatial (among neighboring pixels) and spectral (among different color planes) redundancy, decreasing the amount of bits to be transmitted over the network. On the other hand, wavelet-based image compression employs DWT and involves two-dimensional wavelet decomposition of the original image, generating low and high frequency subbands.

When defining image-based optimizations, characteristics of the coding technique can be exploited to generate data with different levels of relevance. For progressive coding, source nodes may transmit only low quality scans, in order to save energy. For wavelet-based images, the separate subbands may be exploited to define different transmission priorities. Whatever the case, most relevant data for the reconstruction of the original image must to be always preserved over lower relevant data.

Other possibility for image-based optimizations is exploiting the content of gathered images, instead the coding characteristics. In (Cheng & Shang, 2007) the most relevant parts of image snapshots receive high-quality encoding, since they are most relevant for the application. The remaining parts (e.g. background details) are then encoded with huge compression (e.g. 100:1), reducing the overall size of the encoded image. At the destination, all parts of the same image are reassembled, resulting in different visual qualities of regions of the same image. Doing so, the reconstructed image is suitable for the application requirements and energy is saved when fewer data packets are transmitted, enhancing efficiency when compared with transmissions of images with uniform high-quality compression.

Video Optimizations

Video streaming in sensor networks is resource-demanding by nature. Actually, the same constraints in terms of delay and quality considered for image transmissions may apply for video streaming, with addition of some extremely relevant characteristics, as high bandwidth demand. In this context, efficient video compression is highly desired, but processing, memory and energy constraints of visual source nodes will generally forbid the use of complex coding algorithms.

The coding process of raw video may follow different approaches, achieving high or low compression. A usual approach is to consider information of the scene, such as motion and variation of luminosity, for higher compression. Most Internet video codecs are based on predictive coding and it is natural to try to adapt such codecs to video streaming in wireless sensor networks. Those codecs exploit the data statistics to reduce the transmission rate, performing intra-frame and inter-frame coding. In fact, video-based optimizations in WSN have considered predictive encoding because the inner characteristics of such codecs are very propitious for cross-layer optimizations.

In (Politis *et al.*, 2008) it is proposed a multipath predictive-encoded video transmission in wireless sensor networks. The proposed approach discards less relevant frames (containing complementary details) in order to decrease the source transmission rate, dynamically adjusting the transmission flow when the attainable bandwidth is insufficient. Other optimization approaches that have been proposed in the last years also employed predictive coding when relaying and recovering video data packets (Costa & Guedes, 2011), where error recovery, congestion control and security have been optimized following different approaches.

Optimizations on video streaming may be also performed considering the relevance of retrieved information. For example, in an intrusion detection system, no data may be transmitted in the absence of a relevant event, significantly saving energy. Following the same perspective, optimizations may define different levels of quality for segments of the transmitted videos, employing different number of frames per second or color schemes. A typical optimization could start high-quality video streaming only on the occurrence of relevant events or on scheduled time.

ADAPTIVE MULTIMEDIA TRANSMISSIONS

The overall performance of wireless multimedia sensor networks can be considerably enhanced when some network optimization solutions are employed, addressing issues as energy efficiency, reliability and delay-aware data transmission. Although many optimizations are based on characteristics of multimedia coding, the performed optimization has only significance for the source stream. In a different way, some optimization approaches will be concerned with a group of sensors and their transmission behaviors, which may adapt to the current monitoring context.

Multimedia sensing may have different monitoring contexts along the time, which may be reflected in different levels of global QoS. In other words, sometimes it does not matter the way multimedia data is encoded, but the significance of the sensed data for the application. For example, source nodes may have different sensing relevancies, or they may be assigned to different relevance levels in the occurrence of critical events. Sensing coverage may also be optimized to achieve equivalent monitoring with fewer active sources. In all these cases, the way multimedia is sensed and transmitted is considerable changed, whatever is the employed codec.

The potential of source nodes to retrieve relevant data may be exploited as an innovative parameter of global QoS. And such potential is a direct function of the expected targets to be monitored, instead of only the deployed network characteristics, resulting in a new paradigm for prioritization (Costa & Guedes, 2013). Doing so, packets from different source nodes may have different priorities for the network, since data from the most significant source nodes are more important for the application quality. For example, in industrial control applications, multimedia sensors that gather information from critical areas, even in normal operation, are more relevant and should receive prioritized treatment by the network.

Frequently, a critical situation needs to be monitored with higher visual quality and the retrieved information needs to be delivered with lower end-to-end delay than usual transmission. In the occurrence of a critical event, as a bomb explosion, multimedia sensors that retrieve data from the area of interest must be quickly assigned to a higher relevance level. In the network perspective, there will be part of the network that is retrieving more relevant data or that is transmitting with stringent requirements for high bandwidth and low latency. In such way, the network as a whole should try to assure enough resources for the most relevant information, whatever are the data types or employed codecs.

Besides sensing relevance, the optimal configuration of multimedia sensors may result in monitoring of equivalent information for the application. This may be common in wireless visual sensor networks, where source nodes gather information following a directional sensing model. In this scenario, the use of optimal orientations may select a small group of visual sensors that still can view the same targets originally viewed by the initial sensors. For example, different optimization algorithms are proposed in (Ai & Abouzeid, 2006), aiming at the computation of the initial orientations of visual sensors in order to cover as many targets as possible, activating the minimum number of sensors. Doing so, fewer data packets will be transmitted over the network, potentially reducing energy consumption and assuring higher throughput and lower delay.

Data compression is often desired in multimedia transmissions, but the expected benefits are more evident for resource-constrained networks. In short, compression is aimed at finding the most concise representation of an original signal, which still has an acceptable quality level. In general, multimedia algorithms that achieve high compression are complex and may demand considerable energy of source nodes. Moreover, some codecs do not provide error resilience, which may be particularly prejudicial for wireless multimedia sensor networks. As an alternative to traditional methods, compressed sensing is a

new paradigm that allows monitoring with fewer measurements than traditional methods (Pudlewski & Melodia, 2010). The idea is to sense data in a compressed form, instead of sensing data in a high rate and then compressing the sampled data. For wireless multimedia sensor networks, compressed sensing allows the development of low-complex video and image codecs. Besides energy saving when fewer data packets are transmitted, compressed sensing has an inherent resiliency to link errors, due to unstructured visual data representation.

Although bringing different results, the discussed approaches are good examples of how multimedia monitoring may adapt to different monitoring contexts. The same network may even apply different monitoring paradigms for different areas of interest and for different source sensors. The response to critical events, the sensors meanings and compression approaches should be considered as dynamic characteristics of the network, which need to adapt to different monitoring contexts and sensors configurations to achieve higher efficiency.

FUTURE RESEARCH DIRECTIONS

Multimedia transmissions in wireless sensor networks still present many challenges that will foster the development of new solution and optimization approaches. There are many relevant topics that will guide future researches in this area, comprising relevant issues as energy-efficiency, real-time transmission, security, error resilience, mobility and availability.

Many cross-layer optimization approaches exploiting characteristics of multimedia coding have been proposed in the last years. In this context, the way multimedia coding techniques evolve may impact optimizations in WMSN. With new codecs being developed, bringing different results in terms of computational complexity, data compression and error resilience, new options will be available for multimedia transmissions. And some coding techniques may be more suitable for resource-constrained sensor networks.

As energy efficiency should remain a major concern for the upcoming years, multimedia-based algorithms in wireless sensor networks should be designed to reduce energy consumption while achieving the desired optimization.

Multimedia sensors may be embedded in mobile nodes. Sensors mobility may allow a large variety of innovative monitoring applications where multimedia sensing will adapt to different scenarios. If sensors are embedded in robots, drones or cars, optimized algorithms should be employed to dynamic positioning of multimedia sensors. In a different perspective, new algorithms should be developed to adapt the network topology and routing algorithms when mobile source sensors are deployed. For example, if low-power cameras are embedded in glasses, and people wearing those glasses are passing by in random directions, the sensor network should adapt to efficiently retrieve the desired information.

Other relevant research issue is sink mobility. As multimedia sensors may gather a lot of information, a mobile sink might move over the monitored field retrieving sensed data. If transmissions happen only when the sink is near, energy is saved over the network when avoiding some packet relaying. And this scenario could be even more complex if multiple mobile sinks are deployed, although the achieved performance might be significant.

Directional coverage by visual sensors also imposes many challenges that still require proper investigation. In this context, sensing redundancy should be properly addressed, since redundant nodes could

be exploited to extend the network lifetime and to reduce data transmissions. In general, if less source nodes are activated, fewer data packets are transmitted over the network.

Generally, new challenges in transmission rate adjustment, energy preservation, congestion control, error recovery, multipath transmission and in-network compression should still arise, requiring additional research in multimedia-based and context-aware optimizations. Some of these challenges may be more stringent in specific monitoring applications, especially when concerning heterogeneous multimedia sensor networks.

CONCLUSION

Wireless sensor networks have been one of the main research topics in digital communications. Composed of many low-cost battery-operated devices with sensing and computing capabilities which cooperatively communicate in a wireless manner, WSN allowed a variety of innovative applications for sensing in wide, hostile or even hard access areas, as battlefield surveillance, industrial control, environmental monitoring, rescue operations, home entertainment and pollution detection, among many others. When sensors are equipped with inexpensive low-resolution CMOS cameras and/or microphones, multimedia data can be retrieved from the monitored field, allowing a new scope of applications. The resulting wireless multimedia sensor networks enhance the understanding of the physical world, improving scalar monitoring and control applications and fostering the development of new multimedia-based sensing functions.

In this chapter, we covered the most relevant topics concerning multimedia transmissions in wireless sensor networks. The main design issues for these communications are discussed, concerning topics as multimedia monitoring, multimedia coding, QoS, routing, error recovery and congestion control. In fact, the covered topics are relevant when designing multimedia transmissions in resource-constrained sensor networks, supporting in planning, deployment, configuration and management of WMSN. Furthermore, the discussed strategies for optimizations may guide future developments in these networks, significantly benefiting the use of practical multimedia monitoring applications and new research in this area.

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KEY TERMS AND DEFINITIONS

CIF: A common image resolution often used on videoconference and video streaming systems.
Depth of View: The distance between the nearest and farthest objects that can be sharply viewed.
DCT: Discrete Cosine Transform allows progressive-based image coding.
DVC: A video coding paradigm that shifts complexity to the decoder side.
DWT: Discrete Wavelet Transform allows wavelet-based image coding.
Field of View: The area viewed by a camera-enabled sensor. It has a direction of viewing.
Jitter: Time difference in packet arrival time.
Latency: The overall time for processing and end-to-end transmission. However, it is usually a synonym of transmission delay.
QoS: Quality of Service, indicating the expected quality for some service or application.
Sink: A resource-full node that is the gateway of the network. A WSN may have one or more sinks.
TDMA: A popular modulation scheme where transmission is performed in time slots.
Throughput: A measure of the successful message delivery, associated with the transmission bandwidth.
VGA: A common resolution often used to indicate the visible area of screens.
VoIP: Voice over IP, standing for voice communications in Internet.
Wireless Multimedia Sensor Networks: A network composed of resource-constrained sensors equipped with a camera or a microphone for multimedia data monitoring.
Wireless Sensor Networks: A network of resource-constrained sensors and optionally actuators.

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Chapter 3
Past-Blogging:
Defining a Practice

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ABSTRACT

In this paper, the authors conceive past-blogging as a narrative practice which is based on a specific media format. The practice can be initially defined as an account of past events developed according to blogs' most common characteristic: the reverse chronological order of published posts, in which the most recent posts appear on top of the page. Past-blogging practices give rise to cultural products developed in various digital media platforms, especially in journalistic and educational contexts. In order to understand this phenomenon, the authors conducted an empirical and qualitative analysis of 34 cases in which content producers narrate past events by reenacting them or telling their history as if they were happening in the present. The sample – composed by different categories of events, platforms, narrative strategies, motivations for the content production and participation of audience – demonstrates how historical events have been represented within digital media.

INTRODUCTION

Media play a significant role when it comes to creating representations of historical events. News companies, radio stations, magazines and online news portals often produce special coverage during celebration periods, such as anniversaries of relevant historical events. This practice ranges from broadcasting documentaries, interviewing witnesses and historians to offering interactive features, like newsgames. In Ebbrecht's (2007) words: "When history becomes a current event, because of anniversaries or rising

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public interest in specific historic topics, media has the role of communicating and emphasizing the importance of remembrance." (p. 223).

However, there are still practices and media formats that ought to be studied so that an understanding about contemporary representations of historical events can be reached. In this paper[1], we propose the study of what has been called "past-blogging"[2] practices, which will be empirically studied through specific media formats used by journalists, educators and bloggers in general. We aim to identify the characteristics associated with the practice of past-blogging, defined here as the act of live blogging past events, as if they were happening in the present. They are, at the same time, retrospectives and reenactments of historical events produced in digital media, especially on social networking sites and journalistic platforms. In other words, producers of historical content blog about the past using digital communication strategies to compose a narrative in the present. By appropriating the already established term "live blogging", which is also related in many ways to the practice we analyze here, we elaborate on the idea of past-blogging.

The research questions guiding our investigation are: What elements define the practice of past-blogging? What do these media formats reveal about the way history is represented nowadays in the context of digital media? In order to address these questions, we have analyzed the content of 34 cases of past-blogging practices, aiming at identifying common elements among them.

In this paper we first contextualize the perspective from which we describe blogs and social media as environments where memory practices take place. Then we present the case studies we have undertaken in order to identify differences, similarities and patterns among past-blogging practices and respective platforms. Finally, we discuss the results and propose future developments for this research.

PLATFORMS, USES AND PRACTICES

The use of blogs to narrate events is directly linked to its origin as "web" navigation "logs" (Blood, 2000). Since these tools were initially created by hand using html, the most recent entry used to be added to the top, with all other messages being pushed down the page. That led to the emergence of one of the most classic features of the blog format: the reverse chronological order (new entries on the top, older entries on the bottom).

Initially, blogs were used for personal purposes, such as for navigation logs or personal diaries. But over the time they started to be recognized as a medium for news. Blogs started to be seen as spaces for news especially during the Iraq War, with warblogs being used to report what was happening on the scene (Recuero, 2003; Wall, 2005). This use is directly related to historians' use to blog about contemporary history and current affairs (Cole, 2011). "Historians addressing current affairs can function journalistically, doing information-gathering, presenting analysis and synthesizing or aggregating large numbers of narrow articles" (Cole, 2011, p.669). These digital platforms started to be used because they allowed for agile, easy and flexible ways of publishing and sharing news and messages. Today one can find blogs focused on various topics and communities of interest, from cosmetics, fashion and health care to tourism, education and scientific popularization - just to cite a few examples. We are here concerned with the appropriation of blogging practices in regard to historical events.

News events are occurrences that take place in the everyday routine that are important and different enough to be transformed into news (Rodrigues, 1996). Using a blog-like structure to narrate news events as they happen is an appropriation of the format, a practice commonly referred as "live blogging"

(Thorsen, 2013, Thurman & Walters, 2013). Live blogging is employed in the coverage of events that entail breaking news, like unexpected natural disasters, or scheduled and planned series of messages about big events, like Oscar and World Cup (See Typology of Live Blogs at Guardian.co.uk in Thurman & Walters, 2013) or even academic conferences. Historical events are mainly transformed into news events when their anniversaries are celebrated or when a present event news piece recalls them. When a new terrorist attack happens, for example, other previous similar events are evoked by the media. Live blogging platforms are commonly employed to narrate breaking news events, while historical events are presented in past-blogging practices and respective media formats.

Blogs can be seen as a particular type of format for relaying history. Other formats are possible, such as books or movies (Lähteenmäki and Virta, 2016), in which history is retold in written discourse or through live action pictures. Every format has its specificities, allowing for some appropriations as well as denying others. While films are a popular way of presenting history, it may not be historically accurate, as some adaptations have to be made to fill in gaps in history. The live blogging format, for instance, has some specificities, such as the fact that it allows for participation of the public that is accessing the feed, or needs some adaptation in terms of language and discourse so that history is relayed as something that is taking place in the present. There are other technical possibilities that enhance the format, such as the possibility of adding historical photos, or adding links to sources where users can find more information about the event that is taking place. Temporal differences can also be noted – the movie will take place on its duration (90 minutes), the novel can be read all at once, but the live feed may take as many days as it took for the history to unfold (Lähteenmäki and Virta, 2016). As Lähteenmäki and Virta (2016, p.10) state, "different forms of representation can carry out different aspects of representation better than others (a photo of a landscape seems to offer more to its viewer than a verbal description, for example)." It is in this sense that we look at past-blogging practices and its respective media formats.

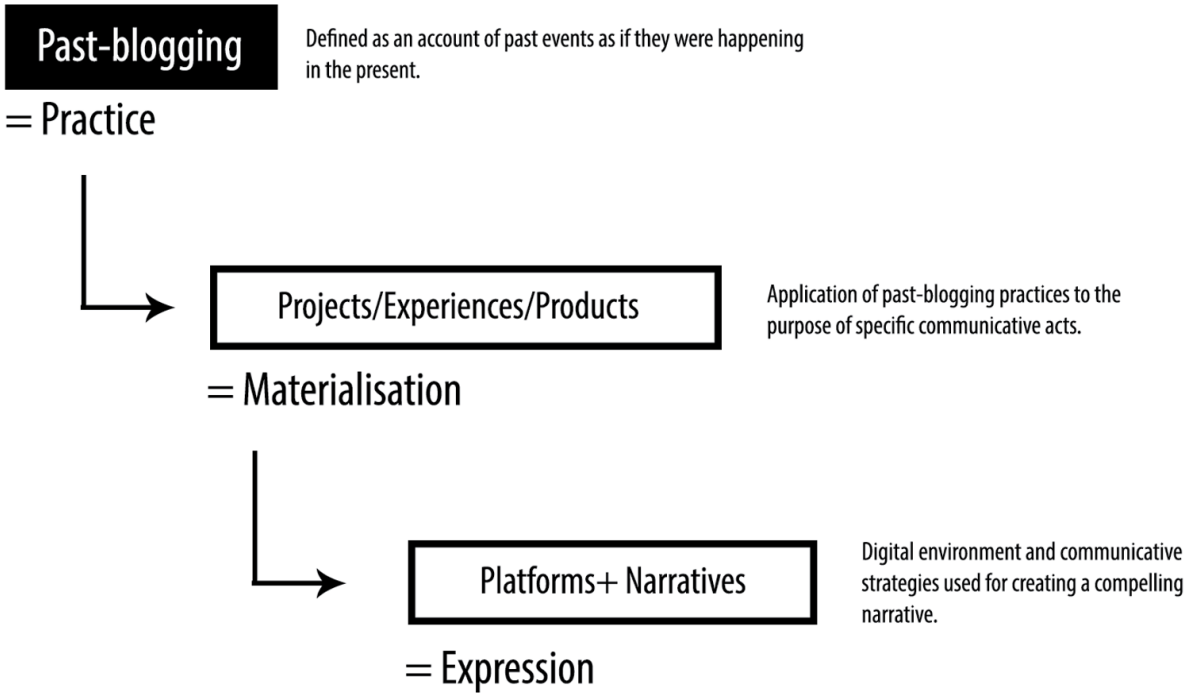
PAST-BLOGGING

Here we are especially interested in the media formats derived from past-blogging practices, which can be defined as the practice of live blogging past events. Journalists and educators often use these formats in order to narrate and reenact historical events. History is presented in a compelling way, raising awareness of the past event in the present historical context. One of the effects to history of such a communicative practice is the production of "a present past updated through narrative." (Bonsanto, 2014, p. 8) strategy. The use of the format also stimulates participation as blogs and other similar tools allow for comments and other forms of interaction and feedback. Figure 1 shows a systematic view of the concept.

In this research, we regard past-blogging in a much broader sense that goes beyond the blog platform and also encompasses other tools sharing some of the core characteristics of blog (such as in using a common feed where posts are delivered in a reverse chronological order). Examples include social network sites such as Twitter and Facebook. This sense of temporality presented in blogs, as well as in Twitter timeline, Facebook news feed and live blogging platforms used by news portals, seems to work well when it comes to the retrospective representation of historical events. The content presented in past-blogging practices follows the order and time in which important moments of historical events took place. This gives a sense of synchronicity and accuracy to the proposed narratives, especially to reenactments.

Past-blogging can be also described as modes of narrating the past that are ascribed in the affective turn of the field of history (Agnew, 2009). By narrating the past as if it was happening in the present

Figure 1. Structure of the concept of past-blogging



moment, the normal flow of a Twitter timeline is interrupted, for example. This characteristic challenges a fundamental issue for the construction of narratives, the context of production and reception of the account. At the same time, the possibility of "experiencing" a past event through its narration brings history closer to people, promoting a "sympathetic identification with the past" (ibid., p. 302; Collingwood, 2005, p. 189). This can be especially observed in past-blogging practices identified as reenactments of historical events. In such cases, one can often see the simulation of characters' performances, and the description of historical sites and situations. According to Agnew (2009 p. 300), media products that use reenactments as a communicative strategy share a "concern with personal experience, social relations and everyday life, and with conjectural and provisional interpretations of the past". Bonsanto (2014) has specifically studied the narrative effects produced through the past-blogging practice performed by Folha de São Paulo in 2014. His discussion about the sense of topicality of past events produced by journalistic accounts sheds light on important implications of past-blogging practices for those experiencing such a narrative.

Turning the past into something more gripping does not rely just on news. Social actors working in educational sectors, especially history teachers, have been struggling for getting and keeping their students' attention:

The stories of the past presented in media, especially on television, are far more visceral than those presented in the classroom. Further, whereas the classroom teaches history with careful attention to objectively presented facts, the media may encourage the personal and emotional connections with the past that are associated with collective memory. (Edy, 1999, p. 72)

In a very mediatized and immersive context, the alternative pointed out by several scholars and teachers (Kansteiner, 2006; Naujoks, 2014) seems to be the incorporation of such media into educational environments. These uses of the past (Ricoeur, 2004) for educational and journalistic purposes (Edy, 1999, p. 83) are also part of the past-blogging phenomena. Since these practices are part of a "process of the present appropriation of history" (Ebrecht, 2007, p. 222), it turns out to be necessary to understand how they are produced and what are the elements constituting them.

A similar reflection about the appropriation of digital technologies for the production of historical accounts has been undertaken by Lähteenmäki and Virta (2016). This case study on the past-blogging product about Finish Winter War[3], produced by YLE – Finland's national public service broadcasting company –, confirms and complements various aspects presented in the overview we aim at providing. The authors refer to the phenomena as "relaying history: transporting portrayals of past events to the present time and format of social media to highlight and elevate their significance in Finnish history and encourage others to use the platform for similar purposes." (p. 5). Through the project @Sota39 (@WinterWar1939, the twin project in English), the paper analyses the "Twitterification of history" (p. 19), and covers a wide range of implications the use of digital media – in this case, Twitter – brings to the work of historians. Besides that, a deep look into interactions between audience and professional content producers is also taken. The complementariness of that study and ours lays on the fact that both problematize the same phenomenon from slightly different perspectives. While Lähteenmäki and Virta (2016) draw focus to the consequences of writing historical accounts through a different/new technology, we intend to examine how this narrative genre intervenes in the very act of producing digital content itself. This distinction becomes clear if one looks at the nomenclatures chosen in both studies: past-blogging on the one hand and "relaying history" on the other. Of course these are two sides of the same coin, since "history is a term that means both what happened in the past and the varied practices of representing that past, media are historical at several different levels." (Gitelman, 2006, p.5) Together they provide a full contribution for internet studies and history scholarship.

Hence, what we propose here is an overview that covers a range of examples, their form, and production process. A look into news reports about past-blogging experiences reveals that some characteristics are common between them. For instance, in terms of preparation, they usually demand a lot of time, a combination of sources, and the elaboration of posts in advance, so they can be posted exactly at the time/day intended (Bradshaw, 2015; Fleegel, 2015; Sawers, 2011). Some coverages even used tools to schedule posts for a specific time or date (Fleegel, 2015; Sawers, 2011). In terms of tone and language used, the most successful cases relied on retelling the story through a specific (Long, 2012) point of view, based on historical facts.

Current linguistic marks or new interpretations are also added to the narrative, as if the past events were taking place as present time Twitter breaking news (Rogers, 2013). The purpose is usually to illustrate to people how things worked out as they took place (Crymble, 2010; Sawers, 2011). The topics of these past-blogging practices are mostly major historical events, approached when they complete a new milestone (such as when they are celebrating 10, 20, 50 years, and so on), which inspire massive commemorations and moments of reflection. The participation of the public can help enhancing the narrative as they give suggestions in terms of sources and content (Bradshaw, 2015; Schuessler, 2011), as well as provide feedback (Bryant, 2011) and help giving visibility (Fleegel, 2015) to the content produced, by sharing and commenting on it.

METHODS

Previous exploratory observations indicated that several journalist and educational past-blogging practices were taking place on the Web. In order to construct a representative sample of cases to be analyzed, we used Google search engine and looked for results including the keywords history, reenactment, live tweeting, live blogging and retrospective. The combination of these terms directed us to blog posts, news reports and even podcasts[4] in which past-blogging practices were discussed. By following the hyperlinks of those search results, we managed to gather 34 different cases of past-blogging practices within multiple platforms. These methodological procedures proved to be effective and allowed us to map enough cases for a qualitative study.

The past-blogging examples we have collected refer to the events listed in Table 1, which presents the frequency of occurrence of each event, as well as the historical periods they represent and some other

Table 1. List of past-blogging projects analyzed

Event	Frequency (#)	Purpose	Platforms
1847 trek of the Mormon pioneers	1	Educative	Twitter
1848 attempt at German unification	1	Educative	Twitter
American Revolution	1	Educative	Twitter
Battle of Britain	1	Journalistic	News portal
Battle of Gettysburg	1	Educative	Twitter
Battle of Quebec	1	Educative	Blogspot
Battle of Waterloo	1	Journalistic	News portal
Brazilian Military Coup	2	Educative/Journalistic	Twitter/News portal
Byzantine Empire	1	Educative	Twitter
D-day	1	Journalistic	News portal
Fall of Berlin Wall	1	Journalistic	News portal
First spaceflight to the Moon	1	Educative	Twitter
Gallipoli Campaign	1	Educative	Twitter
LA Riots	1	Educative	Twitter
Parliament Burns in London (1834)	1	Educative	Twitter
September 11	2	Journalistic	Twitter
Sinking of Titanic	2	Educative/Commercial	Twitter
State funeral of Winston Churchill	1	Journalistic	News portal
The Cuban Missile Crisis	1	Educative	Twitter
The Declaration of the Juliana Republic in Santa Catarina	1	Journalistic	Twitter
The exodus	1	Educative	Twitter
US Civil War	2	Educative	Twitter
World War I	1	Journalistic	News portal
World War II	7	Journalistic/Educative	Typepad, News Portal, Twitter, Facebook

characteristics. These projects materialize past-blogging practices in the sense that they represent specific examples on how historical reenactments took place in various platforms and for a variety of purposes.

This sample covers 24 different events[5] that have had international, national or local repercussion. The historical periods are also varied, ranging from contemporary events (September 11) to the Ancient and Middle Ages (Byzantine Empire). In this sense, the timeframes represented seem irregular, considering that the Fall of the Berlin Wall took one day and the World War II lasted six years. These dissimilarities point to the flexibility and multiplicity of applications provided by the platforms where past-blogging practices take place.

After selecting the cases to be analyzed, we identified the main characteristics of each case. We conducted our empirical observation during the first week of February 2016 (Feb 01-07). For each of the 34 occurrences, we identified and described the approach used in the product (i.e. minute by minute, most important actions taken by certain characters), platform (i.e. Twitter, Blog), verb tense used on the narrative, motivation (reason why the product has been created), identity of the narrator(s) of the story, participation of the public (how active and engaged they seem to be), and sources used (materials used for the description of the event).

One of the most significant limitations of this methodological procedure is the selection process. There is no effective way of finding examples of past-blogging practices in a systematic way, especially because this is a format that is still being developed. Thus, we had to work with a random sample containing examples in English and Portuguese. In order to contribute to the field and promote the study of these practices, we have made available a collaborative directory[6] where multiple cases can be shared by anyone.

RESULTS

The qualitative analysis of the past-blogging cases provided us with an overview of this practice. As we are dealing with a media format that has been explored by very few scholars (Bonsanto, 2014; Lähteenmäki and Virta, 2016) – as far as we are aware now –, we propose a description of its features and elaborate a comprehensive definition. The results show patterns among the cases studied, as well as trends and particularities in the narration or reenactment of past events in the present.

Events

Most of the cases represent contemporary historical events. Among them, two events, World War II (7 times) and September 11 (2 times), share similar characteristics, such as the international repercussion. Their content has also inspired a great amount of cultural and media products, such as films (documentaries and fiction) and books (novels, academic, etc.). Past-blogging is a practice that gives rise to a new format for the mediation of these historical events.

Despite the diversity of events, two main themes embrace them: politics and conflicts with a national or international background. National events include the Sinking of Titanic (twice), the Military Coup in Brazil (twice), the Parliament Fire in London (1834), US Civil Wars (twice), the American Revolution, 1848 attempt at German unification, the Battle of Gettysburg, the State funeral of Winston Churchill, and the Battle of Quebec. Despite the immediate national reference, many of these events have also had an international impact. At the international level, we can mention the First spaceflight to the Moon,

D-Day (WWII), Fall of Berlin Wall, and other cases about WWI and WWII. Finally, the local level was represented in the Declaration of the Juliana Republic (Santa Catarina, Brazil) and in the LA Riots. One particular case deals simultaneously with three events: WWI, WWII and Cold War. As said before, the scale of these events is not watertight, though we adopted these categories for analytical purposes.

Some cases are not based on a recent historical period, but in the middle ages, ancient times or even in a mythological past. Considering this temporal distance, in some cases, past-blogging producers have to find alternative sources or narrative strategies for storytelling. That is why certain contents depend on the imagination and silences along with voices surrounding the past (Salmi, 2011). These aspects give room to new ways of accounting history: "Could it not also mean seeing the past as a world of possibilities? Then history would not be a closed entity but would remain open, potential, and a scientific account of it would have to include a place for the possible as well as the actual." (Salmi, 2011, p.178). Taking these statements as premises, we look for evidence to answer the following question: What are the potentialities of digital media platforms explored by producers of past-blogging narratives?

Platforms

Different features provided by digital media also play a key role in the way narratives are constructed. Within the analyzed sample, the most common platform is Twitter (21 cases). Some of the past tweeting practices (a specific type of past-blogging) incorporate features of the platform into the narrative, such as hashtags, lists grouping various characters represented by different profiles, the use of mentions "@", incorporation of pictures, and so on.

News portals also present their own past-blogging formats. In the online version of the British newspaper The Telegraph, a series of past-blogging narratives (5 cases) have been produced. The journalist Laurence Dodds has been responsible for editing most of the past-blogging products, including the Fall of Berlin Wall[7], the State funeral of Winston Churchill[8], the Battle of Britain[9], the D-Day[10], and the Battle of Waterloo[11]. No special layouts have been created, so journalists use the same structure of a normal article to work on past-blogging narratives. What makes this format special, though, is its content. Archival material, such as newspapers scans, video reports and pictures that were produced by The Telegraph in 1989 during the Fall of the Berlin Wall, for example, are integrated to the minute by minute narrative, a characteristic of digital journalism practices. Similarly, Folha de São Paulo –project that explicitly uses the term past-blogging– has employed the usual "minute by minute" template used in live news coverage to produce the past-blogging narrative about Brazilian Military Coup[12].

Three cases have been produced within blog platforms. The topics approached by these blogs are diverse. The website World War II Today[13] focus on the account of the War and even the posts' dates are replaced with the date of the original event[14]. This aspect has not been observed in the other two examples. The blog Grasping History[15], on the other hand, presents a special section for its past-blogging experiment. The scholar J. Bradford DeLong publishes messages on a daily basis related to what was happening on the same day in World War I, II, post war period or Cold War. The author does not explain the reason for choosing one or another event each day and this seems to be made randomly. The third case refers to a series of posts about the Quebec Siege produced in Christopher Moore's personal blog[16]. From August to September 2009, Moore narrated day by day the most relevant moments of this event. These series of posts were identified with the same tag, which allows readers to go back to these specific texts, including a similar title (Live blogging the Quebec siege + stage of the account).

Another platform used to this purpose was Facebook. As in other cases, a page dedicated to World War II[17] is updated with daily messages reminding its followers of what was happening in the context of WWII on the same day. Facebook's interface also appears on the meme about WWII created by Humor School[18].

The creative appropriation of platforms enriches the analyzed cases. Even those examples based on existing structures - news portal, Twitter - explore potentialities of digital media and promote new socio-technical processes for narrating the past.

Narrative Strategies

To understand how these narratives are constructed, we turned to the subjects responsible for conducting each past-blogging product. In most cases, the narrative is conducted either by omniscient narrators or by the voice of characters involved in the story, which are represented by different profiles on Twitter, for example. Fictionalization is one of the strategies applied to the narratives. In the case of the US Civil War[19], for example, the narrator is a fictional journalist who was able to report the event as it was happening. On the other hand, professor and journalist Jeff Jarvis used his personal Twitter account[20] to tell his own witnessing experience on September 11, 2001 in New York.

These narrative strategies, together with the "real time" effect promoted by the use of verbs in the present tense as well as the synchronicity of past and present events, are supposed to promote an empathetic and engaging reception of the accounts. In this sense, the excitement and tension experienced by those who participated in the represented events when they took place are frequently translated into minute-by-minute narratives (like in @TitanicRealTime[21], the Hijack of the flight of UA93[22], 1894 Parliament Fires in London[23], among others). Bonsanto (2014) provides a relevant reflection about the narrative genre produced by Folha de São Paulo in its past-blogging about the 1964 Brazilian Civil-Military Coup. In his words, past-blogging practices promote a "temporal articulation by updating time through the narrative" and, as an outcome, opening space for looking at "the past as something new." (p. 7)

The use of the voice of original characters, which come to life in the form of Twitter profiles, for example, shows that past-blogging narratives also intend to reenact the past. This has been especially visible in the projects developed by Twhistory[24] initiative. On the reenactment of the sinking of Titanic[25], characters such as Captain Smith (@Capt_Smith) and the telegraphist of the ship Jack Phillips (@J_Phillips1912) interact via tweets and mentions (by using the @username syntax). During this reenactment the audience could follow the event through a list of tweets especially organized by Twhistory (Jensen et. al., 2010), where all the actions performed by the characters (each one in a different profile) were centralized. In another past-blogging experience[26], focused on the minute-by-minute "live tweeting" of Titanic tragedy, we observed the use of hashtags (#) like #crew, #captain, #BoatNo1, #firstclass and so on. These two cases show how the same event can be framed through different narrative strategies, even if the same platform is employed.

Humor is also a category identified in some of the analyzed cases. The entertainment website College Humor has creatively proposed the reenactment of the World War II as if it was happening in 2011. Each country (USA, Russia, and Germany) and some individuals (i.e. Adolph Hitler and Joseph Stalin) involved in WW II were depicted as Facebook users. In the fictional News Feed, countries exchange political and bellicose threats in an informal way, imitating language, slangs and behavior characteristic of many Facebook users. The post on the website has become a well-known meme, which still circulates within various social media.

Motivations and Public Engagement

Moreover, the analyzed cases also display information about motivations that inspired scholars, educators and journalists to create past-blogging experiences. More than half of them have been launched in commemorative periods, especially the anniversaries of the events. In these periods, events are put on the public agenda by media (i.e. special reports on magazines, websites, newspapers, TV News, etc) and other cultural products (books, documentaries, etc). All these aspects contribute to draw the attention of audiences to those events.

Some past-blogging projects have been produced for more generic reasons, such as the interest of the author in a certain event. The most exemplar case here is the Twitter Profile "WW2 Tweets from 1944"[27], a successful[28] past tweeting project created in 2011 by historian Alwyn Collinson. After noticing the way witnesses and participants of the Arab Spring were narrating those events, he realized that a similar strategy could be used to engage internet users with the past. By using a micro-history approach, his tweets are filled with biographical data. The main intention, in his own words (Collinson, 2012, online), is to show the "human face of history", because "people don't want to care about history, unless we give them a personal touch". Furthermore, the author believes that by taking his followers out of the comfort zone of historic distance, he can prompt "visceral connections" between history and people.

This same perspective is put into practice by educators who have developed past-blogging projects with their students, such as the Cuban Missile Crisis[29] and the 1848 attempt at German unification at St. Paul's Church[30] or Redemocratização[31]. The gain, in these cases, would be the pedagogic effects of engaging students with the content learned in an immersive way.

The participation of the public in some of the analyzed cases is also evidence that past-blogging projects promote a connection between people and history. As Lähteenmäki and Virta (2016, p.4) state, with public participation, "the narrative shifts to a more inclusive way of writing history". Frequently the public can interact with the author of the narrative, leave comments or share information. The catchphrase "rich get richer and poor get poorer", however, is useful to explain why certain past-blogging projects have more visibility and participation than others. Participation can also take part when users help disseminating information (Rainie & Wellman, 2012), by sharing or reposting content from past-blogging experiences. In the cases analyzed, we identified that products created by news portals (The Telegraph, The Guardian, Folha de São Paulo), private companies (The History Press) as well as individuals who have had space to advertise their narratives in traditional media (Alwyn Collinson) are more likely to receive likes and reactions from the public.

In the case of the Twitter Profile "WW2 Tweets from 1944", some followers have sent messages to the author about their personal experiences with the war or suggestions of content. Criticism, however, is among the actions taken by the public. Despite being a popular newspaper, the reenactment proposed by The Guardian on September 11 10th anniversary is one of the most known (Bryant, 2011) past-blogging projects which failed. The news portal received lots of criticism from its audience and had to give up the special past tweeting coverage[32] of the event. At the same time, other initiatives representing the same events have succeeded, like the personal account tweeted by Jeff Jarvis[33].

Time, Memory and Preservation of Historical Accounts

The entanglement of different historical and technological temporalities also affects the narrative construction. As stated before, past-blogging practices promote, in certain circumstances, an interruption in the "always new" flow of information that constitutes social networking sites' timelines. Very often "old" news is also shared on Facebook as if they were new – especially due to the lack of attention of users who don't check the publication date before forwarding it to their networks. In the case of past-blogging practices, these ruptures seem even more radical, because the topics reported are recognized as "historical" –a further past. They contrast more deeply with the content of the last updates of friends and pages one receives every minute. As Lähteenmäki and Virta (2016, p.3) note, "When the content is blended into the real-time feed where it is mashed up with tweets about current issues, its historical roleplay is emphasized." Further studies in regard to the reception of past-blogging products will be able to track this kind of reaction more accurately.

If on the one hand these ruptures occur, on the other potentialities reside on the context where these narratives circulate, especially when they are produced on social networking sites. As stated before, historical accounts have been, for a long time, produced through different media, such as books, documentaries, films, and plays. These formats have been appropriated as means through which history is popularized and disseminated, as well as negotiated and disputed. History, in this sense, "is no less of a cultural production in the past than it is in the present." (Gitelman, 2008, p. 212) Some of the analyzed cases in this essay reflect it, as some contents are produced from the participation and interaction between different actors. Active participation in the representation of the past leads to memory work.

Cultural and communicative memories (Assmann, 1995) are also intrinsic to past-blogging practices. Cultural memories refer to events that belong to a further past, preserved mainly by institutions such as museums and cultural products – American Revolution and Sinking of Titanic –, for example. The use of archival material and the exchange of knowledge coming from formal education (school textbooks and master narratives) can be inscribed here. Communicative memories, however, fit with events whose witnesses are still able to share their own direct or indirect experiences. September 11 and Brazilian Military Coup past-blogging practices are some of these cases. Public responses and the aggregation of personal accounts – via messages using project's hashtags, for example - shape and diversify these narratives. Some past-blogging initiatives, like The Telegraph's Fall of the Berlin Wall, could also have profited from this kind of public participation, but the platform used is based on a top-down approach, where not even comments are allowed.

Understanding this memory dimension of past-blogging also reveal its relevance in terms of preservation of cultural knowledge. While some letters, books and diaries written during and about the Second World War can still be recovered and analyzed, digital products don't have necessarily a long lifespan. Today's digital past-blogging are products that present current views about the past, and hence are potential memory platforms that will potentially inform future generations about early 21st Century society's ideas about the past. However, it is possible to argue, together with Lähteenmäki and Virta (2016, p.2) that "While most of these tweets [as well as other past-blogging formats] remain online for later viewing, these bits of information are fragile in form as they are constantly evolving with new references and can even disappear if not deliberately preserved for future use". (p.2). That said, envisioning the real value of these practices in terms of long-term memory products seems an important task.

FINAL REMARKS

The recognition and development of new forms of accounting for the past is an important move for today's society. Digital media is gradually taking part in more facets of social life, including the construction of historical narratives and memories. Past-blogging is certainly a practice that contributes to the renovation of historical narratives. Blogs, as well as other platforms used with this same purpose, are compelling platforms to narrate contemporary history (Cole, 2011).

Apart from the urge for change impelled by digital and social media, the field of history itself reinforces this claim. The affective turn as well as the consolidation of micro-history point to the need of renovation in these narratives. In order to engage readers, students and other people interested in learning about the past, strong, entertaining and compelling storytelling strategies ought to be elaborated. By representing the unfolding processes of historical events (in "real time", minute by minute, day by day) or reenacting the events giving voice (and profile pages) for historical characters, past-blogging projects concentrate on the experience of the past (Agnew, 2009). In the process of developing past-blogging practices one has to think of their readers: What facts will be of relevance for them? What is the correct tone for communicating the past (humor, emotion, factual, etc.)? How to approach and interact with the public? While selecting the content to be published, the author is also framing and proposing a specific reading of the past. This can, in some cases, be a source of criticism, since other ways of interpreting the past are always at stake.

In this study, we observed creative appropriations of established digital media. The blog format, especially the use of its traditional reverse chronological order (Blood, 2000) for accounting past events, is the characteristic that embraces all the analyzed cases. Using live-blogging to present events is a common product of journalistic websites (Thorsen, 2013) and when they start to be used for the narration of past events, new potentialities become visible.

History and journalism also become closer in past-blogging projects for different reasons, such as in the newsworthiness that past events acquire from these practices, or in the new expressive manifestations they allow. Anniversaries of events, for example, transform them again into news events (Rodrigues, 1996). Novel uses of news outlets' archival material also arise and the roles journalism plays in the account of history and the production of memory (Zelizer, 2008) are made even more evident.

While practicing past-blogging, though, educators and historians also become closer to the objective and fast-paced language of digital journalism. If the competencies of these professionals meet at certain point, accurate and engaging narratives will probably proliferate. Ultimately, the integration of history into everyday life media points to new possibilities of popularization and engagement with the past. Storytelling techniques employed by advertisers and the entertainment industry find room for enhancing historical consciousness as well as highlighting the connections between past and present.

Future studies could make an effort to further document this and other practices of contemporary forms of accounting the past through digital and social media. Other questions still need to be addressed so that an understanding of this and other practices can be achieved. How these practices impact the assessments of history and social memory? As time progresses, will present live blogging projects be consumed as past-blogging sources, such as pre-internet newspapers are today?

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ENDNOTES

1 A previous version of this paper was published in the proceedings of the CaTaC 2016 Conference. Elements reproduced here with kind permission of the editors.

2 The first occurrence of the term was found on Folha de São Paulo's past-blogging about the Brazilian Civil-Military Coup: http://aovivo.folha.uol.com.br/2014/03/30/3145-aovivo.shtml

3 More information about the project can be found on http://yle.fi/aihe/historia/sota39

4 Our main sources were, for example: *Twitter Blog* (https://blog.twitter.com/2015/live-tweeting-the-lusitania-s-last-voyage); the *website "Make Use Of"* (http://www.makeuseof.com/tag/experience-the-biggest-historical-events-of-our-times-through-twitter/), the *blog of the researcher Marcelo Träsel* (http://trasel.com.br/tag/reencenacao-historica/); the Project Twhistory website (http://blog.twhistory.org/reenactments/), and the podcast "Live-Tweeting The Past: A History Lesson?" on Huffington Post Live website: (http://live.huffingtonpost.com/r/segment/live-tweeting-the/508023f302a7607292000029).

5 The sum of the total number of past-blogging practices analyzed is 34 because some of these events have been represented in more than one platform, such as WWII (7x), September 11 (3x), Titanic (2x), Brazilian Military Coup (2x) and US Civil War (2x).

6 A form for the inclusion of new projects is Retrieved from https://goo.gl/forms/zXmSLIC5MkXzf8IA2 Contributions sent via this form will be analyzed and shared on the directory: https://goo.gl/AAlovb

7 Retrieved from http://www.telegraph.co.uk/history/11219434/Berlin-Wall-How-the-Wall-came-down-as-it-happened-25-years-ago-live.html

8 Retrieved from http://www.telegraph.co.uk/news/winston-churchill/11375818/As-it-happened-The-state-funeral-of-Winston-Churchill-January-30-1965-live.html

9 Retrieved from http://www.telegraph.co.uk/history/battle-of-britain/11865303/The-Battle-of-Britain-as-it-happened-on-September-15-1940-live.html#disqus_thread

10 Retrieved from http://www.telegraph.co.uk/history/world-war-two/10878674/D-Day-6th-June-1944-as-it-happened-live.html

11 Retrieved from http://www.telegraph.co.uk/news/uknews/battle-of-waterloo/11676475/The-Battle-of-Waterloo-as-it-happened-on-June-18-1815.html

12 Retrieved from http://aovivo.folha.uol.com.br/2014/03/30/3145-aovivo.shtml

13 Retrieved from http://ww2today.com/

14 For example, instead of informing the date "Feb 12, 2016" - date in which the post has been published to the blog - the editor uses only "Feb 12, 1941", with no further references to the actual year of publication of the post.

[15] Retrieved from http://www.bradford-delong.com/liveblogging-world-war-ii/

[16] Retrieved from http://christophermoorehistory.blogspot.de/search/label/Quebec%20siege

[17] Retrieved from https://www.facebook.com/WWIIHistory/

[18] Retrieved from http://www.collegehumor.com/post/6650094/facebook-news-feed-history-of-the-world-world-war-i-to-world-war-ii/page:2

[19] Retrieved from https://twitter.com/CivilWarReportr

[20] Retrieved from https://storify.com/mbjorn/jeff-jarvis-jeffjarvis-remembers-911-on-twitter

[21] Retrieved from https://twitter.com/titanicrealtime

[22] https://twitter.com/UAFlt93

[23] In the case of the Parliament Burns in London (1834) the real time account is hypothetical, since there are not enough accurate registers that allow for a detailed real time narrative.

[24] This initiative has been created in 2009 as a platform that supports online reenactments. Further information at: http://blog.twhistory.org/about/

[25] Retrieved from https://twitter.com/Twhistory/lists/titanic-tweets

[26] Retrieved from https://twitter.com/titanicrealtime

[27] Retrieved from https://twitter.com/RealTimeWWII

[28] The profile has more than 300.000 followers and its author has given interviews for BBC, New York Times and The Telegraph, just to cite a few. The page has also been translated into many languages, such as Romanian (https://twitter.com/RealTimeWWII_RO), Portuguese (https://twitter.com/2aGM_TempoReal), Italian (https://twitter.com/RealTimeWWII_IT), French (https://twitter.com/RealTimeWWII_FR), Hebrew (https://twitter.com/RealTimeWWII_He), Korean (https://twitter.com/RealTimeWW2KR), Latin (https://twitter.com/LatRealTimeWWII), Finish (https://twitter.com/RealTime_2MS), German (https://twitter.com/RealTimeWK2) and Arabic (https://twitter.com/RealTimeWWII_ar)

[29] Retrieved from https://twitter.com/Twhistory/lists/cubanmissilecrisis

[30] Retrieved from https://twitter.com/Twhistory/lists/paulskirchenprojekt

[31] Retrieved from https://twitter.com/democracia1985

[32] Retrieved from https://twitter.com/911tenyearsago

[33] As it can be hard to recover information published many years ago, users interested in the content produced by the Jeff Jarvis created an especial timeline for his tweets on Storify: https://storify.com/mbjorn/jeff-jarvis-jeffjarvis-remembers-911-on-twitter

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Chapter 4
Digital Resource Management Strategies

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ABSTRACT

Digital technologies have transformed the shape of the libraries in recent years. Digital literacy has grown exponentially, and digital devices have proliferated personal computers, servers, mobile phones, tablets, laptops and mobile wireless devices. Library users, in the new era of information and communication technology environment expects to access traditional print material and more concentrated on digital information resources. So, in order to meet the user demands traditional libraries are vigorously changing their shapes and moving towards digital libraries. Obviously there may be changing in the nature of duties and responsibilities of a library professional. Since, managing of digital resources in the library is entirely different from physical print assets of a traditional library, there is a need of systematic and unique premier framework of strategic planning, innovative policies, establishing, collecting, licensing, sharing, and monitoring of digital information resources and this challenging task is called Digital Resource Management.

INTRODUCTION

With the dawn of internet, has brought revolution in availability and accessibility of scholarly and scientific communication and opened gateway to world literature. Innovations are drastically changing information technology, information resources are migrating from print to electronic form. These days, literature on electronic format is more easily available than the printed versions with added features of search ability and availability. Hence for these two reasons, e-resources keep count over the printed material, though printed materials has its own advantages. There has been an exponential growth in the use as well as number of electronic resources like electronic journals, CD ROM's commercial and free databases, and resources available from the internet and other computer based electronic networks.

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Accessibility of e-resources has considerably changed the interactions between users and library staff. Since flexibility of accessing information resources through internet or web based is easier. User can access digital resources anywhere & everywhere, authorized, authenticated and multiple accessing of same resource simultaneously. This leads to shift of print resources to digitalized resources. Already users have had access to a various research publications on DVD/CD, both paid and free online databases. In the past few years libraries were purchasing individual copies and made access through standalone machines. Now days on expanding serving the digital resources through library web based consortium networking services for digital resources to their users with the help of internet. The innovations of ICT and www bring in new ideas for the institutional library community. The new paradigm started due to the advanced infrastructure of ICT and advanced e-publishing, e-journals. These help to grow digital resources like video, audio, e-books and e-journals. In order to facilitate easy access of information with fast and accurate, many publishers, researchers and academicians' are working towards users interface.

Now a days libraries are more serious towards the management of information resources than in the earlier past, due to information explosion, widespread use of information and communication technology, proliferation of information resources in different formats, like books, journals, CD's, DVD,s newspapers, research reports have contributed top the flow of information. This has led to challenges towards storage, efficient retrieval and effective use of information. So, to establish ICT infrastructure, defining new policies, creation, capturing, organizing of digital collections, budget constraints, staff-training, licensing, practical and trails on digital resources, monitoring, migration from print to digital, fact based report generation etc need a systematic framework and is termed as digital resource management strategies.

DIGITAL RESOURCES/ ELECTRONIC RESOURCES/DIGITAL FORMATS

Digital resources are defined as digital, electronic, streaming video, audio recordings, CDs, DVDs, VHS recordings, and subscription databases. Digital Resources are defined as material (data/or programs) encoded or manipulated by computerized device.(AACR-2000) Electronic resources refer to those materials or services that require a computer for access, manipulation, or reproduction including, but not limited to, numerical, graphical and textual files, electronic journals, bibliographic or full-text databases and Internet resources.

Today the users limit their search only to such resources or databases which are available in full text. Hence these e-resources have become most common medium of scholarly communication. More and more scholarly publications are being made available on-line. According to Barker, there are three types of documents used in digital resources.

1. **Static:** Static are the most basic, they contain fixed information and never change their form(such as traditional online data)
2. **Dynamic:** Dynamic documents also contain fixed information but also able to change their outward form, the way embedded materials if presented to users (such as multimedia CD-ROMS)
3. **Living:** Living documents are able to change their form (outward appearance) and these embedded information. (such as information on the web) Devi and Devi (2004)

Need:

- World wide accessibility if permitted.
- The information available in digital form is very easy to handle and transit.
- Electronic preservation is very useful in case of frequent use.
- The data in digital form can be edited, processed and distributed in a very simple manner.
- The security of information is most important factor to preserve the documents in digital format.
- Very large amount of data can be kept and preserved safely in digital form in a very limited space.
- A large amount of information can be send from one place to another place at low cost through email.
- Digital preservation reduces printing cost, low cost is involved in mass replication.

TYPES AND FORMAT OF DIGITAL RESOURCES

The digital resources of library, includes the following, which should be acquired by library as per their requirement, information and communication technology infrastructure facility, man power and financial provision etc. The three important formats of e-journal are available which are Online e-journals, CD-ROM journals, and Networked journals and other digital resources include e-books, e-papers, e-reports, e-content pages, e-clippings, in-house web based and online databases. It is very difficult task for collection of management of print assets in special libraries like mass media libraries and telecast libraries. However converting them to digital form preserve it in CD-ROM/DVDs for a long time.

- **Online E-Journals:** Pay and use bases subscribed online hosts are the online e-journals they are not considered as part of the library collection and are accessed through internet. Typical e-journals serial directory provide separate listing of serials available on online and on DVDs versions.
- **CD-ROM/DVD E-Journals:** These digital resources are available on the optical media for storage of information. User or librarian cannot erase or record data or information into it. DVDs and CD-ROM contains huge amount of digitized data. Examples are AGRIS, ADONIS etc. DVDs are most useful in special libraries like museum libraries, mass media libraries, telecast and All India Radio stations libraries since they have got e-clippings, multimedia based digital resources.
- **Networked Journals:** Various reputed national and international journals available in e-versions and are accessed through mailing list, newsgroup, discussion forums, blogs, and are distributed through E-mail, FTP or Public cloud computing technology. When librarian receives abstracts of new arrivals alerts, can extract full-text resources can be downloaded using FTP from the web portals.
- **E-Books:** Most of the publishers are coming up with digital format along with the print format. Multiple library users can access same E-book concurrently .There are lot of advantages of e-books: Less space, no maintenance and including animations, multimedia, easily coping and disseminated. E-books also contain vast amount of information. Now international publishers of scholarly journals like Emerald insight, Springer, Taylor & Franchise, Willey international, Elsevier science are stepping in to e-books publications and made their name in academic and research world.

- **E-Reports:** Old and precious research reports, reusable print assets and publications of research scholars, scientists reports, are now scanned and converted them into .PDF, JPG or BMP format and made available through their library website or through cloud computing technology and made available to their users. These are the part of library collection, classified based on subject categories & archived and store in server computer database.
- **E-Content Pages:** Most of the librarians provide browsing facility to extract required digitalized form of e-book pages, conference proceedings, workshop outcomes, seminar summaries etc. traditional search leads to excessive physical search and leads garbage or junk file accession. However this textual content may be scanned and stored in cloud technology or in a local library server and made availability in the form of PPT, PDF, JPG, TIFF, ZIP etc.
- **E-Clipping:** The special library collections are multimedia, clippings, digital photos, audio recordings, online newspapers clipping, news clipping in telecast libraries etc belonging to this category. These are popularized by specific users like scientist, engineers, reporters, editors, doctors and research scholars.
- **Online Databases:** It is an online collection of sequence of similar records organized and integrated in single file and often made available through computer based data, rich number of high quality e-databases not only bibliographic but also full text resources is available and growing in their number to meet the user demands. Such databases provide information to the research scholars and scientist for their specific field.
- **In-House Databases:** In this category, current back volumes of serials, thesis, experts previous exams question papers Seminar reports, academic project reports, research proposals are included. These are created by individual libraries and made available through intranet.
- **Web Based Resources:** Apart from the above categories of digital resources there may be availability of information through wikis, news groups, blogs and are containing fruitful information. (Pandey. 2002)

EMERGENCE OF DIGITAL RESOURCE MANAGEMENT

Swain etal. (2003) discuses, that the present day scenario, management of change is very crucial. There are two types of factors leading to change in the libraries, the one is internal and the other is external factors. Internal factors can be introduction of new service, application of ICT in libraries, book purchase policy, marketing strategies, cordial relationship between library staff etc. The external factors outside the libraries influence in a huge way. Such changes arise due to political and economic environment, legal and government policies of parent organization, drastic advancement in technology, change in information needs of users etc.

The popular belief that the new technology will replace human labour by robots is utterly false. Actually the new technology will employ more people who are highly skilled and highly trained (Drucker, 2008, pp. 1-18).

The revolutions of ICT affected every footstep of present library system. So, these technologies influenced institutional libraries & are facing many challenges, to overcome these challenges successfully traditional library management need to be redefined. In today's situation of library management may be

redefined as: "A dynamic, highly intellectual human activity of creating and maintaining a digital collection by using various resources and by performing various managerial functions to serve efficiently and effectively to meet the library user's demands of locally and remotely by introducing advanced suitable techniques, technologies and fact based practices."

MANAGEMENT OF DIGITAL RESOURCES IN MEDIA LIBRARIES

Management is defined as "the work of creating and maintaining environment in which people can accomplish goals efficiently and effectively." Management of technology encompasses the management of research, product and process development.

The three jobs of management: managing an organization or library; managing managers and managing workers and work, can be analyzed, studied and appraised separately. A management decision always affects all three jobs and must take all these three into account. And the most vital decisions of the future of digital resources are made often as decisions of the present, be it on budget, ICT infrastructure, subscription or renewal of digital resources, usage, maintenance, standards or service to the users (Drucker, 2008, pp. 1-18).

Media libraries hold collections of print and digital media. Audio visual materials play an important role in disseminating required information to the people within few seconds. In order to meet the needs of the users effectively, digital media libraries has to use a combination of advances in technology and have the ability to design, build, manage and use global electronic networks for establishing digital libraries throughout the world (Moghaddam, 2010).

Technology responds to needs and opportunities and the provision of resources. It is necessary to manage the digital resources in a systematic and well organized manner. So question arises why management of digital resources? What are the policies? How management strategies provide the library to serve in a better way with professional passion? The points listed below necessitate the need of digital resources management strategies:

- Users' service through greater access to accurate digital information sources and globalised reach.
- Concurrent access of same information resource by multiple users.
- Enhanced information resources and knowledge satisfaction among users.
- Less bulky than print resources and more economical and safer means of storing and keeping track of digital information resources.
- Easier access to digital information resources like old reports, e-Journals, e-Books, Online databases and even audio visual materials etc,
- Reduces errors and eliminating the ennui of long and repetitive manual processing.
- Greater accountability and transparency in operations by monitoring.
- Improved efficiency and effectiveness in administration and management of digital resources as it has unprecedented access to real-time information.
- More reliable security for sensitive and confidential information.
- Appropriate knowledge-based action and intervention can now take place in a timelier manner.
- Library networking through web based architecture.
- Digital collection enhances the R & D efficiently and accurately. (Devi and Devi, 2013)

STRATEGIC MANAGEMENT

A successful organization needs to develop effective strategies for achieving their mission and strategic planning is the organized process for selecting these strategies. Strategic management is generally considered as the process of formulating, implementing and evaluating strategies for an organization.

According to Drucker (1954) "Management is about setting yourself objectives and then break these down in to more specific goals or key results".(pp.18-25)

A strategy could be.

- A plan or course of action or a set of decision rules making a pattern or creating a common thread;
- Concerned with the resources necessary for implementing a plan or following a course of action;

According to George S. Odiorne, "Management by objectives can be described as a process Whereby the superior and subordinate managers of an organisation jointly identify its common goals, define each individuals major area of responsibility in terms of results and use these measures as guides for operating the unit and assessing the contribution of each of its member."

In the words of Koontz, O'Donnell and Weihrich, "Management by objectives is a comprehensive managerial system that integrates many key managerial activities in a systematic manner, consciously directed towards the effective and efficient achievement of organisational and individual objectives."

Chandler (1962), who made a comprehensive analysis of the interrelationships among the environment, strategy, and organization structure has defined the term strategy as the determination of the basic long-term goals and objectives of an enterprise and the adoption of the course of action and the allocation of resources necessary for carrying out these goals".

The Professors at Harvard Business School, viewed the term strategy as the pattern of objectives, purposes or goals and major policies and plans for achieving these goals, stated in such a way, so as to define what business the company is in or to be and the kind of company it is or it is to be.

According to Glueck (1980) strategy is a unified, comprehensive, and integrated plan relating the strategic advantages of the firm to the challenges of the environment. It is designed to ensure that the basic objectives of the enterprise are achieved.

The word strategy has entered in the field of management more recently. At first the word was used in the terms of Military science to mean what a manager does to offset or potential actions of competitors. Originally the word strategy has been derived from Greek "Strategies" which means 'general'. The word strategy, therefore, means the art of the general. When the term strategy is used in military sense it refers to actions that can be taken in the light of action taken by opposite party. Strategic Management is a systematic, organized and professional approach that allows the management of digital resources to focus on achievable objectives and to attain the best possible results to increase the organizational digital library performance to achieve organization *goal* (Ruth, 1983).

To provide vision for the future, leadership and an agreed framework for the conduct of business in an ever more rapidly changing and globally competitive environment organizations or institutions whether small or big are obliged to plan their activities. In many organizations the very notion of strategy has become devalued what is being rejected is strategy as pedantic planning ritual. Strategy as foresight architecture and intent and organizations redefinition to create new competitive space, is the greatest value added that senior management can contribute

THE 21ST CENTURY CONTEXT FOR STRATEGIC PLANNING:

The subject of corporate marketing strategy and its role in achieving a competitive edge has assumed greater significance in recent years for four important years:

1. The first is the context of global uncertainty and continuous change that followed from the major international economic crises of 1973, 1979 and 1991-92 and the associated political and environmental upheaval.
2. The second reason driving strategic thinking is the remarkable development of ICT in the 1990s. Information and Communication Technology (ICT) has facilitated the globalization of trade through the instant exchange of information so that changes in prices, product offers and international currency rates are now subject to continuous 24 hours changes and competitors and all stakeholders, creating a volatility that changes the whole nature of forecasting.
3. The third also driven by the information revolution is the ability of companies to step across traditional industry boundaries with supermarkets, banks, dot.com companies etc., entering the field of travel distribution.
4. The fourth is the continuing growth and expansion in travel and tourism of a small number of large, transnational and global organizations locked in fierce competition for market share and sales revenue.

These four reasons are especially powerful in 'information rich' at international level. These new approaches heighten the need for corporate vision, leadership, coordination and support at the same time restricting the direct operational involvement of staff (Venkadesam et al., 2004).

DIGITAL RESOURCE MANAGEMENT STRATEGIES

There is a proliferation of e-resources and it is difficult to make right selection out of so many available resources which have very subscription rates. Therefore through evaluation of the product has to be made before purchase or subscribed for proper utilization. Digital resource management strategies may be considered as managerial level or top level management that makes a framework and policies about how to establish, collect, organize and manage the digital resources with the help of operational level strategies or middle and low level management to achieve excellence in organizational goal of a digital library. "DRM activity might therefore be called the 'brains' behind well managed digital library services. The Holy Grail of ERM is management of the entire lifecycle, with support for the following kinds of tasks:

- Discovery of new products.
- Product evaluation and comparisons.
- License negotiations.
- Ordering and renewal.
- Tracking license terms.
- Point of use information about license terms and technical support.
- Creation of web gateways.

- Individual title access through catalogues, searchable title lists and link resolves.
- Overlap analysis of database products.
- Usage analysis.
- Access management.
- Proxy services.

Various facets involved in the digital resources management strategies are:

Requirement Assessment

User's information needs has to be taken care. Comprehensiveness, scope, subject coverage, accuracy, availability in time, scholarly, extensive content, updateness etc of the product has to be checked. Communicating with libraries and library users already referring the digital resources and its reviews will help for prediction or decision and evaluation and also duplication and data hampering of existing digital resources may be avoided.

Periodical feedback from users and decision of the library committee are important factors for taking decision for licensing / purchasing / acceptance or rejection of e-databases. Migration from existed or additional computer hardware, software and speed of the internet should be taken care while managing digital resources.

Interacting with Vendor

Interaction with trade parties or vendors regarding negotiate pricing, licensing, security facts (authentication & authorization). The vendors should be supportive to various search operators, user-friendly and instant customer services and compatible with existing hardware and software.

While negotiating for subscription of e-database there are some important aspects to be considered: whether it is in print format or digital format, online DVDs and online access through website and price list and comparative statement can be done which is quite expensive. But content, access, cost, taxes are also tough considerable points.

Trial of Digital Resources to Be Procured

A trial enables the librarian to offer the e-resource to some or all users – who may include users, librarians, research scholars alike and then base a decision on their feedback. During the trial process, the librarian distributes the digital resource in the specific areas of the library environment through intranet, notifies the relevant audience, and obtains feedback. Librarians pay considerable attention to specific issues while testing digital resource. The librarian provides institutional list of IP addresses to the trade parties for enabling the access. The librarian can proceed for the approval of the products after completion of the trial and its usage appraisal.

Acquisition of Digital Resources

Suppose library committee decides to finally purchase and subscribe to the resource, Library professional carries out an acquisition process that somewhat resembles the process for print resources; obviously an extended detail is necessary to know by librarian.

However, an additional level of detail is required, such as, information about the license and the availability of the resource to various populations of users. Also, when a library is acquiring e-journals as part of a package from an e-resource aggregator, such as EBSCO, the librarian needs to know which journals are covered by the package and for what period of time; ideally, the librarian would have the option to pay one lump sum for the entire package or to pay separately for each title. Furthermore, the print and electronic formats may be linked in such a way that cancellation of the print format would invalidate the license agreement for the electronic format. Another issue is how to handle the distribution of a payment between the licensor of the package and one or more interface providers.

Keeping in mind the requirements of the institutions and ensuring technical feasibility of the product, the librarian has to negotiate with the vendors with necessary amendments before its final acceptance. After going through above mentioned formalities one can proceed for final purchase.

Access to Procured Digital Resources

Once final access is provided by the trade parties, users should be informed about the availability of digital resources and they should also be informed about various aspects of licensing issues. To ease the access the librarian has to provide link to library website, create alphabetical list of the resources. Notify the product through e-mail, in-house notifications, campus circular etc.

User Support and Promotional Activities

Demo of the product supplied by the trade parties should be incorporated in the orientation programme, user education, usage training, license/lease agreement and providing contact details of the library staff on websites. Feedback from the users regarding the product from time to time should be taken seriously and incorporated in the library evaluation activities.

Monitoring the Usage of Digital Resources

Any changes or modifications in the usage pattern made by the trade parties, at their convenience, should be eagerly monitored along with popularity of the product among professional colleagues. User report provided by the trade parties should also be considered.

Cancellation/Relegation/Renewal

In case, the usage of the database or product decline considerably due to inferior quality or access problem one has to think of some other options. If the product cost outgrows its benefits, its circulation is stopped by the vendor or support services altered then one has to go for cancellation. But if the services of the product are highly satisfied and beneficial to both the users and the institutions then it is best to proceed further for the renewal. (Singh, 2010).

STRATEGIC PLANS TO OPTIMIZE THE DRM FLOW CONTROL

While defining new policies for digital library, Library professionals should keep in mind about various management issues like *Human resources management, disaster* management, Training, copyright management, security management, preservation management, finance management etc. So following are the strategic plans to optimize the DRM flow control:

- Monitoring the preservation implications and priorities for preservation of different information Resources,
- Store and organize digital resources and ensure high security, automated checking, archiving and back up with adequate disaster preparedness and recovery procedures,
- Document collections including file formats, software and hardware dependencies,
- Classify these digital resources based on its content and functionality,
- Record preservation of metadata that facilitate effective and efficient management, and
- Develop appropriate pathways to access these resources in conformity with its authenticity, intellectual property rights (copying, storage, modifications and use of specific resources) and cost effective as well.

INTERNAL DIGITAL RESOURCE MANAGEMENT

Digitalization and digital access are integral part of the library activities. Library & information centers are currently in a transition phase from traditional print to digital information collections. Traditional libraries are changing to digital library form and some are already in progressive stage. The traditional libraries already existed print asset are to convert them into digital form, which has to be converted to digital form, organized, retrieved and disseminated among the users. Hence internal digital resource management proposes creation, discovering, preserving, archiving, implementing through web based automation of existed print materials to digital format by utilizing existed technical staff, information technology environment, to achieve enhanced productivity of the library. The digital content management requires important functions like:

- Innovation (Trail based sample conversion of physical asset);
- Creation (Scanning, OCR, Metadata creation);
- Discovery (Indexing, searching of metadata standards);
- Preservation (archiving, migrating, collection, dissemination tools);
- Management (Adding/Deleting/Modifying collection, Monitoring, usage report generation. Venkadesam, S et al. (2004).

THE ROLE OF LIBRARIAN IN THE STRATEGIC MANAGEMENT OF DIGITAL RESOURCE

Storage, preservation and dissemination is becoming a skilled task The different types of skilled professionals include the domain experts, computer experts, training experts and users who are I need of

different formats of knowledge which includes text document, images, graphics, animations, audio and video recordings and multimedia digital resources. The digital librarian should be responsible for the following duties in digital resource management strategies; Gray, Sharon(2002).

- Establish, organize, manage the digital knowledge and information and in the digital library.
- Disseminate digital resources and provide digital reference services and electronic information services.
- Provide information mining from the emerging knowledge warehouses.
- Handle the responsibility of massive digitization, preservation for a long term planning.
- Deliver training to supporting staff and users for usage and maintaining of digital resources and to navigate for effective searching.
- Decision making in critical situations like natural disaster.

COPYRIGHT AND LICENSING

A major assumption of the information age is that information will be available to all for a free. But the contents are protected by copyright law whether they are published on paper or on the internet. Copyright law is a national law and Berne Convention of 1886 brings the principle international treaty. Article9(2) of the Berne Convention for the Protection of Literary and artistic Works provides that countries may allow for exceptions to the author's exclusive right or reproduction in certain special cases, provided that such reproduction does not conflict with a normal exploitation of the work and does not unreasonably prejudice the legitimate interest of the author. Under this Article, libraries can digitalize the content but uploading the same for public access requires permission of the copyright owner. So depending on the license terms and conditions, the resource has to be provided to the user. Digital resources have problems at creation as well as management levels. Copyright, legal and financial issues are to be handled properly. There are large number of terms and conditions which are to be settled during purchase of digital resources. Media libraries are privately owned corporate libraries providing services and collections to their specific users only and pay-per use of information or licensing fees may apply for the required information. Dr. Kaul, H.K.(2012)

SUMMARY

Stepping in to a digital library by library professional is witnessing a drastic change in information Technology. Library users are demanding more digital resources and customized search. To establish a digital library there must be necessity of a professional framework called digital resource management. It is defined as organizational top level process consisting of important activities such as defining new policies, planning, organizing staffing, directing coordination, monitoring, reporting, managing financial issues etc. to achieve organizational goals and objectives of any organization. So, management of digital resources consists of systematic outline to ICT Infrastructure for long term digital collection, selection, creation, acquisition, evaluation, licensing, access and promotional activities. It is the combination of digital resource systems, sufficient and proper allocation of staff, adoption and standardization. Strategic planning, policy making and documenting workflow and procedures are interrelated activities that are

hallmarks of professionals. Library professionals should work towards creating, innovating policies, documenting their workflow and planning in all areas of digital resource management. Digital resources have not been able to replace printed material. Peter Drucker (2002) has rightly stated that online edition delivered over the internet to be printed out by the subscriber for readability. UKOLN project has coined the phrase 'hybrid information environment' which is likely to continue in the present 21st century (Samantaray, 2010).

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Chapter 5
Security in Digital Images: From Information Hiding Perspective

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ABSTRACT

Due to the swift growth of the using of the digital multimedia in the internet these days, the security in digital images has become a very important issue. Lately, significant attentions are given by many researchers in the field of the security for digital images, and several image encryption techniques have been developed to improve the security levels of these images. Different techniques can be applied to protect intellectual property rights for digital images and prohibit illegal copying. The aim of this chapter is to introduce the most important techniques that have been developed to implement the security in digital images such as digital watermarking and image steganography.

INTRODUCTION

Image processing can be defined as "the manipulation of an image for the purpose of either extracting information from the image or producing an alternative representation of the image" (Rafael & Richard, 2002). Image processing has several stimuli that may be categorized into the following:

- To implement the security levels to face attacks versus the images such as: copyright violations or image integrity.
- To eliminate undesirable components those are distorting the image or to improve the pictorial information in order to be interpreted by human.
- To elicit useful description and representation by showing the images in a more evident shape.

Digital images have been lately implemented in many several fields and disciplines. However, with some types of computer programs, those images and its data can be duplicated or modified easily. If these duplications or modifications are illegal, then they will make us questionable when considering the digital images as proof in a legal issue. The differentiations between digital images and the nature

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of texts, the traditional textual security techniques are not adequate to be implemented on the digital images for two major causes (Alireza & Woo, 2011):

- The size of text format is mainly much smaller than image. Thus, to secure and encrypt the data of image, the traditional techniques of cryptosystems require much time to be implemented.
- When the text is decrypted, then the resulted text must be matched with the original text. However, this issue and rule is not necessary to be always true with the images.

With the growing use of multimedia applications such as image processing applications, the security has espoused a significant manner on the storage of images and communication. In the literature of the security of multimedia information system, there is no comprehensive or thorough review for two causes (Shiguo et al., 2009):

- The variety and intricacy of security issues and the congruous protection in the multimedia information system could be varied.
- The nature of multimedia systems is emerging continually, which fetch emerging security threats and their solutions continually as well.

The sharing of digital data became easier than ever because propagation and existence of: computer networks, storage tools, and imaging devices. Such type of sharing data; however, the questions on "how sensitive information can be protected?" have increasingly needed to be answered. For instance, when the user of digital camera in the mobile-phone needs to enhance and improve his private picture with one of the online image processing applications. The user who owns the picture concerns the privacy of his picture. At the other side, the online application (image processing website) concerns the issues of the protection by improvement the technologies against any attacks. The goals of image security are mainly found to ensure the following issues:

1. The originality of the image, and proprietorship of the creator or the sender of the image.
2. The safety of the data image, by ensuring that the image had not been changed.
3. Privacy, by protecting the proprietorship and content of the data.

Recently, digital media protection will be a mandatory issue with the growing of distributed multimedia systems. This is specifically significant for the protection and implementation of some types of intellectual rights such as copyright. The protection of copyright includes the authorization of image proprietorship, and it may include the recognition of unauthorized or illegal copies of a digital image. In order to prohibit the unauthorized or illegal distribution or copying the digital media like images, many number techniques were needed. In the case of placing the digital images on the internet imposes them at danger of steal and replacement especially when no protection techniques were used.

One of the most important techniques which enforce such sensitive data, images and copyrights is an image watermarking (Chang et al., 2002 ; Ruanaidh et al., 1996 ; Shih & Wu, 2005). Another science or technique to do the same task is cryptography by securing data which dismantles it using some encryption algorithms (Highland, 1997 ; William, 2003). Steganography is developing and a very robust technique for securing data because it does not provide evidence to doubtful. It can be defined as "an art and science of hiding data in other innocuous medium" (Artz, 2002 ; Wang & Wang, 2004 ; Altaay et al, 2012).

Three mandatory characteristics must me imposed by security of images, as mentioned in (Fridrich et al, 2002):

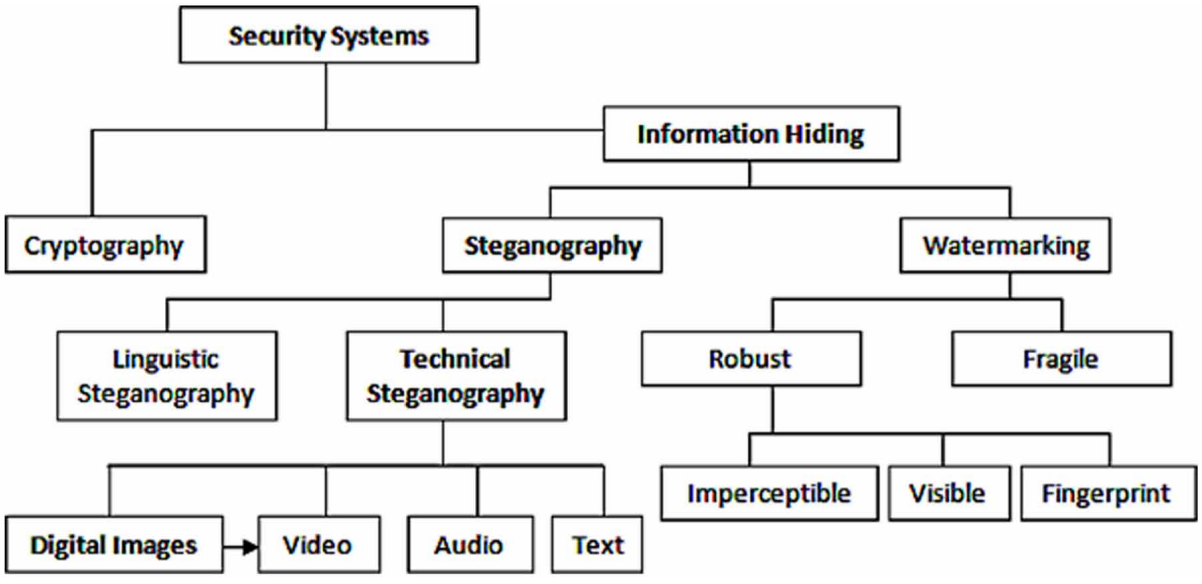
- **Confidentiality:** The images will be used and accessed by only the authorized persons.
- **Reliability:** Can be taken from two perspectives:
  - **Integrity:** An unauthorized person will never alter the image;
  - **Authentication:** It can be examined if the image belongs exactly to the right and authorized source or person.
- **Availability:** An image should be able to be accessed and exercised by the authorized persons in the normal situations within reasonable time.

Background

This chapter provides an analysis and criticizes the various current techniques under the two main information hiding techniques: watermarking and steganography. Different popular criteria and guidelines depicted from the literature. Figure 1 shows the most techniques, types, and classifications that will be discussed in this chapter.

This chapter swivels about the watermarking and steganography in digital images and does not introduce of steganography such as: linguistic, audio, video. Additionally, cryptography will not present because its carrier and the secret data are a text based, with some minor extensions to the digital images. So, it is beyond the field of this chapter.

Figure 1. The overall disciplines of information hiding
(Chaddad et al, 2010).



Digital Watermarking

In order to protect digital images, concealed confirmation notes and copyright comments can be added by the technique of digital watermarking (Rafael & Richard, 2002; Cox et al, 2002). In image watermarking, information in images can be embedded based on some characteristics of the images such as the redundancy of the images and the perceptual feature of human. Because of the low vulnerability of the human visibility to slight modifications and the elevated resilience of digital images, a very few number of persons can percept these slightly added modifications.

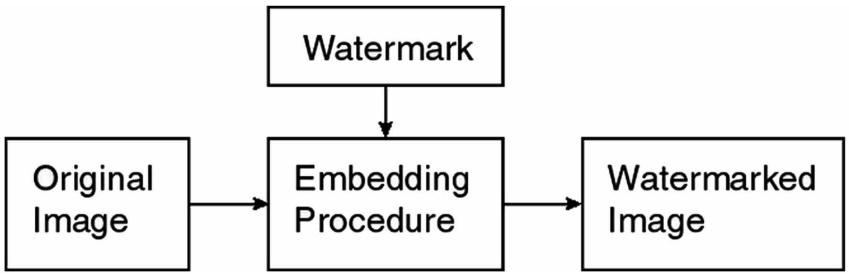
It is very important to embed hidden information within an image to make sure that the protection of the copyright is achieved. Only entitled person with the protection of the copyright can access this information of the image. The best method to do this is to put the information of copyright into the image by intelligently adjusting the chrominance and luminance values of the specific pixels. Keeping the watermark secret and its location could provide an additional protection. If this information found by an unauthorized person, then he will never understand its meaning.

To protect the digital images, many techniques are found such as: authentication, encryption can be utilized along with the image. Figure 2 depicts the procedure of general embedding watermarking technique.

The optimal characteristics of a digital watermark have been mentioned in many papers (Cox et al, 1997; Swanson et al, 1996 ; Pitas, 1996). These characteristics involve:

1. To prohibit retardation of the original image, a watermark should be not noticed by humans.
2. A watermark should not be statistically discovered or eliminated.
3. The extraction process of watermark should be short and simple. At the other side, the detection process should be time consuming.
4. The detection process of watermark should be very precise. In other words, minimize the possibility of false positives (detecting spurious watermark) and minimize the possibility of false negatives (missing real watermark).
5. Several watermarks can be generated, in order to mark too many number of images.
6. Watermarks should be arduous to several types image processing such as: compression, additive noise, and filtering.
7. The right proprietor of the image should be determined by the watermark.

Figure 2. General image watermarking procedure



Several watermarking techniques as in (Berghel & O'Gorman, 1996; Cox et al, 1995; Macq & Quisquater, 1995) have to recognize a perfect differentiation via many watermarking characteristics such as: the computational cost, robustness and quality.

Watermarking and steganography are very similar from different perspectives. Both of them require to entrenched information within a cover message with slight to no devolution of the object. However; watermarking -in order to achieve a robustness characteristic- needs a further requirement. An optimal steganographic system would entrench a huge magnitude of information, quite securely without noticeable devolution to the object. However; at the other side, an optimal watermarking system would entrench a magnitude of information. This added information should not be changed or eliminated without producing the object quite unusable.

Digital Image Watermarking Classification

Most of the significant classifications of watermarking based on several watermarks (Petitcolas et al, 1999) are given as follow:

1. **Visible Watermarks:** When the user cannot read the image, the watermark is considered as invisible watermarking (the watermarked image cannot be read using the same as the original image).
2. **Invisible Watermark:** Invisible watermarking, where the watermark is invisible to the user (it cannot be read through regular image reading).
3. **Fragile Watermark:** It can be defined as tamper-proof watermarks. This type of watermark is crashed once it is processed. It is intended to be crashed when it exposure to any shape of processing or even copying. It means that if the watermark is not found, then means that this copy of the image is an illegal copy.

Classification of Image Watermarking Techniques

The frequency sensitivity can be referred to the response of the eye for some frequency changes such as: spatial, time, or spectral. Spatial frequencies are distinguished as textures or patterns, and spatial frequency sensitivity is always defined as the sensitivity of the human vision to luminance alters (Friedman, 1993). It has been shown that a human eye is being very sensitive to luminance alters in the mid-range spatial frequencies, and this sensitivity minimized at lower and higher spatial frequencies. The techniques of the digital image watermarking may be classified into two main categories:

1. **Spatial Domain Techniques:** These techniques of watermarking can also be implemented using color separation. The watermark will be displayed in only one of the color bands, in such cases. This will make the visibility of the watermark is perfect and it will be very hard to discoverable under normal situations. However, the hidden mark displays instantly when the colors are detached for specific processing tasks such as printing. This makes the document which contains the mark not useful for the printer and the watermark can be eliminated from the color band. These types of techniques are mainly used in the commercial field like journalists.
2. **Frequency Domain Techniques:** In compared with the spatial-domain techniques, the frequency-domain techniques are more broadly implemented. The main objective in this classification is to embed or insert the watermarks into the spectral coefficients for the image. The mainly used trans-

forms as in (Friedman, 1993) are: the Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), and Discrete Wavelet Transform (DWT). The characteristics of the human visual system is better seized by the spectral coefficients is considered as the main reason for watermarking in the frequency domain. By other words, the low-frequency coefficient is considerably perceived and the high-frequency is believed inferior. To gain a trade-off between robustness and imperceptibility, most techniques embed watermarks in the midrange frequencies.

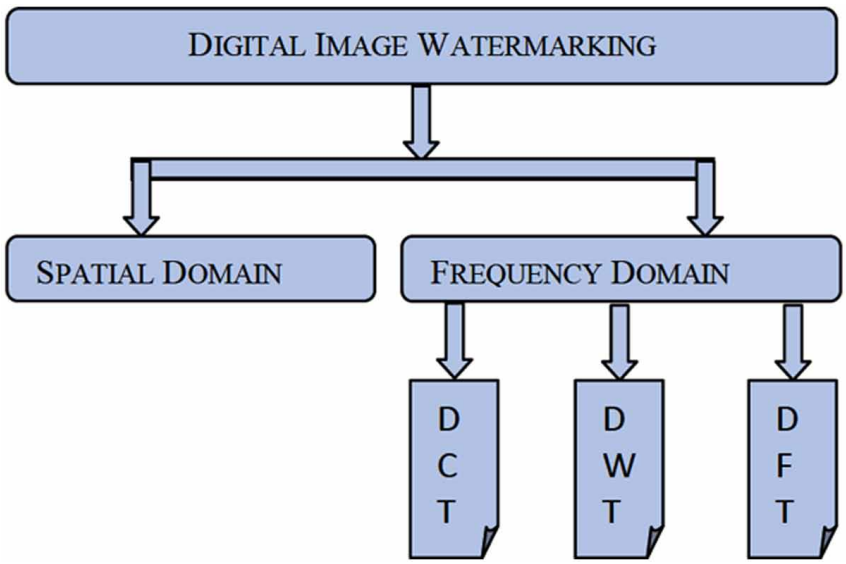
Figure 3 shows the operational fields of Digital Image Watermarking. The spatial domain will come after the wavelet or frequency transformation domain from the robustness and compatibility perspectives based on the common standards of image compression. The frequency domain involves different types of transformations such as: Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT).

Characteristics of Watermarking

In the digital image watermarking, the concepts: characteristics, properties, requirements or attributes can be used interchangeably. The applications and their purposes of the digital image watermarking will determine their characteristics. These characteristics should be considered once the watermarking system is designed. The main characteristics of the digital image watermarking are given as in (Ming-Shing & Din-Chang, 2001 ; Sin-Joo & Sung-Hwan, 2001):

1. **Invisibility:** When a watermark is embedded within the image, then it will be invisible and the content will contain the hidden watermark inside. A hidden watermark can be discovered by only the owner or an authorized person. These watermarks are used for different applications such as: author or content authentication and it could be used for detecting illegal copying.

Figure 3. Digital image watermarking classifications
(Jobenjit & Shivani, 2013).



2. **Robustness:** An embedded watermark should not be affected or destroyed by an image processing or forgery attacks. Even if an attack removed the visible watermark, then it could be restored by the backup invisible watermark. The original image incorporates the visible watermark into, whereas the watermarking system adds an invisible watermark to this image. Consequently, it can be considered as a watermark within another one which creates binary watermarked images. Thus, a robust watermarking can be developed using this technique. In order to achieve more robustness levels, watermark could be added to different locations inside the image. So, it could be retrieved and restored easily if more than one or more watermarks were removed.
3. **Security:** Generally, a watermark must be confidential and not discoverable by any user except the owner or an authorized person. Moreover, there watermarks should be accessed by those authorized persons. Using cryptographic keys a very important characteristic can be achieved in the watermark and security at the same time. So, the algorithm of digital watermark and its details could be propagated globally. A signal of specific watermark is associated with a particular number which uses to express and embed a watermark. This particular number is must be kept secretly and it could be used to make sure who is the authorized and the owner of digital image. The invisibility will be foible or weak when there are many constraints and restrictions on the robustness. Consequently, when the watermarking system is being designed there should be a significant consideration and trade-off between the invisibility and robustness (Brajesh et al, 2013).

Applications of Digital Image Watermarking

There are many number of image watermarking applications, the main applications as indicated in (Hartung et al, 2005 ; Jobenjit & Shivani, 2013) are given in the following:

1. **Fingerprints:** In such applications, information about the authorized receiver is embedded into the image. Several watermarks are embedded into each published image in the fingerprint application and enable the owner of the image to control and place the images that are unauthorized acquired or altered. Linking distinct information about each published copy of the digital image or content is known as fingerprinting, and a suitable solution for such applications is a watermarking because it could not be visible, known or even isolated from the contents (Kougianos et al, 2009). Adding or embedding information about the legal usability of the image will prevent an illegal copying or using of that content (Keshav & Dheerendra, 2010).
2. **Image and Content Authentication:** In these applications, the main objective is to discover alterations to the image. Different image attributes like edges could be used in order to compare with the existing images to detect any differences. A message authentication technique can be applied as a digital signature to solve these types of problems which derives from cryptography science. Digital signature mainly performs several types of content summary. Tampering could be detected and considered when any portion of these summaries had been altered. The rule of digital signature here is to make the detection process.
3. **Medical Applications:** On the MRI and X-ray images (reports), the patients' names are printed by a visible of watermarking techniques. The patient can gain benefits and take the right treatment by the significant task that offered from these reports. If two reports for different patients are mixed up, then this may result a catastrophe (Coatrieux et al, 2006).

4. **Copyright Protection:** A watermark can be embedded into the image to achieve a copyright of information. If there is a disagreement on the proprietorship, then to know who is the right owner? The watermark will be extracted as evidence and it will be used to resolve this trouble (Jain & Xiang, 2005).
5. **Broadcast Monitoring:** This kind of monitoring is applied mainly in the advertising field in order to ensure that the material broadcasted as the commitment and agreement between different parties such the client advertisement firm (Yusof & Khalifa, 2007).
6. **Tamper Detection:** Tamper detection can be detected by using fragile watermarks. If this watermark is crashed or even altered, it denotes existence of tampering and then this will make a digital content is questionable.
7. **Content Description:** Captioning and labeling of the host image and other further information can be embedded into this type of watermark. For such types of applications, the watermark capacity should be comparatively huge and it does not include constraints or restrictions on the robustness requirement.

Drawbacks of Existing Watermark Systems

1. The main trouble of most of the watermarking systems is that there is no system that can face most of the image attacks or manipulations. These systems are completely sophisticated to be performed timely.
2. **Digital Fingerprints:** The main issues with concern to this application are: Legal Issues, Security Concerns, and Technological Compatibility.
3. **Encryption:** Electronic devices are used to store encrypted information of criminals, or they used secure channels.

Attacks on Digital Image Watermarking

A watermarked image could be modified by mistake or intention. Thus, the robust feature should be found with the watermarking system in order to discover and elicit the watermark. A modification or alteration is considered as an attack that can be performed to distort the quality of the image by adding some deformations. The classifications attacks of the digital image watermarking can be categorized into: non-geometric and geometric attacks. If the watermark is weak, then the attack will be successful and the watermark will be considered as a watermark with a very low acceptable limit (Jobenjit & Shivani, 2013).

1. **Geometric Attacks:** A group of parameters that can be implemented on the image are known as geometric attack. In other words this type of attacks is mainly basic geometric mutations or transformations within an image. Geometric attack may involve: cropping, rotation, scaling, translation, warping, etc.
2. **Non Geometric Attacks:** It involves different signal image processing steps such as: printing, averaging, filtering, sharpening, brightness, scanning, gamma correction, addition of noise, compression of image, etc.

Image Steganography

Steganography is a hiding information technique for digital media such as images in order to hide the presence some or all of the information. In this case, cover media is the digital media without hidden information; whereas the stego media is with (Birgit, 1996). Steganography can converge both authorized and unauthorized weal. The target of communication in steganography is a concealed message and the cover data means how it can be sent. The secret and hidden information as along with the cover data could take any shape of the media such as: audio, image, video or even text. It is well know that the Information security is a very critical subject in all computerized systems around the world and it will remain. Digital Steganography as in (Shuozhong, 2005 ; Bailey & Curran, 2005 ; Kahn, 1996) is considered as of the major trigger that can be used to implement the securing level on the data. Using steganography, the secret information are hidden within signals as an insignificantly information.

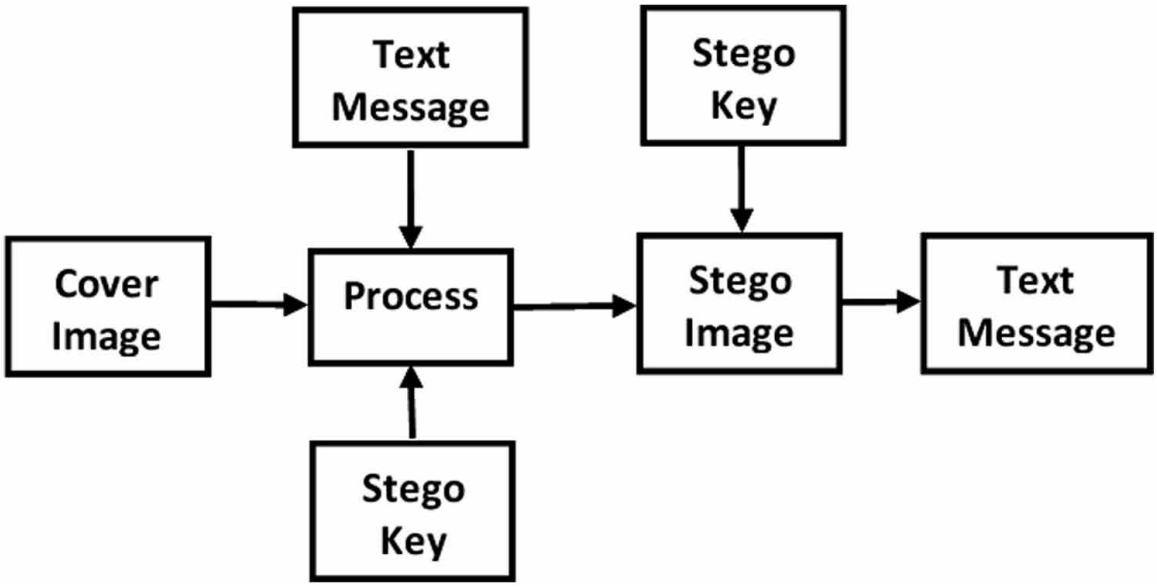
The steganography depends on the reality of the observation and senses of the human that are not enough in compare with computerized systems. Thus, the human senses such as: hearing or vision does not have the ability to discover very slight or teeny alterations in visual or auricular scenes that makes a steganography a very strong technique to hide the important information (Birgit, 1996).

Steganography (Cox et al, 2007) is implemented as a secure communication channel by hiding the secret information into some multimedia materials (such as images) and then sending them to recipients insignificantly. Only the intended recipient who engaged the transmitter has the ability to discover these multimedia materials and then grab the secret information from. The main difference between Steganography and watermarking is that the multimedia material (such as images) can be detected to know if it was altered and doubtful by a third party. This phenomenon is called steganalysis. This third part has the ability also to decide to eliminate these illegal modifications if they are occurred. The steganography algorithms will be considered a robust algorithm when it has the strong resistance level to the primary and ultimate steganalysis techniques.

A cover image is used in steganography as the carrier of concealed message and should have regular and unhurt presence without arousing any type of mistrust. The cover image could be called as stego image if it has the hidden message and then use it for discovering the message at the recipient side (Jamil, 1999; Munuera, 2007 ; Sanjay & Kanak, 2012). The secret key that could be simple or composite, with the usability to insert message into the cover image and discovering message which embedded from the stego image is called stego key. This key can be created by achieving some computations based on some criteria such as (the size of the cover image and its texture) or it can be generated randomly. The general procedures of steganography are presented in Figure 4. The features of the cover image that are using to conceal the message in it are referred as embedding domains. Transform domain techniques or spatial domain techniques can use these features and characteristics. In the past, the image pixels are altered and manipulated straightly for embedding. However and recently, before the images really embedding, the message should be transformed mathematically (Ratankirti et al, 2013).

As mentioned that the main idea in steganography is that it depends on the reality that human does not have the ability to know if an image file or a sound or even a portion of text really comprises concealed information. Steganography is a very efficient technique for protecting information especially when the unauthorized receiver of information or assailant does not understand or discover that the digital media (images) given before them really includes concealed information because when this is discovered, steganography unlock itself up to assault and forfeits its most powerful feature: innocuousness, which represents the detection feature of steganography.

Figure 4. General skeleton of steganography
(Sanjay & Kanak, 2014).



Classification of Image Steganography

The existing steganographic methods were classified in (Brajesh, et al, 2013) as follows:

1. **Transform-Based Steganographic Methods:** In these methods, the signals will be mapped to other types of domain like Fourier transformation or even DCT (Pevny & Fridrich, 2007); the gained co-efficient are modified.
2. **Palette-Based Steganographic Methods:** The steganographic message will be hidden within the indices or the palette bits. The number of colors should be taken in account to be sure it will not exceed its allowable limit, when the image file format has been used.
3. **Spatial Domain-Based Steganographic Methods:** Least Significant Bits (LSB) is the mainly used steganography type in many applications like uncompressed file like BMP or TIFF. In a specific layer, the modification on the least significant bit will result a hidden secret message.

The Requirements of Steganographic Techniques

Three main requirements could be applied to estimate and evaluate the steganographic performance techniques as listed and discussed in (Bin, et al, 2011):

- **Security:** Active or passive attacks may be considered as the most trouble with the steganography. If the presence of the secret message can only be evaluated with a possibility less than or equal random appraising key in the existence of several steganalytic systems, then under these systems, steganography could be evaluated as a secure technique. However, in the other cases steganography will claim as insecure.

- **Capacity:** In order to be valuable in carrying secret message, the concealing capacity supplied by steganography technique must be a high as much as possible. The capacity may be provided in ultimate measurement like the secret message size, or it may be a comparative value (e.g. the bits in each pixel, or the secret ratio message) which is known a data embedding rate.
- **Imperceptibility:** Visual artifact scenes could be served by stego images. It will be better when the stego image has a very high value of fidelity when compare to others under the same circumstances of the capacity and security. If the consequent stego image seems unhurt, then this characteristic has to be persuaded for the custodian not having the authentic cover image in order to contrast.

Types of Attacks on Image Steganography

Steganalys is be defined as the attacking steganography science in a combat that never stops. It simulates the existing founded or developed science of Cryptanalysis. A steganalysis system can be created by steganographer in order to evaluate the robustness of his algorithm. Steganalysis can be performed via implementing several techniques or step of image processing such as: translating, cropping, rotating, and filtering. Additionally, it can be performed deliberately by specific program that explores the structure of stego image and evaluates its statistical characteristics such as first and second order statistics (Chaddad et al, 2010). Based on available information for analysis, there are various types of attacks. They can be categorized into six main categories as in (Gangadhar et al, 2013):

1. **Stego-Only Attack:** The stego-image is only available for analysis.
2. **Cover Attack:** The authentic cover and stego images are both obtainable.
3. **Message Attack:** At some point, the concealed message at sometimes could be known to the attacker. But it could be useless for the attacker.
4. **Chosen Stego Attack:** Where the stego-image and steganography tool are already known.
5. **Chosen Message Attack:** Steganalyst generates a stego-image from steganography tool from a chosen message.
6. **Known Stego Attack:** algorithm is known and both the authentic image and stego-image are obtainable.

Steganalsysis can be mainly categorized into universal and specific steganalsysis based on to the tools of targeted steganographic. Universal steganalsysis is known as blind or universal blind steganalsysis, while specific steganalsysis is found to discover some specific steganalsysis. Without steganography algorithms, universal steganalsysis can discover the presence of secret message and workable than the other type of steganalsysis.

CONCLUSION

Steganography is an approach and science that can be used to secure information by hiding messages within some types of covers and suitable multimedia carrier that will never known by attackers. These cover files could take any file format of digital data such as audio or image files. It depends on the

proposition that if the attribute is visible, then this means that there is an obvious point of attack, thus the main target is mainly to hide the very presence of the embedded data.

Over the past decade, digital image watermarking is an increasing research topic that has received considerable interest from the researchers. For copyrights of different electronic materials and media, the watermarking is a very significant domain. With proliferation of digital images on the Internet, sometimes a watermarking is mandatory option. Digital watermarking is the processing of information along with a digital signal. A watermark is a minor image, which is embedded into the host or original image, and results a protected image. It behaves as a digital signature, providing the image a type of originality or proprietorship and it makes the image very resistance to the attacks.

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KEY TERMS AND DEFINITIONS

Cryptography: The art of protecting information by transforming it (encrypting it) into an unreadable format, called cipher text.

Digital Watermarking: A kind of marker covertly embedded in a noise-tolerant signal such as audio or image data. It is typically used to identify ownership of the copyright of such signal.

Discrete Cosine Transform (DCT): A finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies.

Image Processing: The manipulation of an image for the purpose of either extracting information from the image or producing an alternative representation of the image.

Image Steganography: The art or practice of concealing a message, image, or file within another message, image, or file.

Information Hiding: A technique to prevent system design change. If design decisions are hidden, certain program code cannot be modified or changed.

Steganalysis: The study of detecting messages hidden using steganography; this is analogous to cryptanalysis applied to cryptography.

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Section 2

Development and Design Methodologies

Chapter 6
Media Literacy in the Digital Age: Literacy Projects and Organizations

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ABSTRACT

Time has come to equip people communities around the world with digital and media literacy skills. In order make informed decisions, people need ability to access, analyze and engage in critical thinking about the daily messages they receive on a variety of issues such as health and politics. Today's "connected homes" provide people access to latest information and communication technologies. To become an effective participants in the information society of 21st century, people need not only acquire the multimedia skills but also the ability to use these skills effectively. One way this can be achieved is by including digital and media literacy in formal education. The objective of this chapter is to examine the media literacy programs working across the world to equip citizens to analyze and evaluate incoming information. In addition, the chapter provides some specific recommendations to bring digital and media literacy education into formal and informal settings.

INTRODUCTION

During 2009-2010, Ukrainian people saw an unusual set of bulletin boards in a collection of public places. "The person who uncovers that which was hidden–that's a real journalist," read one, against an image of a curtain being pulled back to reveal the word "truth." Another, showing different colored pens writing different letters and numbers, declared that "True news means various views on a single event." These billboards were a rare attempt to teach concepts of media literacy directly to a population at large, that is, anyone who happened to be passing by. The target was the practice of what Ukrainians call jeansa, or hidden advertising, in which a company or politician pays money to a media outlet to get a puff piece, presented as real journalism (Burgess, 2013).

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Many educators have been wary of the well-publicized hype about the unsubstantiated benefits of digital media in education because of their own real-life experience spending six hours a day with children and teens whose lives are more or less infused with cell phones, iPods and laptops. They know that simply using digital media tools is no educational panacea. A recent study of students in grades 5–8 showed that those from disadvantaged families got lower math and reading scores once the Internet arrived in the home (Knight Commission, 2012). Duke University analyzed test score of over 1500 US students to compare children's reading and math scores before and after they acquired a home computer. They then compared those scores to those of kids who never acquired a home computer (Vigdor & Ladd, 2010). The test scores of low-income kids who got computers at home declined more than children who did not get computers. For middle-school students, social networking, YouTube videos and online games can be a potent distraction from homework and other activities.

Even young people themselves are recognizing some limitations of life online. Some are concerned that screen interaction will replace face-to-face social relationships and others wonder if online civic acts are merely "token activism," creating an illusion of civic engagement while actually distancing people from their causes. "Such nuanced stances reveal that teens and adults are engaged in thoughtful consideration of the civic potentials of online life" (Global Kids, The Good Play Project and Common Sense Media, 2009, p. 17).

Whether we live in a democratic society or a one-party state, the ability to examine information and evaluate media messages is a vital skill set in our era. Media literacy can be defined as the skillful application of literacy skills to media and technology messages. There's a lot of stakeholders in the concept of digital literacy such as technology business, government at the state and local level in the world of education both in K-12 and in higher education as well as stakeholders in the activist community, the library community and creative community. Everyone seems to have a reason as to why all citizens in the around the world to be capable confident users and creators using a full range of digital media tools and technology. According to ALA Digital Literacy Task Force, digital literacy is the ability to use information and communication technologies to find, evaluate, create, and communicate information requiring both cognitive and technical skills.

Essential Competencies of Digital and Media Literacy

According to Chu, Lau, Chu, Lee, and Chan (2014), following are the essential competencies of digital and media literacy.

1. **Access:** It refers to finding and using media and technology tools skillfully and sharing appropriate and relevant information with others
2. **Analyze and Evaluate:** It refers to process of comprehending messages in which a user critically analyze the message quality, veracity, credibility, and point of view. It is done while considering potential effects or consequences of messages.
3. **Create:** It refers to composing or generating content using creativity and confidence in self-expression, keeping in view the purpose, audience, and composition techniques
4. **Reflect:** It refers to application of social responsibility and ethical principles to one's own identity and lived experience, communication behavior and conduct
5. **Act:** It refers to individual and collaborative work by a person to share knowledge and solve problems and participate in the community. The problems to be solved can be in the family, the workplace

and the community, and participation in the community can be at local, regional, national and international levels.

Media Literacy and Civic Engagement

For a long time, media literacy has been an important part of thoughtful civic engagement. The digital revolution has made media literacy even more critical. The explosion of digital media and social networking platforms has transformed citizens into publishers and broadcasters. Today, a truly media literate citizen is someone who not only understands the meaning behind the messages he or she encounters, but also has the ability to create quality content and distribute it in a variety of forms in order to become part of society's larger dialogue.

In countries all over the world, whether democratic or one-party states, governments are promoting media literacy as a vital skill set. Media development organizations uniformly say that it is a vital part of their work. Both programming and spending patterns among funders suggest that media literacy programs are a still small but growing focus of overall media development work.

Improving digital and media literacy require nothing less than national community education effort. Sorting through the flood of information most of us encounter daily requires new knowledge and critical-thinking skills. To participate fully as citizens, people need to be able to not just consume media messages but also create and share them. To fulfill the promise of digital citizenship, citizens must acquire multimedia communication skills and know how to use these skills to engage in the civic life of their communities.

As the global movement for media literacy education emerged in the early 1990s, there were many questions and opinions about what media literacy was all about. For the most part, media education activities were limited to grassroots efforts — an innovative teacher here, a pioneering school district there; some efforts were concerned about issues, like violence in the media or tobacco advertising; others were focused on skills, like video production and enabling young people to produce their own media.

Increasingly, media literacy projects are moving not only beyond broadcast to social and mobile platforms, but also into the realms of digital and beyond media literacy training. Producers of such projects recognize that in order to participate fully in the new media world, children, and adults need to be able to access, analyze, evaluate, and communicate messages in a wide variety of forms.

This new reality means that media literacy programs need to reach a vast audience. The objective of this chapter is to examine the media literacy programs and campaigns working across the world to equip citizens to analyze and evaluate incoming information.

CURRENT STATE OF MEDIA LITERACY PROGRAMS AND THEIR SPONSORS

To support the development of digital and media literacy competencies for all citizens, a comprehensive community education movement is needed. Local, regional, state, and national initiatives are essential. There are some key audiences and locations where this work must occur, including children and youth, new immigrants, special education students, juvenile offenders, and senior citizens, in schools, universities and colleges, libraries, youth media and local access centers. To achieve the buy-in necessary for success, initiatives must capitalize on existing local programs and resources and enroll new stakeholders, including educational leaders, members of the business community, and members of professional as-

sociations who are motivated to develop and sustain programs. We would take a snapshot of the current state of media literacy programs and their sponsors and revisit some of the questions that this new area of media development is raising.

Even as media literacy is seen as permeating most everything that media development groups do, it is rarely a stand-alone objective in programming. There are no media literacy line items on their budgets. And few practitioners have evaluated these programs to see what their overall impact has been. In part, this may reflect the fact that media literary is often viewed as a component within a broader program.

It is also a relatively small part of spending on media development, albeit a growing one. Spending by U.S. media development implementing organizations on media literacy is estimated to have risen from 0.2 percent of all media development spending in 2006 to 4.3 percent in 2011, the most recent data available. This is still a negligible amount when one considers that U.S. government funding for media development as a whole represents only about 0.4 percent of all U.S. foreign assistance (ISSU.com, 2013).

Media literacy is also undergoing a major change in the way it is defined. In its traditional definition, "media literacy" meant equipping citizens to evaluate incoming information for bias and accuracy, and it remains a crucial competency for participation in democratic society. But the advent of digital media and social networking platforms has made each of those citizens a potential publisher. In response, notions of media literacy have evolved to include the ability to create quality content and distribute it so as to become part of society's larger dialogue (ISSU.com, 2013).

Yet, in the world of media development NGOs, there are few programs that attempt to target entire populations. Instead, media literacy growth is more commonly treated as occurring through traditional training programs. By its nature, teaching content creation also imparts the skills of good consumption. Many of the activists who attend, say, an NGO seminar teaching how to blog responsibly in a time of political crisis won't make a career in the media, but whatever they do they'll be smart consumers of media for the rest of their lives. Another school of thought is that training programs will spawn high-quality content that will make people understand that not all content is created equal.

Practitioners are only beginning to digest the scale of the challenge. Citizens across the world are not only consumers of media but also have become major producers of media, and this means that media literacy programs need to reach a vast audience. So far, these programs are scattered across the world and have a long way to go before they have the size and scale to be truly effective. And while we may have to wait several more years before the impact of these programs is measurable, we have been able to surface a number of different, and at times innovative, approaches to promoting media literacy.

Here is a sampling of various programs and organizations around the world.

UNESCO

UNESCO might be called the grandparent of the international media literacy movement, with work extending back more than four decades. Its current programs draw their inspiration and authority from a declaration drafted by delegates from 19 countries at a meeting in Grunwald, West Germany, in January 1982. Language from that document can today feel dated, but if you add Pinterest or texting to the examples, it feels entirely modern:

We live in a world where media are omnipresent: an increasing number of people spend a great deal of time watching television, reading newspapers and magazines, playing records and listening to the radio. In some countries, for example, children already spend more time watching television than they do attending school. (UNESCO, 2001, p. 18)

The declaration went on to say that educators must not ignore this trend and should work to promote "a critical understanding of the phenomena of communication" as a "preparation for responsible citizenship." Ordinary people need to know how to analyze media products and use them both for the acquisition of information and for creative expression. The delegates made four recommendation to the world's education systems including encouraging research about media literacy education and increased cooperation across borders to develop media education, initiation of comprehensive media education programs from the pre-school to university level, and development of training courses for teachers.

Another UNESCO conference, in Alexandria, Egypt, in 2005, broadened the concept into a human right by noting that:

Information Literacy lies at the core of lifelong learning. It empowers people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals. It is a basic human right in a digital world and promotes social inclusion of all nations. (Sarah Devotion Garner, 2006, p. 3)

Today, promoting this kind of education is a major part of the daily business of the Paris-based UNESCO, led by the newly founded Global Alliance for Partnerships on Media and Information Literacy. In 2011, after years of work involving teachers, academics, expert reviewers, field tests, and editors, UNESCO published a model curriculum for national school systems. The curriculum provides detailed direction for classroom examination of theoretical subjects such as what information is and how it shapes society. It also contains a lot of practical material: definitions of computer terms; tips for avoiding online scams; and tips on how to convey meaning with particular camera shots and angles. It's now offered in multiple languages. UNESCO is now working with close to a dozen countries to adopt or pilot the curriculum.

In June 2011, educators and officials from the Moroccan government, UNESCO, and Islamic and Arab educational organizations came together to discuss ways to promote media literacy. They issued a detailed declaration calling for such steps as bringing media literacy into the curricula and using it to foster local cultures. UNESCO is also collaborating with partner organizations to develop and launch two online media and information literacy (MIL) courses, one targeting teachers, policy makers, and professionals, the other the public at large. Working with the UN Alliance of Civilizations, UNESCO has drawn eight universities around the world into an academic network on media literacy. To help countries that want to move toward greater media and information literacy, UNESCO is also working to publish a comprehensive framework known as the MIL Policy and Strategy Guidelines. These will include suggestions on what policies to employ, step-by-step implementation processes, and specific resources such as model policy statements.

For 2012-2103, UNESCO set itself some MIL objectives: At least 15 national teacher training curricula will have integrated MIL; at least 12 citizens' media groups (of which at least three are women's groups) will have been formed; and at least 50 public service broadcasters will have applied UNESCO's guidelines for promoting user-generated content.

Neighborhood Incubators

In Armenia, Internews (an international non-profit organization whose mission is to empower local media worldwide) helped finance six InfoTuns (community media centers). These InfoTuns tends to attract a cadre of young activists to take online courses, including in media literacy.

Internews also supported a media website and a mobile museum with exhibits on such subjects as how Soviet news organizations covered the great Spitak earthquake of 1988. Through work like this, general media literacy advances. The program was also looking at classroom instruction, working with the Armenian education ministry to integrate a media literacy curriculum into teacher training and school curriculum.

Restraining the Police Baton

In 2008, men undergoing training as police officers in Afghanistan began receiving a handbook that included two drawings: One showed an angry policeman beating a journalist; the other showed the policeman and journalist working together, each happy with the other. The drawings aimed to build in the mostly illiterate recruits what might be called a specialized form of media literacy: awareness among police that journalists are not spies or provocateurs but should be left to do their work, even assisted.

In conflict zones around the world, select NGOs are working to try to defuse traditional mistrust that exists between journalists, police and military forces. The police in northern Iraq were more afraid of a camera than a gun. To confront attitudes like these, sponsored workshops were organized that brought Iraqi officers and journalists together.

There will be times, of course, when journalists can't avoid conflict with police (reporting on police corruption, for instance). But the idea is to reduce the many unnecessary sources of tension. In addition to Afghanistan and Iraq, countries that have hosted such programs include Ivory Coast, Somalia, Pakistan, Egypt, and South Sudan. Through seminars and other training, one can hope to instill in local journalists the notion that they have responsibilities too. They must behave professionally toward police and soldiers, for example, act as objective observers, and avoid character assassination and emotional rants.

Student Newspapers in China

Student-edited publications are hardly a tradition in the Chinese education system. During 2011-2012, 13 high school newspapers emerged in China's Gansu province. The newspapers were produced by students and teachers who underwent training at American-style "summer camps" and in the schools. The project was approved by provincial, not national authorities. Subject matter included cafeteria food, sports events, teen dating, pollution from neighboring factories, and safety hazards caused by nearby construction. At some schools, principals agreed to sit for interviews, a rare opening up of officialdom. There was probably self-censorship too, as students journalists steered clear of taboo political subjects. For this project, media literacy was the first goal from the start and the hope was to get students to see that there is a different style to newspaper writing and to create demand for that kind of information.

Reaching the Young People of Cambodia

Overseen by BBC Media Action, Loy9 is a project to promote media literacy in youth of Cambodia. A 2010 survey found that Cambodian young people consumed a lot of media and trusted almost all of it. They seemed highly open to being misled by media, whether it was one-sided news or karaoke videos that carried damaging messages about gender (Giraud & Huot, 2012). Loy9, pronounced "loy prambuon" in Cambodian, is a slang for something like "well done!" or "awesome!" The program comes in TV, radio, Internet, and telephone dial-in versions. In broad terms, the goal is to promote participation in civic life by young people, particularly those living in rural areas. This might be accomplished e.g. through a TV serial drama in which a young man runs for election as youth representative on a commune council. With music, brightly colorful animations, and ebullient hosts, Loy tries to cover, in a fun and entertaining way, even some serious subjects. The TV version, aired on Cambodia's two most widely watched terrestrial networks, draws up to 2 million viewers. The idea behind Loy was not only to impart skills to the young people in the village, but also to make a point to the broader audience that behind every video are people who have a particular message they want to convey and choose to show some things and not others. Subjects of direct relevance to media literacy also come up. One show began with the question of why people cry when watching movies that they know aren't real.

Using Game Design in Education: Globaloria

Globaloria, a project of World Wide Workshop Foundation, is a social learning network for designing web-games. The project employed project-based learning where participants created educational games for their personal and professional development, and for the benefit of their communities. Globaloria is suitable for students at all levels and does not require any prior web design or programming experience. Globaloria ran two pilots in West Virginia and in Texas where schools integrated Globaloria curriculum into their school curriculum. The key success factors of Globaloria were the participatory structure of the program that supported learning by doing, partnerships with government, education departments, private and public foundations, local businesses, and institutes of higher education, and the culture of transparency and collaboration that Globaloria brought into schools.

Community Partnerships: The Digital Connectors Program

The Washington DC-based Digital Connectors Program by One Economy identifies young people from diverse low-income backgrounds and provide them technical training. The training helps these young people (called digital connectors) build leadership skills and prepares them to enter the 21st century workplace. Participants give back to their community by training family members and residents on how to use technology effectively.

Adobe Youth Voices

The Adobe Foundation's program, Adobe Youth Voices, is designed to provide youth in underserved communities with the critical digital communication skills. With these skills, youth is expected become active and engaged participants of their communities. Participants use cutting-edge multimedia tools to create various pieces of media (such as videos) and share their ideas about topics that interest them, such as religious and cultural identity and environmental degradation. These works are then shared through a global network of over 500 participating organizations web sites worldwide.

BBC School Report

BBC School Report can be considered as one of the most ambitious news literacy programs ever developed. This program offers training to children in U.K. schools to learn about the practice of journalism and news production. Children learn and develop community-based television and radio news reports. The mission of this project is to engage young people with news, by giving them chance to make their own news in order bring their voices to a broader audience base. Another aim is to provide children with awareness of values behind content creation, such as fairness, accuracy, and impartiality. The program helps students develop skills of gathering information, teamwork and time management, while providing an opportunity to discuss the responsibilities involved in broadcasting to a worldwide audience.

Center for News Literacy

The Center for News Literacy of Stony Brook University train students to use critical thinking skills. With these skills, students are able to judge the reliability and credibility of news and news sources. Experienced journalists are recruited to become News Literacy Fellows and help launch new undergraduate courses that meet the needs of the host universities. The center was working to develop curriculum for high schools and the general public. It was also working to develop a National News Literacy website through which students can collaborate on news literacy projects.

City Voices, City Visions (CVCV)

This is a project of the University at Buffalo's Graduate School of Education. This project aims to work in collaboration with the schools to help bring digital and media literacy to teachers and students and help students meet higher learning standards in literacy and the academic disciplines. CVCV promotes student academic achievement and empowerment using digital media tools. The works created by students and teachers are shared with public to benefit a large number of people.

Common Sense Media

This San Francisco-based non-profit organization (www.commonsensemedia.org) provides independent information and tools about media and technology in the home. The objective is to educate families to make informed choices and have a voice about the media they consume. The Common Sense Media website includes reviews and ratings of various types of media (such as movies, games, mobile apps, websites, books and music) by professional reviewers, parents and kids. The website also provides re-

source materials specifically designed for parents and educators. The organization has also developed a curriculum, focused on digital citizenship, to train students become responsible, peaceful, and safe digital citizens. The curriculum's main focus is on digital ethics and responsibilities. The curriculum uses engaging classroom activities to tackle issues like privacy, cyber-bullying, and online identities.

Digital Media (DigMe)

This program of Roosevelt High School in Minneapolis uses digital media to train students on critical thinking, building meaning, and demonstrating understanding across the subjects. The curriculum is aligned with the national standards in Media Literacy and 21st Century Skills. Students are engaged in reading, writing, analyzing, and discussion activities. Students design and produce projects that demonstrate learning using digital media tools.

Finding Dulcinea, IFC Media Project, and Know the News

Finding Dulcinea is a project that offers contextual background information on news and current events and analysis of how sites with inaccurate and misleading information can be made to seem credible. IFC Media Project is a television series that examines US news media in a bid to uncover the truth about the news. The series provides in-depth reporting on controversial topics facing today's media such as the impact of the economic downturn on the news industry. Know the News is an online learning tool for journalism students and citizen journalists. It explores the issues that shape television news, including bias, authorship, and authenticity, ethics, and media ownership. The website of the tool provides information to help users think critically about TV news by framing news coverage in a global context.

Global Kids and Kids Voting

This organization uses digital media to train students on global awareness and civic engagement. Students develop digital literacy skills, engage in online dialogues and participate in civic action. Kids Voting is a media education program to get students involved in civics. This program offers education curriculum for use during an election campaign. The program integrates civics education and preparation for voting with newspaper reading and media analysis. The program encourages students to analyze and critique political advertisements, news stories, and candidate debates. According to McDevitt and Chaffee (2000) when students are involved in such programs, there is increased student tendency to read newspapers, pay attention to political campaigns, and discussion on campaign-related issues with peer and parents.

National Association for Media Literacy Education (NAMLE)

NAMLE is a US-based organization dedicated provide all people the skills needed to critically analyze and create messages using the wide variety of contemporary communication tools. NAMLE brings together many media literacy practitioners and advocates from diverse fields to bring high quality media literacy education to all.

National Writing Project (NWP)

The NWP is a US-based nationwide network of educators whose mission is to impart the teaching of writing and learning in schools and communities. NWP provides excellent professional development programs to teachers across disciplines and at all levels. NWP offers in all 50 states of USA a special program called "Digital Is". Through this program, educators can share work and practice and think about elements that support effective digital writing and learning of students in a variety of learning environments.

Powerful Voices for Kids

This is a collaborative program that offers a comprehensive media literacy and technology integration program for children and educators, in-school and after-school mentoring, and a research and assessment module. The program aims to strengthen children's thinking abilities and communication skills using language and technology tools to make their voice powerful enough to contribute to the quality of life around them.

Project Look Sharp

This program provides materials, training and support for the effective integration of media literacy with critical thinking into classroom curricula at all education levels. Professional development programs are offered to educators. The material provided enable teachers to integrate critical analysis of news media into their curriculum.

Project New Media Literacies

This program explores ways to train young people with the social skills and cultural competencies needed for full participation in an emergent media society. This program provides resources for educators and learners to integrate the new media literacies into their learning environments.

Salzburg Academy on Media and Global Change

It is a summer education program for students and faculty. This program was created by the International Center for Media and the Public Agenda at the University of Maryland. The program explores media's role in global citizenship, with examination of news media effects on understanding of cultures and politics and capabilities to better cover global problems and report on possible solutions. Students and faculty work together to create a series of curriculum materials to explore these issues. Students learn to identify what news is and how media decide what information matters. Students monitor, analyze and compare media coverage of people and events and understand media's role in shaping global issues.

Silver Surfers Day

This event is hosted by the Office of Communications, the British national government agency responsible for communications regulation, specifically for older people to get a nice introduction to the Internet and practices about sharing photos, online banking, finding other health-related information or other activities specific to their needs and interests.

St. Louis Gateway Media Literacy Partners

This is a collaborative partnership among educators, parents, media professionals and citizens to raise awareness of the importance of media literacy and media literacy education, including the connection between digital and media literacy skills and economic development. The partners in program share the costs of developing programs and services for the community and host events.

The News Literacy Project and Youth Media Reporter (YMR)

This is an educational program to bring experienced journalists into school classrooms. The journalists teach students the critical thinking skills they need to be smart consumers and creators of credible information across all media. Students learn to distinguish verified information from raw messages, spin, gossip and opinion. Students are encouraged to seek news and information to become well-informed citizens and voters. The Youth Media Reporter (YMR) is a professional multimedia web-based for practitioners, educators and academics interested in youth media. The journal documents the insights and leading lessons in engaging young people across all media.

PBS News Hour Student Reporting Labs

This program (http://www.studentreportinglabs.com) is a collaborative partnership between high schools and public media professionals to create investigative video reports. The program provides a flexible curriculum that combines digital and media literacy, media production, news and current events and journalism education.

Admongo

It is an online gaming project launched by Federal Trade Commission (FTC) of USA. This project aimed at helping kids become more discerning consumers of information through analysis of advertisements. The project provides a curriculum and a fun way to look at advertising in the classroom. However, the project lacks meaningful engagement because students are not encouraged to critique or analyze advertisements.

State of Deception: The Power of Nazi Propaganda

The US Holocaust Memorial Museum launched an initiative to impart teaching of digital and media literacy skills by using its exhibit called "State of Deception: The Power of Nazi Propaganda". Under this imitative, teachers participated in a digital and media literacy online workshop that introduced the exhibit and key media literacy concepts through a combination of webinars, lesson plans and online discussions.

Emerson Literacy Education and Empowerment Project (ELEEP)

Emerson Literacy Education and Empowerment Project (ELEEP) is a project of Emerson College, USA. The goal is to engage college students, in collaboration with young youth in the community, and peer to peer mentoring that involves civic engagement empowerment self-efficacy, and agency. It is meant to be gathering of all future leaders and is meant to teach them the foundational skills and competencies in health and media literacy. Students can use their voices when they enter into more formative stages of adult. Being media literate is a good way to filter out the good and the bad media in order to be more informed of what's going on.

DIGITAL MEDIA LITERACY IMPLEMENTATION: ISSUES AND CHALLENGES

Educators and community leaders face many challenges and issues when developing a plan of action for implementation of digital and media literacy program. First, they need to move beyond a tool-oriented approach. Second, they need to address various risks associated with media and digital technology. They also need to expand the concept of literacy, strengthen people's ability to establish credibility and quality of the news, and bring news and contemporary issues into formal education.

Moving Beyond a Tool-Oriented Approach

A great concern is whether people will be able to transfer their self-developed skills in digital media to people beyond their communities (Vadhiyanathan, 2008). The same people who have skills to search for information using digital media tools for youth today that their formal education includes digital media literacy so they are able to experience under broader range of cultural and civic learning that is essential for their intellectual, cultural social and emotional development.

Many schools have made significant investment in technology use. However, teachers still don't make use of digital and media literacy past of their instructional practices. There exists various reasons for this. Some teachers consider using PowerPoint presentation as effective use of digital media, while some don't have time to incorporate digital and media literacy into their instructional practices.

It is obvious that introducing technology in the school alone cannot be sufficient for digital and media literacy education. Schools face many hurdles to achieve their targets of digital and media literacy education and access to high speed broadband internet is one of them (Levin, 2010). The internet filtering implemented at many schools puts serious limitation on teachers and students to access many types of digital media including social media. According to US Department of Education, despite availability of computer in a classroom, more than 50% teachers were not able to display a website to their students because a data projector was not available. Most US student used computer to perform basic tasks such as write documents and make Power point presentations (US Department of Education, 2010).

It is a mistake to take the amount of money invested on technology or number of people enrolled in online learning programs as proxy of digital and media literacy education. Similarly, just providing youth with access to digital technology cannot automatically make them digitally literate. Across a wide range of socioeconomic state in developed world we see parents buy their kids digital devices, including computers laptops and mobile phones. The computer is dominant entertainment device in most homes of developed world (Kaiser Family Foundation 2010).

Professor of English John Sutherland from University College in London, a very outspoken voices among those who believe the technology is killing the art of reading and writing, thinks that "Facebook encourages narcissistic blabbering, video and PowerPoint have replaced carefully crafted essays, and texting has dehydrated language into "bleak, bald, sad shorthand" (Clive Thompson, 2009, p. 1). In a study of writing at Stanford University (Heaven, 2009), researchers followed a group of about 190 students at Stanford for almost 6 years and asked them to contribute all of their writing (anything else they wanted to) to an electronic database. Analyzing about 15,000 pieces of writing that included almost every type of writing (such as emails in 11 languages, text messaging of all kind, journaling, poetry, and PowerPoint presentations), researchers found that students become good writers when they get into colleges. Steady improvement in writing across the college years was also noted. By the time students get the college they understand who their audiences are. Students seem to understand the purpose of writing as they know if they are writing to a college professor that they are not on Twitter. They just know that and they adjust their writing accordingly. The sample of students chosen matched up very well to the demographics of the Stanford class as a whole which meant it was very diverse. The students in the humanities wrote a lot more and had more opportunities for writing than students in the sciences. Gender was not found as a factor that affected student writing. A very important finding of the study was that most students reported liking writing that made something happen in the world that's how they defined good writing. They want writing to do something. They wanted to be active, performative, and make something happen. Students mentioned good writing is writing that make something happen such as a series of posters for an AIDS walk that might raise $60,000 for AIDS research or a poster that would go up on campus demanding a raise in wages for temporary workers. Internet has had huge impact on student writing because now audiences are everywhere in fact it's hard to tell who is a writer and who is an audience anymore. This is because the interaction is so instantaneous that if sometimes someone is receiving a message he is creating message at the same time. So the sense of having a real audience at the other end of your writing is what makes the social networking sites so popular with students and so helpful in terms of getting them writing even more and more because they know they are writing to real people at the other end. While teachers complain of high school students use of Internet speak, such as LOL or WTF, a national study of US college students didn't find a single instance of Internet speak in students' writing. It can be seen that something may be happening between the end of high school and the beginning of college. Students in college seem to know and they know Kairos, they know what's timely what's appropriate in a particular place and time.

Few people think that computers can also be used as a research tool to search for information. However, most people don't have the knowledge and skills required to use the computer for this purpose (Hargittai & Walejko, 2008). A child's experience and approach towards technology can be predicted by analyzing the parents' behavior and attitude towards technology (Pew Internet & American Life Project, 2009).

Research shows that the probability of content creation by students, whether online or offline, increases if at least one of the parents holds a graduate degree. "While it may be that digital media are leveling the playing field when it comes to exposure to content, engaging in creative pursuits remains unequally distributed by social background" (Hargittai & Walejko, 2008, p. 256).

For these reasons, merely using digital technologies in teaching is not sufficient to develop digital and media literacy competencies. It is essential that teacher make use of dialogue and Socratic questioning while teaching about media and technology. It would help promote critical thinking in student about various choices to make when they consume, create, and share messages. As Buckingham (2007, p. 113) points out, "Rather than seeing the web as a neutral source of 'information,' students need to be asking

questions about the sources of that information, the interests of its producers and how it represents the world." Kids Voting program is USA is an example of such program that works to develop these critical thinking skills in US children and teens. Student are involved in news reading and media analysis (Mcdevitt & Cheffee, 2000). Research shows that use of engaging digital and media literacy projects as part of teaching increases the information retention capacity of student and also increases their ability to analyze the context and quality of information websites (Berry & Wintle, 2009; Pinkham, Wintle & Silvernail, 2008).

Game design can be used to develop digital and media literacy skills by involving students in game design help them understand the constructed nature of digital environment and its role in shaping personal and social action. By becoming designer of the game, student gain a deep understanding of the choice available in the structure and function of technology tools.

The digital and media literacy provides competencies learners need to interact with audience beyond their friends, family and experience true participation in community that help them clarify their ideas about the world from different lenses and developing a sense of connectedness to the people around them.

Managing Risks Associated with Digital and Media Literacy

Digital and media literacy competencies can also help address potential risks associated with mass media and digital media such as risks associated with identity theft. In 2009, 10 million US citizens were victims of identity theft often because "they couldn't distinguish an email from their bank from an email from a predator" (Rothkopf, 2009, p. 5). However, this example is just the tip of the iceberg.

Many people are pro-social and contribute to a social network while others exploit digital technology for evil uses. In the developed world, concerns about the negative aspects of media and technology increases and decreases over time. Staksrud, Livingstone, Haddon, and Ólafsson, (2009) identify three types of risk associated with the use of mass media, popular culture and digital media:

- Content risks (i.e. risks associated with exposure to potentially offensive or harmful content).
- Contact risks (i.e. risks associated with people engagement in events such as harassment and cyber-bullying).
- Conduct risks (i.e. risks associated with activities such as misinforming people and illegal downloading).

In developed world, some people completely ignore any risks associated with digital media, mass media and popular culture. While some feel a mix of fear, anxiety and optimism about the risks and opportunities. This situation reflects the need to both protect and empower both kids and youth regarding media and technology and to address the transformative social potential of the Internet in the context of child and adolescent development (Ito et al., 2008). One example is the case of sexuality where empowerment and protection benefits children, youth, and their families as children and youth can use the Internet and social media to get accurate information about sexual health and experience extended forms of sexual expression and experimentation including live chat. Pornography is a multibillion dollar industry. Prevalence of pornography in the lives of youth is far more significant than realized and it can be used to exploit the youth (Witherspoon Institute, 2010). In USA alone, about 15% of teens aged between 12-17 received sexually explicit images from people they knew personally (Pew Internet and American Life Project, 2009). In 2008, up to 35% children and youth in USA were victims of electronic

aggression such as sexting and cyberbullying (Centers for Disease Control and Prevention, 2008). These examples clearly show the intersection between human needs (such as power, intimacy, trust, and respect) and ethical challenges of social participation in the digital world. This is why the link between empowerment and protection is so strong.

Digital and media literacy will not be a solution for social problems and it will not relieve companies and producers of their social responsibility. As Jenkins et al. (2006, p. 19) rightly point out, the one key goal of media literacy education is to "encourage young people to become more reflective about the ethical choices they make as participants and communicators and the impact they have on others." Online media can be used as an amplifier for small groups of people to make a disproportional amount of noise. Despite talk of media as a source of information it can be a generator of gossip, misinformation, and prejudice. Take example of Lisa Clinton, an American citizen working in Doha, Qatar. She was travelling on 18th of December, 2009 from her friend's house to her house. The distance was about one kilometer. The 18th December was Qatar National Day. It took her more than 3 hours to get home. She was so upset for this inconvenience, due to disturbance on the roads due to National day, that she wrote an article on qatarliving.com, a website for news and updates about Qatar. The article brought significant criticism from Qatar nationals as they thought it as an attack on their culture and traditions. An anti Qatarliving page on Facebook was created. A clear polarization was observed as the American supported the Lisa Clinton's stance while Qatar nationals strongly criticized. As a result, Lisa Clinton was socially isolated and lost her job contract in Qatar. She tried posting an apology on every website she thought appropriated but it was too late probably. The most probable reason for this unpleasant series of events was the negligence of webmaster of qatarliving.com who failed to monitor the site content. If he would have monitored the site content, he could immediately remove Lisa's article and comments that came through to stop further disturbance. This one example shows that media, online media in particular, needs to be more closely regulated and be accountable. In this way, the media can play a more destructive than positive role in our globalizing societies. Middle East region is composed of many minorities. Liza's story tells us that we need to train to be tolerant when using media.

Expanding the Concept of Literacy

Digital and media literacy does not replace or supersede print literacy. With the passage of time, the concept of literacy is expanding. Today, literacy is called that ability to share meaning through symbol systems. Print is one of these symbol systems. One need significant investment of time and effort to master print literacy. As such, effective instruction in reading and writing is becoming more important. To read well, people need decoding and comprehension skills and knowledge base to interpret new ideas. To write well, one needs to know how words are used together to form ideas and arguments. Digital media has the ability to get people engaged in learning and to help them pay attention. Motivation and engagement are enhanced through integration of popular culture and digital media and technology in learning. But this is not the sole purpose for implementing digital and media literacy into the curriculum. When used properly, mass media and digital media can support the acquisition of literacy competencies. The concepts of audience, purpose, and point of view must be applied to digital media, popular culture, and print text. By participating in digital and media literacy activities, children and young people can also learn public speaking and advocacy and become able to express themselves effectively (Alvermann, 2004; Hobbs, 2008; Gainer and Lapp, 2010).

Today, online reading is fundamental to digital and media literacy. Online reading requires many interrelated practices such as how to use search engines, read search engine results, and quick reading of web pages to locate the information required. Many people lack these skills (Coiro, 2007) and do not look at relevance of websites to the purpose and goal of the web search.

Digital and media literacy education requires and supports skills of reading, comprehension, and writing. Students' participation in media literacy education programs can strengthen these competencies (Hobbs, 2007). Since long, to promote reading and writing skills, teachers have been urged to make literacy experiences more relevant to students' interests and everyday life.

As pointed out in a report of US Department of Education "Look for opportunities to bridge the activities outside and inside the classroom. Tune into the lives of students to find out what they think is relevant and why, and then use this information to design instruction and learning opportunities that will be more relevant" (U.S. Department of Education, 2008, p. 28).

People do develop many skills informally by using digital media with peers (e.g. in social groups). However, a connection between print literacy and digital media literacy is a must to transfer those skills to new contexts (such as informal to formal and narrow to broad context) (Salomon & Perkins, 1989). Digital and media literacy education can help in such transfer.

Strengthening People's Capacity to Access Message Credibility and Quality

In search of information online, many people give up before they find the required information. People use a small number of search strategies repetitively irrespective whether they find required information or not. According to Cheney (2010, p. 1), "students typically use information that finds them, rather than deciding what information they need"

Many people use a very superficial criteria for assessing the quality of a message and adolescents and young people are likely more susceptible to digital misinformation. But few people, both children and adults, verify the information they find online. Many people tend not to critically analyze information they find from whatever source. Digital media can play a very important role to uncouple the credibility and authority in novel ways. Family, peers, and friends have always influenced one's decision about what to trust. Today, these decisions, as well as our ideas of credibility and reliability, can also be shaped by participation in online communities (Metzger, 2009).

Even for adults, assessing credibility of information is difficult because so many sources of information are available. A simple tactic commonly used to evaluate credibility of a source is the graphic design of the sources. If graphic design looks right, that implies source is credible. Information on Internet is usually context deficient where information about authorship is often unavailable. Search engine aggregate information from multiple sources. With hyperlinking, it is even more difficult for users to follow and evaluate sources (Harris, 2008; Metzger, 2007). This shows that the immediate and immersive digital media also discourage users to be reflective and analytic in their thinking when analyzing the credibility and reliability of the sources of content. This is important because skillful use of digital information can enhance the process of checking the facts and compare the sources.

In order, pay attention to the quality of media messages, people need self-awareness and a general understanding of human perceptual and cognitive process. It is our natural tendency to trust sources as credible only when they reinforce or match our existing beliefs and distrust information that challenges our opinions. This tendency should be emphasized in media and literacy education because it can help

people become more open and receptive to diverse sources and beliefs and address the problems of political polarization and provide a balance between extreme and moderate points of views.

In source stripping, one detaches the content from its source forgetting where information was learned (Eysenbach & Kohler, 2002). Digital and media literacy education increases people knowledge of human information processing, self-awareness, and self-reflexivity. With this knowledge, people can counteract tendencies such as source stripping. Research and assessment tools are needed to help develop best instructional practices that could help develop people's ability to evaluate quality of information they receive from various sources of media.

Integrating News and Current Events

Civics-oriented education, that used every day journalistic resources, has been declining (Hobbs, 1998). Young people avoid reading news because to them the news is a significant source of stress. The news reminded them how insecure the world is and make them feel unsafe and threatened. When they do read news incidentally, they prefer news about entertainment, music, celebrities, and sports (Vahlberg, Peer & Nesbit, 2008). Some researchers think that children or young people should not reach or watch the news because it is not good for them (American Academy of Child and Adolescent Psychiatry, 2002). Violent news content has been shows to induce more fear reactions. Violent news content creates persistent worrisome thoughts in the minds of children and young people (Kaiser Family Foundation, 2003; Cantor & Nathanson, 1996).

Using news and content events in the classroom can be controversial. In the USA, the President Barack Obama's back-to-school speech for school children was heavily criticized as propaganda. In addition, the present media age is marked as competition for and fragmentation within the news audience. We cannot make simple assumptions about the trustworthiness and authoritativeness of sources of information. In a highly polarized, political climate, teachers are hesitant to use news and current events in the classroom (Hobbs, et al 2010; Hobbs, 2001). As Mihailidis (2009, p. 9) pointed out that "Making the connections between media literacy, freedom of expression, and civic engagement can reposition media literacy as the core of new civic education".

In the UK and Western Europe, news and information programs for children and young people are considered public service. But in USA, it is purely a commercial venture. Research showed that teens learning of current event knowledge, through these news programs, occur only when teachers support this learning by asking questions (Johnston, Brzezinski & Anderman, 1994).

Some newspaper industry programs, such as US-based Newspapers in Education (NIE) program, provide newspapers to schools through advertising sponsorship and other donations. However, these programs have declined substantially as newspapers revenues continue to plumped (Arnold, 2010). For communities with very limited resources, access to quality journalism has been an additional expense for school. As Bazalgette, Harland and James (2008, p. 81) observed for USA and UK that "It has proved difficult to support, develop and sustain teaching about broadcast news because of the ephemerality of the subject matter and the effort involved in bringing current TV, radio or Internet news into the classroom".

The use of news media in the K-12 classroom is limited. Regular engagement with news and current events may support the development of learner's background knowledge, build connections between the classroom and culture, and help them appreciate how audiences understand and interpret messages differently (Levine, 2008).

PRACTICAL/MANAGERIAL IMPLICATIONS AND RECOMMENDATIONS

To support the development of digital and media literacy competencies, a comprehensive community education movement is needed. Initiatives at various levels of government are needed. Developing infrastructure and human resources for digital and media literacy education is a lengthy process that requires identification of key audiences and locations to work on. A buy-in from audiences is necessary for success. Initiatives targeted to gain this buy-in need to capitalize on existing local programs/resources of media literacy education. New stakeholders (such as members of professional associations) should be identified and taken on board.

Community Initiatives

Since community leaders often lack awareness of digital and media literacy initiatives, increasing the awareness of digital and media literacy initiatives can help develop effective leadership, promote coalitions/partnerships, and build organizational capacity for sustainability of initiatives. For community initiatives, existing resources in digital and media literacy should be identified. Identification of existing resources would help identify existing resources, core values and priorities of local programs of digital and media literacy education, underserved populations, and gaps in existing programs and services. Small grants should be offered to community sponsors to integrate digital and media literacy competencies part of the existing education programs. Sponsors of community initiatives should offer small grants to develop pilot programs of digital and media literacy competencies targeted to serve specific underserved populations that are in great need of such education. The sponsors or their partners should organize annual community events aimed at increasing awareness of various programs of digital and media literacy education, promote networking, and develop community-level leadership. Schools should utilize their summer programs to impart digital and media education to communities especially children belonging to low-income communities. These summer programs can help blend fun and education and keep children involved in learning. According to Finn (2010), lack of summer learning is a significant factor behind the achievement differential between low-income and high-income youth. National networks of summer learning programs can be built-upon these summer programs. These summer programs can also attract teachers to include digital and media literacy instructional practices into their classroom teaching. Engaging students in activities based on mass media and digital media, the classroom teaching can help students build positive relationships with their peers, and adults, use technology for learning, and develop critical thinking and communication skills. Recent media graduates and professionals may be used as resource persons for these summer programs. That would also provide them with an excellent learning opportunity and build civic awareness. Broadband Internet adoption rates are still relatively low even in developed countries. Many factors are cited by non-broadband users such as access, relevance, lack of digital literacy, and cost. High speed Internet is very important for digital media. Flexible short-term Internet training programs should be developed for busy adults.

Teacher Education

To bring digital and media literacy education into the classroom, knowledgeable and skilled teachers are needed. Across the globe, silos exist between the departments in most colleges and universities. There exist little to no interface between faculty at schools and communication. The lack of incorporation of

digital and media literacy education in the classroom teaching is the most significant factor why most schools leg behind in equipping their students with latest digital and media training. Faculty at most schools of communication have specialized digital media skills. However, the faculty have little experience in developing non-specialized digital media programs that could serve the needs of underserved populations including children and youth. In order inspire teachers to incorporate digital and media literacy education into their classroom teaching, rich digital and media literacy training must be provided to the teachers. That could help universities build interdisciplinary bridges that bring students and teachers together for co-learning opportunities. Meaningful teacher development would also help in this regard. Training of teachers may also be provided online and should include instructional practices of digital and media literacy education. A rigorous evaluation should be part of this training that assesses the impact of training on teacher's classroom teaching practices and knowledge/skill development of students. The resources of news media can be used to strengthen digital and media literacy skills. Today, access to both print and TV news is available 24 hours a day. Emerging online services are available that can help people use, analyze, and share news content. In this regard, technology companies can contribute by volunteering their expertise and resources. Many innovative online tools are available that teachers and students can use to analyze news content as part of their general education. However, a very small percentage of faculty members utilize these tools. Media and technology companies can give small grants to develop partnerships between developers of these tools and key educational groups in a bid to promote the use of these tools. Teachers and students can develop examples of effective use of these tools in instructional practices. If well-publicized, these examples could support the growth of digital and media literacy education across disciplines.

Research and Assessment

To offer a compelling evidence of the need of digital and media literacy is the first step to establish importance of digital and media literacy. For people with well-developed digital and media literacy skills, it would be a mistake if they expect others have levels of skills and competency. One reason people may lack such competencies is non-awareness of the value of these competencies. Compelling test results can help establish value of these competencies. In order measure progression of learning, measures of digital and media literacy would be needed. In this regard, online testing facilities can be developed exclusively for digital and media literacy. Benchmarks of assessment should be developed. These benchmarks would also help establish need of new programs and measure effectiveness of existing programs. Similar to students, teachers also learn best if given opportunity to observe and analyze the peer practices. An online repository of audio/video excerpts of digital and media literacy learning could be a valuable source for teacher education programs around the globe. Besides excerpts, this repository should contain teacher-created lesson plans and other teaching materials. A feedback mechanism regarding this online repository should also be established so that users can provide their feedback so that this repository could be improved on regular basis. This resource could also be used to identify best practices by identifying the most effective instructional practices. This resource could also be used as an effective test to measure teacher's ability to incorporate digital and media literacy skills into their instructional practices. Documentation of instructional practices, in relation to the use of news and current events in the context of digital and media literacy is needed. This will help build a knowledge base to help researchers and educators determine best approaches to use news and current events in the classroom.

Program Outreach, Visibility, and Engagement

Social norms of people interaction with technology continue to emerge as the participation in the digital culture spreads across the globe. To strengthen participants' capacity to effectively participate in this digital culture, participants need to know how to engage with the information. This engagement can be effective when participants understand the role of digital and media literacy in their ordinary lives. An education-entertainment initiative can also help raise the visibility of relevance of digital and media literacy in everyday life. Besides mirroring social reality, entertainment can also help shape popular opinion. With modest investment in such education-entertainment initiatives, social and ethical norms regarding use of digital and media literacy could become part of social norms of ordinary lives of people. Community education programs for digital and media literacy must put youth on the center stage with help from local/national celebrities to bring people attention to these programs.

To foster the development of digital and media literacy, professional associations needs to be developed further. That would enable educators to share experiences about "what works," and establish relevancy of digital and media literacy education to a wide range of stakeholders. A leadership conference for educators can raise the visibility of digital and media literacy among policy makers and other stakeholders and could help bring new leaders into the field.

Measuring Program Success

Evaluating success of digital and media literacy initiatives is a challenge. There exist no standard tools for assessment of digital and media literacy skills. Digital and media literacy initiatives vary in their scope and size and follow different approaches to evaluate program success. While no organization implements a comprehensive evaluation plan, some key themes can be identified (Donnelly, 2011).

First, digital and media literacy initiatives must empower users to make their own meaningful choices, critiques, and content. To be successful, digital and media literacy initiatives must set clear goals, and evaluate their success using a clearly-defined criteria.

Second, the media literacy programs must also focus on how successful their learners are in both understanding media concepts and their applications of concepts demonstrated by a piece of media production such as a short film.

Third, digital and media literacy initiatives must set feedback mechanism for both teachers and students to obtain a comprehensive understanding of how well a given initiative worked.

Fourth, most of the data collected in the digital and media literacy initiatives is qualitative and can take many forms, including case studies, interviews of students and teachers, and students' assessments. External evaluators should be hired for analysis of this data to ensure depth of analysis as well as objectivity.

Fifth, the evaluation data should be published to inform researchers and teachers of best practices. It can be done e.g. by publishing video case studies and providing a toolkit that outline lessons learned from the program. Sharing information and developing shared practices and lessons learned would help ensure development of the field and success of future digital and media literacy programs.

FUTURE RESEARCH AREAS

Media forms and contents continue to diversify. As such, the skills required to understand, assess, and evaluate the media has become increasingly diverse. Future research is needed to evaluate media literacy demonstrated across different communication contexts. This would help place media literacy in the context of new users of media. Another area that needs further investigation is the activities/choices of youth regarding digital media. This knowledge is central to the understanding of youth media literacy.

Increased diversification of media has increased scope of impact and influence of social, cultural, and other contextual factors on the development and improvement of media literacy. Future research is needed to explore the perceptions and role of various stakeholders in fostering media literacy. It would also help make appropriate policy and educational recommendations.

Youth develop skills to engage in particular communication activities. They use their skills and time to pursue interests which are part of their identity. It is still a formidable challenge "to identify the types of contents, modes of engagement, skills and literacies, and opportunities for participation that we as a society wish to encourage and enhance" (Livingstone, 2002, p. 243). Future research can investigate this issue further.

As mentioned earlier, the change in writing of students, between the end of high school and start of college, is something which is very interesting. A future investigation into this phenomenon can enhance our understanding of the role of students as content creators.

CONCLUSION

A global movement for digital and media literacy education is developing all over the world .European Union identified media literacy as a priority in their agenda for 21st century. Media literacy includes all forms of media including conventional (TV, newspaper etc.) and non-traditional (Internet and all other technologies of digital communication). Media literacy has become the fundamental competency for both media professionals and non-professionals (such as teachers, students, parents etc.). In both European Union and USA, issue of media literacy has been recognized as a critical issue for social and cultural development. In United States, researches argue that most US citizens are yet to experience the true transformative potential of the Internet. Internet can change lives and now its time to pay attention to develop those human competencies and skills that people would need to become effective participants in the digital age of 21st century.

It is now obvious that technology alone is not a savior. Technology, Internet and related communication technologies, will not be sufficient to improve education. Use of modern digital technologies cannot make people become smarter or enhance their digital literacy and other skills needed to be successful.

In fact, novel digital technologies can hinder the process of human development because of technology's potential to offer many time-consuming distractions. These distractions can interfere with regular activities of people. A study by Duke University found that most US citizens used computers at home mainly as entertainment devices. A shift in this approach is not possible until unless an active, learning-oriented approach is cultivated in the society.

It is expected that an increased appreciation of the delicate balance of protection and empowerment in the use of digital media will ultimately lead people better manage their increasingly connected lives. Making digital and media literacy part of education, imparted both in and out of the school, can bring

many fruitful results. First, parents can gain understanding of balancing the protection and empowerment of their children when they use digital media. Parents can give attention to balancing their children activities related to digital media with other activities of play and learning. Second, people will gain understanding and ability to ask critical questions (such as source, purpose etc.) about various messages they receive (e.g. blogs and political opinions). Third, teachers will be motivated to use engaging instructional methods in their teaching. These methods will be helpful not only connect literature with science, health and history but also bridge the learning of classroom and outside world. Fourth, people of all ages will become responsible and their communication behavior will reflect respect for others and a sense of personal accountability for their online and off-line actions. Fifth, students will learn to use digital media tools to create and compose authentic messages for real audiences. Students will learn and develop skills and knowledge to become an effective communicator. Sixth, people from all walks of life will be able to find, share, and use information to solve problems of their everyday lives. People will be able to provide meaningful participation and social actions in their communities and nation.

In the process of enhancing media literacy, teamwork, collaboration, and social responsibility will flourish. Students will learn to use digital media tools to locate required information quickly. Media professionals increasingly recognize the need of consumers that are more active, engaged, intentional, and have a strategic orientation regarding their use of media. An opportunity to promote quality media products will automatically emerge when people have high expectations of quality media products (such as news). Supporting digital and media literacy for all people is essential in the formation of coalitions and partnerships across globe.

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KEY TERMS AND DEFINITIONS

Citizen Participation: Citizen Participation refers to the process of providing private individuals an opportunity to influence public decisions.

Civic Engagement: Civic engagement means working to improve the quality of life in a community. This can be done through both political and non-political processes.

Digital Learning: Digital learning refers to learning that is facilitated by technology and gives learners some control over time, place, path and/or pace.

Digital Literacy: Digital literacy refers to the ability to use digital and communication technology to locate, evaluate, use and create information.

Information Literacy: Information literacy refers to one's ability to assess the need of information, find the required information, and evaluate, use and communicate this information.

Media Creation: Media creation refers to the creation of content in any field of communication, entertainment or information.

Media Literacy: Media Literacy refers to one's ability to access, analyze, evaluate and create media in a variety of formats.

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Chapter 7
Information Overload as a Challenge and Changing Point for Educational Media Literacies

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ABSTRACT

This article deals with the concept of information overload as a crucial element of the changing information environment. Against this background, the authors discuss an alternative process for the conceptualisation of educational media literacy. By combining two nationally-based concepts on media literacy (German and Anglo-American), the yield of such a transnational approach will be demonstrated. The first section is dedicated to a historical overview. Based on the observation that humanity is currently dealing and always has dealt with information overload, leads to the necessity of coping with said overload. To this end, the second section will present and didactically reduce both discourses to their essentials. The third section provides a possible conceptualisation of both concepts and practical application of the combined approach for scholastic learning. The aim of this paper is to stimulate an international exchange on media literacy.

THE CHALLENGE OF INFORMATION OVERLOAD

Clay Shirky, media professor at New York University, said at the Web 2.0 Expo in New York in 2008, "It's not information overload. It's filter failure" (Shirky, 2008). This paper aims at demonstrating, that humanity is and always has been dealing with information overload. From an educational standpoint, the solution to so called information overload "revolve[s] around the principle of taking control on one's

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information environment" (Bawden & Robinson 2009, p. 187). Digital media change the information environment. This is due to many factors, including the changing places of knowledge and their authorities or simply the technological basis of digital media. It is the responsibility of education media literacies to tackle these factors and to give adequate recommendations for action related to information appropriation with digital media. This understanding of information overload leads directly to the discussion about information literacy.

The present chapter outlines the possibilities to cope with information overload by bolstering the competencies of media users. Therefore, the authors will discuss an approach to face the changing information environment for educational media literacies without abandoning originally educational ideals. The first section is dedicated to a historical overview of the said information overload. The approach points out the theoretical foundation of the German theorem of competence as well as Anglo-American literacy research. To this end, the second section will present and didactically reduce both discourses to their essentials. By using the information landscape in digital media, the possibilities of a mutual complement of both specific nationally-characterised approaches will be demonstrated in the third section. Furthermore, this section provides practical application of the combined approach for scholastic learning. The authors assume that combining both concepts will result in an important contribution to the research field. Combining the German literacy approach with the Anglo-American one means integrating subject-orientated ideals into a concept which is naturally based on users' activities in the media environment. The subject-orientated ideals refer to the confident and independent handling of digital media, which implies a reflexive distance to the way information is generated by digital media. This distance enables the use of digitised information in relation to subjective demands and living environments. This criterion of literacy is called media critique (Ganguin, 2004, 2006, 2014). The pragmatical approach can be used to identify specific "top-down"-challenges caused by the way digital media have changed the manner of generating and presenting digitised information. The management of information will continue to prefer pragmatic solutions. But for an educational approach on information literacy, which tries to implant idealistic values on education, the scope of digitised information should extend to looking for possibilities to use the current state of the information landscape.

Information Overload History

People have been discussing communication or information overload since and during the rise of each new media. The authorities, who foster or inhibit information overload, are changing, with it, and so the structures and challenges for the users do. Therefore, the chapter is dedicated to emerging challenges for media literacy because it is not just necessary what or which, but also *how* digital media are and how they are dealt with by people.

People have been exposed to an overload of information, from which they need to make selections, since the dawn of humanity. Whether the invention of letterpress printing, the telephone, or photography, people have faced a "regretted inability to read" (Bawden & Robinson, 2009, p. 182), listen or watch. The rise of digital media, where watching, listening and reading are familiar practices and especially with the implementation of the social web as a user-generated database, gives the impression that this 'regretted inability' is growing immeasurably to an information overload. Stimulus satiation as sensory overload does not necessarily depend on media, but media visualise them and improve their transparency, making the information quantifiable, showing them "in cold print". For this, media are reproductions of reality as well as they are part of reality throughout their possibilities to act with them, both techni-

cally and content-related (including trading). With media, empirical reality becomes a cultural encoded continuum, which could be seen when the brothers Grimm wrote down oral fairy-tales for instance, or also since the point where it has been possible to take photographs of single elusive situations. Media "are constructed complexes of habits, beliefs, and procedures embedded in elaborate codes of communication" (Anderson & Curtin, 2002, p. 24) and concerning, places of information-collection such as libraries are obtaining "bodies of knowledge and per se published science" (Schanze, 2001, p. 234).

The rise of each new media is driving the process of information overload forward. Developing graphic characters, in addition to oral tradition, information was collected through several media. With the invention of Gutenberg's movable-type printing, a media system and cultural practice was rising around 1440 upon which today's mass media is based. With the Protestant Reformation, people started to address and reach a broad audience with their written information. When the "press" was reacting to public-orientated current incidents, the information increased further. Distribution of newspapers via post led to a wider dissemination of information. Broadcasting enabled the reception of cross-border channels. In the advent of the First World War, the appeal was extended to the entire population, who became interesting as voters (Stöber, 2003a, p. 150). Already Otto von Bismarck (1869) sharpened his statement about the various sources of information, saying that in the past there was the proverb "He is lying as if it were printed. In the future, it will perhaps come to the saying: He is lying as if it were telegraphed." (Stöber, 2003b, p. 240).

By looking at the past, it can be noted that such gatekeepers who were lying as if it were printed or telegraphed were always present, fostering or – sometimes unintentionally – inhibiting information overload. One of the first medial information overloads in the Gutenberg age was inhibited by religious authorities. The clergy started controlling the new mass media early on, which preserves unity of faith (for both Protestants and Catholics alike). Pope Innocence VIII established a prior censorship in 1487. It was needed to make clear that instances like this always have influenced information and thoughts but it was not as visible as censorship is today; it was not "in cold print". Furthermore, economic motivations are on display in "Postdebits", which inhibit information overload in newspapers, leading to the high prices of media, e.g. so that broadcasting or telegrams do not "overwhelm" the people or their material availability (Stöber, 2003b, 140). For this, on the one hand, censorship inhibits information overload and on the other hand, it ensures that the 'right' information are overloading.

Later, the influence of the church decreased and politics gained the upper hand over moral, ethical or aesthetic censorship. In contrast to print media, films were *ab inicio* established in and classified as commercial law; in Anglo-America as well as in Germany. In Prussia, the local Berlin police were responsible for film-censorship until 1906, whereby they used the General Land-Law from 1794 as a foundation for their actions. Also in the USA, the state – especially the local Chicago police – protected the moral order for films starting in 1907 (Stöber, 2003b, p. 64). The states collected taxes and started to educate journalists and moviemakers as gatekeepers on a subordinate level. During the Second World War in Germany, the transition of the National Socialist German Workers' Party (NSDAP) led to convictions and expropriations to an all-embracing centralization and nationalization of media and with it to censorship. It could therefore be said that the information overload controlled and inhibited thinking about the radical handling of mass media. The burning of books on 10th May 1933, where socialist, Jewish or other not system-compatible media were destroyed symbolically and materially, the unification of mass media under the Reich's Ministry of Public Enlightenment and Propaganda, or the punishments for receiving foreign broadcasts (Kohl & Hasse, 2001, p. 174) are some examples of establishing an ideological information overload.

The beginning of governmental influence also simultaneously strengthened media as an economic product. Nevertheless, what was regarded as improper by the church, was continued by governmental power, as well as the economic system that carried on governmental functions such as youth media protection and taxes.

All those gatekeepers have in common that they are using their power in a culturally pessimistic way. The main focus is on moral and ethical aspects along with law and order, which are important factors for the retention of the power of the authorities. Societal values need to protect, which means protecting people who cannot protect themselves. In the past these were women, the youth and children as well as the lower class(es), who needed to be kept separated from media, at least from the authorities' perspective (Barth, 2002, p. 82). They had a deep concern for information overload (already the rising use of the telephone caused immediate excitement) (Stöber, 2003b, 62). On the assumption that behaviour patterns are copied one-to-one by these groups, fear increases with each new media. Youth media protection was and is an overload inhibit factor because the youth need not select what already has been filtered. In Switzerland, censorship of films forbids young people (until the age of 18), from visiting the cinema until the middle of the 1960s. In the United States, youth media protection was more advanced in 1930 because media censors in the U.S. attached conditions to parental support. The control measures were compiled as a non-governmental department in 1922, and served as an early encapsulation of non-governmental censorship. In Germany youth media protection was orientated on the model of the U.S., but instead of accompanying the action of the children, their information overload should be inhibited through age-limits. The linear cause-effect assumptions are typical for views of new media (from the "Werther-Effect" up to "killer games"). Besides too much information, the authorities' concerns were also shifted to the concept of aesthetic habits such as "wrong" or "false" content. This moral assessment goes in hand with economic worries of how the old media will continue. Since governmental influence is decreasing because of the developments during the Second World War – where propaganda and nearly total control of media emanated from the states – the economy has become more powerful and thus technical and "false" appropriation are in the focus of information and information overload. The view on information overload is changing due to society facing worse consequences of controlled media and connecting with new developments in digital media.

Digital Information Overload Regarding History

Digital adventages and, especially the rise of the user-generated internet, foster information overload. Digital information overload means now, for example, participation because no licences, privileges, permission to print or publish, limit people. No index of opinions restricts creating information. Fewer barriers (except technical obstacles) such as profession access-control or frequency allocation prevent publication. Wikipedia as non-commercial could be called a digital world library. Information are arranged and managed, linked and stored there for usage; the reader pass is an internet connection.

Apparently it seems like, censorship currently does not inhibit access to and the flow of information. The economy presents the power structure which determines aesthetic, moral, as well as technical standards, "wrong-and-right" use or marginalised people. The power of censorships has changed from the Catholic point of view to market logic. Gatekeepers are neither popes nor ministries. Alphabeth Inc., Microsoft Cooperation, Oracle Cooperation, IBM, Apple Inc., Facebook Inc., Electronic Arts, Sony or Vodafone Group Plc are some of the new commercial information "overloaders" and overload inhibiters.

They develop and filter, code and decode, buy and sell publishing, organise and manage information or companies, software or management systems, like the clergy or governments did in the past.

Nevertheless, who has the power and where information comes from, is not as necessary as it is to confront who is pulling the strings and for which purpose. Culturally pessimistic ways of thinking are repeated with the rise of digital media. The telephone disrupted and violated privacy in 1902 like smartphones do today. This, however, seems more like a question of politeness and conventions than of overload. In telephone books, the telephone book authors react to this deficit with recommendations for action (Stöber, 2003a, 198); nowadays an equivalent concept is internet "netiquettes". The accusations that media make people stupid and violent occured with the rise of books for women and youth. These books are/were often scolded as trashy and smut literature (Scholz, 2004, p. 17). Today videogames or smartphones run this same gauntlet. At least early propaganda papers were used to spread the word to opponents of reformation (Stöber, 2003a, 140). They had a similar structure and aim as the present filter-bubbles generated by algorithms e.g. from Google Analytics.

Nowadays, the thought of information overload through books is greeted with smiles and smirks. This has probably come to be due to the well organised and developed structures of administration and management for written texts such as libraries, archives or museums. Furthermore, the fact that censorship or youth media protection for books is not a point of discussion, shows how times and opinions about media can change. This could also be the fate of the supposed problem called information overload: it is not just the mass of information (quantity), but more the way the information is handled (quality), and organised. In the case of digital media, filtering and selecting as well as digital media's authority/reliability become high priorities. Furthermore, these issues demand innovative skills, abilities, attitudes and know-how of the users themselves; the aim is for users to *participate* and not just *use* new media. While neither information overload nor structures of power are new concepts, media make the structures visible and offer the possibility to conceptually grasp power structures if users are able to cope with media challenges. To find out *how* digital media are dealt with by people, media appropriation needs to be in the central focus. Media literacy is thus the path for a participated, self-determined subject in a mediatised world.

THE CHANCE OF EDUCATIONAL MEDIA LITERACIES

The condition of a permanent possibility to engage with multiple information activities with media electronics is actually a brand new status. Considering the limited possibilities in the last centuries for lifelong learning, the current opportunities trend to a new approach to literacy. Apparently, this allows for the vision of the so-called overload as a chance for low-threshold access to a wide range of information.

Digital media is metaphorically not a library but an information supply service. Therefore, the question of how to handle information overload begins with the question of how to handle information and leads to the question of how information is distributed and presented. This section illustrates an approach to answer this question from the application of the German theorem of competence and the Anglo-American models of educational media literacies. The pointed outline follows methodically Gustav Grüner's concept of the vertical reduction (1967, pp. 414-421). The vertical reduction allows one to reduce the huge amount of contributions in both concepts and to simplify them "in a way that the crucial aspects of the concepts are still valid" (Futschek, 2013, p. 1).

The German Theorem of Competence

The German theorem of competence is very much based on the work of Dieter Baacke. Media competence[1] has to enable subjects to engage in reasonable decision making with media technologies (Baacke, 1980, p. 287). According to Baacke, the theorem of competence became integral to the social sciences in the 1970s. Baacke extended Chomsky's linguistic competence theorem and Habermas's communicative competence theorem to a very first media competence theorem. With his hypothesis that mass communication and personal communication stick together, the former influences media socialisation (Baacke, 1980, p. 333). On the basis of this principle, mass communication can foster or inhibit the yield of media competence. Baacke concluded that media competence enables people to reasonable solutions with the objective of an empowered citizen (1980, p. 287).

Due to the increasing proliferation of personal media in the 1990s, the boom of the term media competence had started. In particular, in educational policy context, the term was often used as a key qualification for the information age. As a consequence, more and more models and definitions of media competence appeared. This is to the detriment of a content-related specification of media competence. By means of a content analytical study in 1999, Harald Gapski identified 104 different definitions of media competence for the period from 1996 to 1999. His work highlighted the subject-orientated origin, with its idealistic and universal claim (2001, p. 208, 242).

The more widespread use of digital media and an increasing mediatisation of society has led in the past years to new challenges relating to the German discourse on media competence. The term "Web 2.0" is repeatedly used as a decisive argument for a renewal of media competence models (Gapski & Gräßer, 2007, p. 11; Süss, Lampert, & Wijnen, 2013, p. 131). Furthermore, other aspects have been mentioned: the technological base of personal computers (Zorn, 2011, pp. 176-183), the permanent availability of media via mobile devices, a converging digital media landscape, new processes of knowledge construction (Pscheida, 2010), new ways of presenting information, enhanced possibilities for producing content (Sutter, 2010, p. 47), the opportunity for "informational self-determination" (Gapski & Gräßer 2007, p. 25), questions regarding privacy issues and semioticised algorithms (Zorn, 2011). All these aspects were brought into the discourse on media competence only as fragments.

With this scale of new challenges, the question arises whether older models of media competence respond to the specific characteristics of digital media. At least to subsume the challenge caused by digital media under the established models is debatable. This point of discussion is traced back to the deductive approach of the German media competence models (Herzig & Grafe, 2012, p. 93). The established models are divided into several dimensions, which the respective author or authors claim to be appropriated. Those models are not based on empirical work, but on the theoretical position of the author(s). Thus, the media competences representing dimensions are not necessarily those required practically. This means that every deductive model inevitably has to subsume what are given by theoretical derived dimensions. With this in mind, it can be noted that the German media competence models operate strongly idealistically.[2] Hence, the theorem of competence, which was originally developed as a manner of acting with media (Baacke, 1998), appears in an idealistic, normative and theorised way. Consequently, the dimensions of media competence models appear to be abstract. If the theorem of competence intends to refer to human actions as central principle for solving tasks, the specific of digital media has to be identified. Especially the way digitised information is generated and presented plays a decisive role for the conceptualisation of media competence.

In this regard, the German discourse on media competence offers no pragmatic approach. In 1996, Dieter Baacke postulated that media competence comes up with an empirical emptiness that needs to be filled. About twenty years later, this is still an urgent demand. For an operationalization of media competence, the German theorem of competence is tainted with its idealistic theorized origin. Therefore, the following sector focuses on the Anglo-American models of educational media literacies, which is based on a pragmatic foundation. This enables educational media literacies to identify specific "top-down"-challenges caused by digitized information.

Anglo-American Models of Educational Media Literacies

In contrast to the German discourse of media-competence, the theoretical foundation of media literacy is based on the concept of pragmatism. But first of all, it has to be taken into account that there is not only one approach to or definite use of the term "literacy". On the one hand, there are several disciplines operating with the term, each of them in its own way. On the other hand, the term mostly relates to a specific application, for instance, library, computer, technology, visual, critical, new media or digital. Thus, every syntagma has its own scope.

In the German speaking discussion, Christian Swertz and Clemens Fessler came up with a proposal to sort out this matter. Swertz and Fessler discussed a "general distinction between information literacy and media literacy" (2010, p. 1). In this context, information literacies refer to technical skills whereas medial literacies are based on an educational understanding of a reflective and self-actualizing media reception and production (Swertz & Fessler, 2010, p. 27). This distinction seems to be comprehensible at first glance, but the interpretation of both concepts and their application in science are not clear. The connection between those two concepts is not disjointed. The following examples illustrate this point: Renee Hobbs, for instance, sees in digital and media literacy the ability to "create content in variety of forms, making use of language, images, sound, and new digital tools and technologies" (2010, p. VIII). Information literacy in turn, comes for the BIG6 Skills, developed by Eisenberg and Berkowitz, with a self-actualizing reception:

"The examination and assessment of the information problem-solving process" (1990, p. 9) is an integral component of this model. To pick up two more examples: The PLUS model by Herring (2004) contains "the ability to reflect on the process" (p. 74) whereas the 'Seven Pillars Model', developed by SCONUL (Society of College, National and University Libraries) defines a literate individual as able to, "critically appraise and evaluate their own findings and those of others" (2011, p. 9). By including the ability of critical evaluating, these understandings of information literacy go beyond the technical skill definition by Swertz and Fessler. Thus, the general distinction between information and media literacy might not be able to represent the English speaking discourse of literacies. This analysis leads to the conclusion, to search for common grounds within the discourse on information literacy.

The BIG6 and PLUS models mentioned above are divided into six and four stages respectively. Beside those popular stage models, there is another point of view which Daniel Bawden pointed out: "This viewpoint [sees] information literacy less as a series of competences to be mastered and more as a set of general knowledge and attitudes to be possessed" (2008, p. 22). Notable examples are the set of seven key characteristics by Bruce (1997), the definition of ALA (American Library Association) or the eight competencies by the CILIP model (2012) as well as the already mentioned SCONUL model (2011). The general distinction between the stage models and the set of competencies results reserved to the former is characterized by a process, meanwhile the latter is an interaction between the respec-

tive competencies. Such a distinction refers to the process that Lankshear and Knobel offered for digital literacies when they distinguished conceptual from standardised operational definitions (2006, p. 13). One example of conceptual definitions is provided by Paul Gilster. He identifies four key competencies: knowledge assembly, evaluating information content, searching the internet, and navigating hypertext (1997, p. 130). This is surely a fundamental difference. But at the substantive level, both approaches are very similar, and thus they include the abilities to identify a need for information, to locate, use, evaluate and organize these aspects. All of these abilities mentioned above refer to idealistic or operational standardised actions by the individuals.

The same approach can be seen within the media literacy discourse. One of the most cited definitions of media literacy is the following succinct sentence formulated in 1992 by the Aspen Media Literacy Institute: media literacy "is the ability to access, analyze, evaluate and create messages in variety of forms" (Livingstone, 2004, p. X). In 2003, this definition was supplemented by two more competencies named "reflect" and "act" (2003, p. 15). Another popular approach has been proposed by W. James Potter, who identified seven skills of media literacy and furthermore a summary of three tasks of information processing. To give a brief overview, the skills contain actions such as "breaking down the message", "judging the value", "using general principles" and the information process is divided in three actions, named "task", "goal" and "focus" (Potter, 2004, pp. 36-38). Besides these two elements, Potter's approach contains the subject perspective by adding to his media literacy model the personal locus.

The personal locus is composed of goals and drives. The goals shape the information-processing tasks by determining what gets filtered in and what gets ignored. The more you are aware of your goals, the more you can direct the process of information seeking. And the stronger your drives for information are, the more effort you will expend to attain your goals. (p. 35).

In this sense, the personal locus is a control mechanism of the information process operating with the knowledge structure in a person's memory.

Thus, both approaches of media literacy and those of information literacy mentioned above operate with human actions. This, to break it down, is due to the theoretical foundation of the literacy discourse, which is based on the concept of pragmatism.[3] The philosophical concept of pragmatism understands the principle of acting as the decisive factor for solutions of life tasks. The literacy discourse and so, as this section has shown, most of the media or information literacy approaches are highly influenced by idealistic or operational standardised actions by individuals. Of course, there is a general distinction in the focus of every approach between technological skills and critical understandings. But also the critical abilities tend to appear in idealistic or operational standardised actions[4]. This concept can be traced back to the pioneering work for media literacy that has been done by Len Masterman. In one of his definitive works "Media Awareness Education: Eighteen Basic Principles" (1989) he claimed that "the central unifying concept of Media Education is that of representation. The media mediate. They do not reflect but re-present the world. The media, that is, are symbolic sign systems that must be decoded. Without this principle, no media education is possible. From it, all else flows" (Masterman, 1989). This is a fundamental distinction to the German discourse of media competence, where the core principles are based on an idealistic and subject focused perspective ("bottom-up").

The following section extends the descriptive manner of this article to an exemplary approach on a theory-based educational understanding of information literacy in the digital age. Therefore, the German perspective of media critique will be combined with a technical based perspective on the semiotisation

of information, which is the crucial prerequisite for idealistic or operational standardised actions. Solving tasks by actions implies the situational context, which frames the actions. The pragmatic approach can be used to identify specific "top-down"-frames caused by the impact digital media has on the way digitised information are generated and presented.

THE CHANGE OF EDUCATIONAL LITERACIES

This section deals with the conceptualisation and practical application of both concepts presented in the previous section. As exemplary for the German discourse, the difficulties in operationalisation of the subject-orientated, idealistic and abstract theorem of competence will be shown by the concept of media critique. By including the digital characteristic of semiotised information, the mutual combination of both concepts is going to become accessible. The section ends with the practical application of the combined concepts in scholastic learning.

Media Critique

This section on media critique aims to outline the necessary inclusion of digital characteristics. The ability to engage in media critique demonstrates a cognitive process that centres on evaluating media based on certain criteria (Ganguin, 2004). This process requires knowledge of both the process of understanding and decoding media language as well as analytical ability in order to even be able to criticize media. These requirements are stipulated firstly in relation to one's self in the form of reflection, for example of media influences.

One problem with the empirical investigation of media critique is the fact that, theoretically, if a person is critical of media, he is not only critical of one medium but generally critical of all media. Thus it is truly a hallmark of competence that competence depicts a meta-trait that provokes situationally adequate action where the situational should be the medium itself. However, the phrase 'should be' implies that this is not in line with reality. It cannot be deduced that only because someone can critically appropriate newspaper content that this same person can simultaneously approach other media critically. This thus poses the question of whether the ability to carry out media critique is a generalized ability that can ideally more or less be applied to all media equally or whether there are certain requirements that lead to differing competencies depending on the medium, i.e. are media specific.

In this context, when dealing with the socialization process of young people, it is centrally important when dealing with communications media for them to learn how to understand language, symbols and develop the ability to interpret images. According to Piaget, this ability refers to the preoperational stage, the stage of thought in symbols that runs from the second to the seventh year of life. In this case, the ability to decode information requires a thought process that plays a major role in the semantic development of language and thus also of media language. Since a person has to be able to decode information and media symbols in order to understand media language since these symbols can take various forms, this process of information is collected under the heading of coding or 'symbol system'. For this reason, this text will use the term decoding ability.

Symbol systems can, for example, be verbal, pictorial or numerical. This can lead to the thesis that, for example, a book with its language, which I naturally have to decode, addresses very different senses and abilities than a film. In a textual decoding process, a person has to translate symbols into words,

words into sentences and sentences into concepts and information. For this reason, one could postulate that it is 'easier' to watch T.V. than to read a book since a book requires at least the abilities of reading, text comprehension and interpretation. Thus the path to different information processing systems has to be different for different media and therefore the decoding ability is dependent on the decoding level of a particular medium.

Additionally, many media use certain symbols or metaphors. The identification of the patterns among them is a challenge in many cases. Since some codes are not obvious but rather are frequently hidden within the dramaturgy, one first has to discover them as codes and then identify them. Many media also invoke particular symbols that are often references to other medial codes. Additionally, every culture and society has certain symbols and signs that are integrated encrypted within medial depictions in order to, for example, underline and clarify certain issues. We often always associate the same particular meaning or interpretation with certain symbols (for examples flags) so that frequently a verbal explanation of the symbols is no longer necessary since we already know what they mean. We have, however, gained this knowledge through experience in the socialization process. In this manner, a previous cultural understanding is needed when dealing with the decoding of symbols. Otherwise, one cannot recognize and decode them.

Digital media thus work with digital codes and are especially distinguished by their increased richness of information such as, for example, multimedia or virtual reality. The increasingly blurred division between sender and receiver plays an important role here. This leads to new challenges in the implementation of media critique since frequently the offers that are on hand in, for instance, the internet, are produced unfiltered and with a greater diversity. With television there is usually a long production and certification process involving many parties that eventually culminates in broadcast publication. In the internet, each and every individual person can publish whatever he/she wants, whenever he/she wants. Therefore, due to a lack of publication monitoring, it could be ascertained that every claim becomes information and thus the power of publication becomes decentralized. In this regard, Ramonet talks of a "democratic censorship":

As opposed to autocratic censorship, it [democratic censorship] is no longer based on the oppression and curtailment of data, on their abridgement or the prohibition to publish them but rather to the contrary on their accumulation, on the oversaturation and on the excess of information. (Ramonet, 1999, p. 35)

One result of a lacking supervisory body in the internet therefore is an excess of information since anyone can publish anything. This excess of information that a medium has to offer can represent a reason for selectivity. Due to the diversity of offerings, people have to differentiate and select among them and must decide more on their own; this is the case if they cannot subsume them under a prescribed generalization. The increasing relevance of media-specific critique thus arises from the circumstance that digital media exhibit increasingly stronger media characteristics that stand in contrast to the familiar world of most users and demand an increasing, independent competence for assessment from their users.

Therefore, in this sense, it can be verified that media dependence is one problem related to the ability to decode information in the sense of media critique. This is the case since different media use different systems of symbols and encoding and play with quantitatively as well as qualitatively different signs and symbols that are often hidden, although especially digital media, due to their excess of information, display a high level of decoding as well.

The Semiotisation of Information

In the previous section, it has been already explained that media competencies depend directly on the symbolic system of media technology. This statement refers directly to Len Masterman's conclusion about what distinguishes media education from other disciplines: "The media, that is, are symbolic sign systems that must be decoded." (1989, para. 2). Obviously, information overload is a repeatedly used term related to new media technology such as the transformation of oral to literate culture, the rise of printed books or, as we can see, the digital age. The focus on the information landscape needs to be much more than identifying main issues or potential problems. Trying to understand specific characteristics of the current essence of information has to face the question, "how is information scattered and presented?".

This topic refers to a wide range of scientific discourses. To name only a few: psychology, corporate communication, health communication, library science, information studies, science and technology studies, empirical educational research and communication and media studies. The fact that information overload appears as a crucial object of investigation is based on the mediatisation of all social areas. The mediatisation is characterised by an advancement from analog to digital technology. Tackling the root of information overload as a phenomenon in the digital age leads to the influence of digital technology on the way information emerges nowadays. As already mentioned, this article focuses on a media educational perspective on the mass of information media users encounter in modern society. As there is a myriad of possible approaches to the digital information landscape, this section takes one particular point into consideration. This will be the semiotisation of information in the digital age. On the basis of this aspect, the chance for educational literacies to combine media-specific aspects with subject-related ideals can be illustrated.

Information presented by digital media is totally semioticised. This is not necessarily something new in communication and media studies. Printed words semioticised oral words and radio or television engineering use electromagnetic waves for semioticised information transfer. But what is the special issue with digitised information? The digital code is not only exclusively a representation of information (Masterman, 1989), but also an interpretation through an algorithmic language. The algorithmic language is the basic feature of digital media, as already Lev Manovich pointed out: "New media may look like media, but this is only the surface" (2001, p. 48). All media reduce objects into syntactical characters, which is indeed a first step of semiotisation. Furthermore, and in contrast to print, radio or television, digital media operate automatically through algorithmic language. Thus, every representation (the surface) is based on machine-interpreted data and so on an abstraction of the interface from the algorithmic language. This process can easily be demonstrated by the adaption of a website related to the user. For example, while searching for a specific article someone intends to buy, the algorithmic language interprets personalised data and offers a customised output of information. Computers perform operations through a programming language. Thus, every process of information emergence and presentation has to be reduced to an operationalised form.

If educational media literacies, especially information literacy, orient themselves towards the specific features of digital media, they need to face those challenges. To find these potential features, this chapter recommends identifying them through empirical investigation rather than theoretical investigation.

How the digital technology influences the information process through algorithmic language has been exemplarily pointed out by Andrea Kohlhase's (2008) work. Kohlhase has shown that the user's benefit from information presented by semantic technologies tends to be more voluminous as the designer of the relating algorithmic code intended them to be. This is due to semantic data extending ordinary data

by including the kinds of relationships between the various data elements. Information generates new information, which is one reason for the impression of an information overload. "If the machine is thus empowered, a new set of questions arise naturally, e.g. the semantic currencies" (2008, p. 37). Such currencies can easily be seen as part of the new information environment. Among others, Kohlhase summarises in this aspect the following two currencies (pp. 7-8):

1. **Handover of Semantics (HoS):** A discrepancy between potential and reality of content collaboration. Formalising knowledge down to a machine's level offers no direct or indirect, but just potential value.
2. **Formalisation of Knowledge (FoK):** Capturing knowledge from a Knowledge Management standpoint not only means obtaining any representations but formalised, contextualised representations. Thus the problem of formalising knowledge is transformed into a knowledge representation problem in which the modification of representation is in focus, particularly the translation into semantic data formats.

Now, both of these criteria can be assigned to either stages or sets of educational media literacy models. For this purpose, the above mentioned information literacy models are listed and compared in Table 1.

Table 1. Anglo-American models on information literacy with the assigned competence criteria

ALA (2000)	SCONUL (2011)	Bruce (1997)	PLUS (2004)	BIG6 (1990)	CILIP (2012)
Determine the extent of information needed	Identify (FoK)		Purpose (FoK)	Task definition	A need for information
Evaluate information and its sources critically (HoS, FoK)	Scope (HoS, FoK)	Information technology conception (HoS)	Purpose (FoK)	Information seeking (FoK)	The resources available (HoS, FoK)
Access the needed information (FoK)	Plan	Information sources conception (FoK)	Location	Location and access (FoK)	How to find information (FoK)
Use information	Gather (HoS)	Information process conception (HoS)	Use (HoS)	Use of Information	Ethics and responsibility of use
	Manage, Present	Information control conception		Synthesis	• Work with or exploit results • Communicate or share findings • Manage findings
Understand issues surrounding the use and access, and use of information ethically and legally (HoS)	Manage, Evaluate (HoS, FoK)	Knowledge construction conception	Self-evaluation	Evaluation (HoS, FoK)	Evaluate results (HoS, FoK)
Incorporate selected information into one's knowledge base		• Knowledge extension conception • Wisdom conception			

Both criteria, the Handover of Semantics (HoS) and the Formalisation of Knowledge (FoK), can be assigned multiple times. Those "top-down"-issues have to be known by the users and therefore they are central criteria of information literacy. This procedure allows for the combination of specific features of digital media with educational ideals. Moreover, it constructs an operationalised model of information literacy.

Summary of the Description Mentioned Above

1. Digital media are semioticised.
2. Semioticised digital media operate with automatic algorithms.
3. Digital media represent machine-interpreted data.
4. Specific features of digital media should be adopted by educational media literacies.
5. Operationalised model of information literacy can be constructed.

The strategy and necessity of combining specific features of media with educational ideals also take place in formal learning processes. How they are addressed to pupils in an application-related way is described in the following section.

Source Criticism as Scholastic Scope against Information Overload

Bringing both perspectives of media literacy and media competence together is just the first step needed in an approach about participating subjects and thus dealing with a supposed information overload. To give an example, the focus of this section deals with the challenges of selecting medial information nowadays. Thereby media criticism and particularly source criticism is a desirable ability, which should be reconsidered to avoid the idea of information overload through digital media. Especially turning the gaze towards schools and their responsibility (and theoretical aim) raising self-determined subjects.

An advantage of medial information – caused by the fact that media are mediators and cultural content – is that structures (of power) are "in cold print" and thus indicated visually. They can be analysed and criticised. With the invention of script and later book print, educational institutions established and cultivated the praxis of medial information. Especially schools feel and take responsibility for passing on this culture to the next generation and aiding in their appropriation. Pupils learn to write and read letters – as semiotic symbols of languages – followed by reading and understanding texts as well as interpreting poems or prose texts during their school careers. But analysing movies, games or radio features are not included in the curriculum; neither of student teachers nor pupils. In the 1920s attempts were made to integrate telephony in scholastic learning because it was seen as a "culturally basic ability" (Stöber, 2003a, p. 202). This attempt failed because the usage was told as a matter of course, regardless of whether that not just technical, but also changes of communicative frames and skills such as nonverbal communication or protection of privacy. During the rise of the medium of film, scholastic learning integrated film as a mediator as well as their content became an object of criticism which was formed and established in the "educational film movement" in the 1920s. Meanwhile the praxis of criticism disappeared in the curricula, and media (as film) are more used as mediators than issue of debate, a destination, which has been attributed to each new rising medium. However, it would be even better to integrate media and their content culturally critically into each school subject, which has been demanded strongly since 1992. In

regard to information overload, one criteria of literacy should be media criticism, especially criticism of sources because in an information overwhelmed situation it is needed to select for participation.

One access could be adapting source criticism from historical source criticism, like history teachers let students evaluate pictures or texts. A common approach for this practice orientates itself on Borowsky, Vogel, & Wunder (1989) and divides historical critique of sources into source criticism on the one hand with description of source, outer and inner critique and on the other hand interpretation of sources, including analysis of content, context and solution.

Adding Digital Sources, This Procedure Changes

1. **Own Purpose:**
    a. At first – referring to media literacy –, a step before the first step needs to be added, where the pupil must determine the purpose of searching for and criticising information as well as the extent of the information. To achieve this, it is necessary to have an overview about where, how and what can be looked for and to understand what is needed.
2. **Source Criticism:**
    b. **Description of Source:** The second step resembles the evaluation of information and its sources. It is important to know which sources are how and where available, which is followed by the question if the content is the same and everything depends on whether using the internet is possible or not. Usability and the ability to analyse are important in order to distinguish information. Usability itself presents a structure where power can be manifested.
    c. **Outer Critique:** Decoding plays a decisive role for outer critique. Describing the source in its connection with the seeker, the asked questions, which locate the pupil in time, space and into society and in relation to the sources, could be which sources are serious, how are the sources connected or which structures of power refer to them. An aspect for digital media which had never existed before appears: searching in books or libraries, in picture books or encyclopaedias, does not leave any traces behind. Looking up information in digital media, so called digital fingerprints can be easily collected through cookies or personalised settings. Therefore, it is important to know who is collecting what information and who works together with whom. Not just data protection, but also copyrights are a more diverse topic to know about.
    d. **Inner Critique:** Multimodality describes well what traditional source criticism applies to a source's content. Digital information offers diverse modalities which can be – depending on usability – opened. To choose a source targeted, media appropriation skills and abilities are necessary. For digital information this means decoding as well as technical equipping. For example, it is impossible to listen to an audio-track in a very noisy environment similar to the way it is impossible to listen to an audio-file without headphones or the ability to push a play-button. Moreover, it is important to know where it is possible to find which kind of mode of the same content. In a library, books are arranged by content; all library books with similar topics are grouped together. This is not possible in digital sources like it is in traditional print media libraries. In digital sources, due to the unlimited content available, it is possible that the same topics are on completely different sites without any links.

3. **Interpretation of Source:**
    e. **Content:** The passing on of semantics is crucial for digital content. As described above, reading and understanding texts is learned in school from the first year onwards, whereas understanding and interpreting a picture or the content of films, games or apps needs to be tapped autodidactically.
    f. **Area of Statement and Embedded Context:** Understanding digital content should lead to literacy programming language, editing images, cutting audios and visual material, filtering or search engine optimisation. Through learning by doing, structures and symbols can be seen, reflected upon and understood. Encoding allows a view on structures of power. Discovering contexts and understatements, knowledge about economy, market and media history as well as source history could be instructive.
    g. **Solution and Summary:** The best source with the best information is useless if the pupil is not able to manage and present it. Therefore, passing on semantics, decoding reflection skills, and the critical power of judgement are required. A written or audio text can be read out, if it is not possible to present it, but a picture or film is useless if the pupil does not know how to integrate it into his/her presentation.
4. **Subject-Related Solution:**
    h. A critical reflection on one's personal standing regarding media, its sources or more generally, to the society in which media is embedded, produces results additional to the media-centred approach. A question could be, how media appropriation has changed within the information seeking process, how can it be adapted further, or how it has changed values, skills and abilities. Regarding digital media, changes of a filter-bubble and whether one's own presentation and reproduction of the information is clarified in its licence could be reflected upon. This approach could be developed further and concretely applied for every teaching subject and each medial device. For example, the reflection of each source a teacher is using, and how it has been found – beyond history lessons – would provide grounds for media criticism.

Some General Issues can Already be Combined

Issue 1: In a mediatised world, media need to be regarded as cultural practice, which demands an integrated media-education within each school subject.

Issue 2: Digital media information occurs in diverse forms such as texts, graphics, diagrams, pictures, films, banners, sound, audio, vibration, and so on. How to read a picture or react to a sound needs to be appropriated, in the same manner reading and understanding a text is. Therefore, scholastic education needs to expand the portfolio from books and texts to multimedia, which requires diverse strategies for each medial device and each medial content.

Issue 3: Criticising medial information, requires understanding of it. For digital media, more challenges are added through their semiotic structure of content, where understanding means decoding as well as encoding.

Issue 4: With digital semiotic, topics such as protection of data and privacy are accompanied.

Issue 5: Critique can refer to aesthetical or moral aspects or regard power structures such as censorship or filtering methods.

Media critique is understood as a complex multidimensional construct, consisting of the abilities to perceive, to decode, to analyse, to reflect and to judge medial content in its specific presentation (Ganguin, 2004, p. 4). For this, objective criteria are as essential as subjective ones, which results in subjective norms and values of a single person. Therefore, experience, observation and theoretical exploration are required to form media-specific knowledge. Knowledge about digital media is simultaneously consequence and precondition for learning processes and with it the basis to live and act independently in a mediatised world. Informal knowledge cannot be sufficiently achieved, e.g. about objectives and means of global media companies, if the information about it must be critically questioned; first the motivation is needed and secondly the ability of source criticism is necessary. For this reason, media criticism should take its place in formal learning processes, according to reading, writing, counting and interpreting. Establishing media criticism in schools is necessary because self-organisation and self-determination substitute the need of a 'digital-media-librarian' who arranges the information. On the pragmatical side, the media literacy/media-competence of criticism also prevents and avoids existing filtering and selecting systems from remaining undisputed and exercises their power.

CONCLUSION

Every change of the information environment has (re-)emerged new problems with regard to media behaviour. One driving force for that is certainly the wide-spread distribution and popularity of digital media. The discourse on educational media literacy has always been in response to the latest new media technologies. After a phase of irritation, anxiety and pedagogical prevention, follows a phase in which the possibilities of self-determined activities with media are highlighted. (Hüther & Podehl, 2010, p. 116). This paper interpreted the information overload as a crucial element of the changing information environment. Instead of spreading fear, this chapter applies a cultural-critical approach. It is then possible to reflect upon an adequate conceptualisation of educational media literacies for the new information environment.

The approach presented here is based on a transnational procedure. Due the global impact of digital media, the authors believe in the yield of an international exchange related to the discourse on media literacy. As the chapter has shown, both approaches presented on media literacy have their own characteristics. The German-speaking discourse on media competence is especially dominated by a subject-orientated and idealistic theorem of competences according to Habermas and Baacke. Important as the orientation on pedagogical ideals may be, German media education has not yet been able to conceptualise a media (or information) literacy model suitable for the digital age. The section on media critique has outlined the necessarily inclusion of digital characteristics.

In contrast, the Anglo-American discourse on media literacy follows the tradition of American pragmatism. The action model of pragmatism follows a problem-solving approach implying the definition of the situation and thus the information environment. Almost all models in the Anglo-American discourse operate with media activities by their users. There is, however, a lack of the specific characteristics of digitised information in those models. How easily they can be assigned to the models proposed, has also been showed.

It can accordingly be concluded that a possible conceptualisation of information literacy based on a pragmatical approach might be useful to identify specific feature of digital media. This "top-down" approach, can be added later on with educational ideals ("bottom-up"). Beginning the conceptualisation of

media literacy from the actual requirements of media users is an unusual approach for the German media literacy discourse. Identifying specific features of digital media with Anglo-American media literacy models and adding them later on with educational ideals may be an alternative approach for educational media literacy and a contribution for the transnational exchange of media literacy.

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KEY TERMS AND DEFINITIONS

Discourse: A discourse combines all relevant factors the topic of the discourse is dealing with. Amongst others, this may consist of the historical background, cultural and power characteristics, communicative practices, the constellations of actors or the disciplinary orientation. The discourse shapes and forms all topics included with its own characteristics. Thus, every interpretation reveals the discourse and depends on it.

Information Literacy: Information literacy describes the handling of information in and facilitated by media with educational values. This includes self-determined, reflective and purposive activities. Moreover, all factors relevant to handling the information (the information environment) are taken in account. Approaches to information literacy can be assigned to either library science, empirical educational research or holistic approaches to research.

Media Critique: The ability to engage in media critique demonstrates a cognitive process that centres on evaluating media based on certain criteria. This process requires knowledge of both the process of understanding and decoding media language as well as analytical ability in order to even be able to critique media. The general competence of media critique then has to be implemented through performance in concrete, media-critical action in which there are media-specific requirements so that the required level of media critique can differ from one medium to the next.

Media Literacy: Media literacy describes the handling in and with media through educational values. This includes self-determined, reflective and purposive activities. Moreover, all relevant factors for media activity (the media environment) are taken into account.

Pragmatism: Pragmatism is a philosophical paradigm focusing on specific acts. Through the problem-solving processes, thinking results and can be expressed with language. Pragmatical approaches integrate the definition of the situation and contextual factors. Thus, pragmatism stands aloof from the rationalistic paradigm.

Semiotisation: Semiotisation describes the process of a syntactical reduction and semantical abstraction of sensual perceptions through media. Every media technology (e.g. print, radio, television, digital media) semioticise sensual perceptions (e.g. noises, colours, movements, touches) to mediatise them. Media technologies work with the use of syntactical reduction. Furthermore, digital media operates with semantical data, containing semioticised information about the syntactical data. This enables digital media to interpret and abstract data to new information.

Theorem of Competence: The theorem of competence is the foundation of German media competence discourse. It has been brought into media education by the work of Dieter Baacke and refers to enlightenment ideals, such as autonomy, emancipation, critical ability and self-determined activities.

ENDNOTES

1 Media competence is literally translated from the German term “Medienkompetenz”. This is not comparable with the term “competence” used in the Anglo-American discourse on media literacy.

2 For example, Baacke (1996): media critique, media knowledge, media use and media creativity; Pöttinger (1997): perception competence, use competence and action competence; Schorb (1997): assessment, knowledge, acting (translated by the authors).

[3] Gerhard Tulodziecki already pointed out the relation between literacy and pragmatism: "the understanding of literacy is based for example on insights of cultural studies or on the concept of pragmatism and is a modern concept of education in an information and knowledge society." (2012, p. 50).

[4] One Exception is the approach by Bruce (1997), who constructed an evidence-based model that abstracts the action to higher categories.

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Chapter 8
Creating Global Classrooms Using Universal Design for Learning

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ABSTRACT

Media and digital content has become an integral part of our lives. Digital content has expanded the opportunities for accessing information for individuals with special needs and classrooms with culturally diverse students. Because the digital content is taught through multiple modes, it provides access to information previously available only through print formats. By incorporating universal design into the classroom, the students are using media and digital literacy skills, preparing them for the global world in which they live. In this chapter, a description of universal design will be provided, how to use the digital and media content to create a classroom that honors diversity, and how to use universal design for teaching different languages. The concepts of universal design and the global classroom are pulled together through project or problem-based learning. Finally, a glimpse into the future classroom technology is provided.

INTRODUCTION

Friedman (2005) in his book describes ten technology innovations that flatten world. The massive investment in fiber connections, followed by the bursting of the technology bubble, bridged the way for an inexpensive communication infrastructure connecting the continents of the world. These connections allowed us to begin to work and to collaborate in ways that were not possible before by instantly sharing information globally (Friedman, 2005). As the world flatten, the reliance on technology for communication, collaboration, and sharing increased. By 2014, 90% of American adults owed cell phones, of which 58% of those were smartphones. Tablet computers are frequently used, with 42% of adults owning these devices (Pew Research Center, 2014). The Pew study also reported that the usage of smartphones extended beyond telephone conversations. The devices were being used for retrieving

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information, listening to music, using the global positioning system (GPS) for information related to location, and interacting with social media.

For individuals with disabilities, the digital revolution which started as the world became flat was instrumental in opening up the possibilities to the world. First, the information they were able to access increased. Secondly, they were able to gain independence in acquiring that information. With the increasing number of assistive technology tools and better utilization of the digital tools, educators wondered if they were able to support more of the students in their classes in accomplishing educational goals. To answer this question, CAST, the Center for Applied Special Technology, developed Universal Design for Learning (UDL). CAST was founded in as a not-for-profit organization to explore uses for technology in expanding opportunities to access the general curriculum for all people, especially those with disabilities. Universal design for learning (UDL) examines ways to use technology to increase the opportunities for students in accessing the information available to them and reaching the educational goals of the instructor or teacher.

Digital literacy skills are necessary in making the guidelines that are outlined in the UDL model work well for children which have special learning needs. First the digital literacy skills will be described. Then the principles of universal design will be discussed with examples of how the two approaches come together. The different types of assistive technology will be discussed that are used to support individuals with disabilities and non-English learners. Finally, project-based learning brings the principles outlined in the universal design together with the digital literacy skills create powerful learning environments.

Digital Media

With available technology tools, digital media is readily accessible from the palm of the hand. The increased availability of inexpensive, smaller devices allows classrooms to participate within the global community. Digital media introduces students to a variety of ways for interaction with the easily interchangeable and transformable material for creation of new content. Because of the flexibility of digital media, students with special needs are able to access information that once was difficult for them to use in paper-based formats. Not only has access improved, students with disabilities can interact independently with the information.

Digital literacy is becoming an essential skill for all students as more media options are available in digital formats. Digital literacy is the students' ability to use media in a digital format to access information, evaluate, and analyze that information, then create and share new products to communicate (Heick, 2014; Media Smarts, ND; US Digital Literacy, 2014). Becoming experts in the use of digital literacy skills opens the door to other forms of literacy that are essential for students: civic literacy, health literacy, environmental literacy, information literacy, and media literacy (Partnership for 21st Century Skills, 2011).

By using digital media skills, students are able to utilize forms of literacy for non-text based instructional material increasing the options available for them to learn. However, digital literacy skills for students with a disability or who are non-English speaking enable them to access instructional material and global information by providing alternatives to paper-based text (Rose, Meyer & Hitchcock, 2005). Below is an expanded explanation of the following subsets of digital literacy skills: (a) accessing digital media, (b) evaluating and analyzing digital media, (c) producing media, and (d) creating and sharing media (Digital Literacy, 2014; Heick, 2014; Media Smarts, ND).

Accessing Digital Media

Digital media is powerful because of the students' ability to select the form of media in which to use information or their instructional materials. Although print materials are still available, many of those sources are being replaced with the digital forms that are pulled from the cloud to a personalized mobile device. Books, magazines, or newspapers are purchased online and available from computers, smartphones, laptops, or tablets. Even movies are purchased and viewed from the cloud.

Evaluating and Analyzing Digital Media

As students access the digital media, they need to be able to analyze and evaluate the content they are reading or viewing. What is the source of the information? What is the obvious message portrayed? Does the message contain underlying messages? What should the reaction to the information be? What are the implications of that message? In other words, not everything published on the internet is true. Analyzing those messages is important for all students as they encounter increasingly numbers of digital resources in their internet searches.

Producing Media

The newer tools allow us to quickly create digital media. Movie cameras and text editors are part of the smartphone. Young children can now create the media content with the touch on a screen. With those same devices, they can share their creations. These tools are allowing individuals with disabilities to quickly express themselves as alternatives to the pen and paper options.

Creating and Sharing

Connectivity in real time allows students to immediately share their creations with family and friends through the personal social media sites. They can now access information from around the globe, then interact with that content by posting and sharing their ideas. Through these interactions, students are able to influence events around their community and across the world. With this power comes a great responsibility to interact with the media as a global citizen respecting the culture, traditions, and feelings of others who are accessing the same social media platforms. At the same time, the new tools for creating content have become easier to use. These new tools provide alternative ways of demonstrating achievement of academic goals over and above pencil/paper activities and tests. Students who struggle with expression of what they have learn in traditional formats are now able to do so using digital literacy skills in creating and sharing.

ISSUES, CONTROVERSIES, AND PROBLEMS

The evolving technology has been invaluable for increasing ability of the individuals to access the information or to enhance their ability to learn. Through the use of assistive technology, students with disabilities, as well as, English language learners (ELLs) can use the technology to assist them by having the electronic text read to them. Word processors with voice recognition systems allow students

with fine motor challenges to compose stories and essays. In our global world, students with physical difficulties can reach out through their social networks to participate as active global citizens. ELLs are able to access translators and interactive tutorials to assist them in accessing information in primarily English-speaking educational environments. Students with visual disabilities in both visual and visual perceptions require more audio based media to acquire information. Other students with audio disabilities or audio perception challenges benefit from visual aids or text captions on videos to comprehend the world around them. Occasionally, students experience challenges for a variety of reason in social settings. This students can use digital media skills to access their instructional materials from environments that feel more comfortable.

Two major studies determined the prevalence rates of individuals with disabilities in the United States. In a study by Boyle et el (2011), parents reported that 15.04% of the children in the United States between the ages of 3 to 17 had a diagnoses of a disability according to 1997-2008 National Health Interview Surveys. Brault (2012) analyzed data from a survey conducted by the Social Security Disability Insurance Program between May to August 2010 to determine the prevalence of disabilities within the noninstitutionalized population living in the United States. Results indicated that 56.7 million, or 18.7%, of the overall population had a disability.

The Individuals with Disabilities Education Act (IDEA, 2004) identified 13 different categories of disabilities that are entitled to a free appropriate public education in the least restrictive environment. Those categories are mental retardation, hearing impairment, speech or language impairment, visual impairment, serious emotional disturbance, orthopedic impairment, autism, traumatic brain injury, other health impairment, specific learning disability, deaf-blindness, or multiple disabilities.

Although a person with a special need or disability is often viewed as having unique needs, disabilities exist along a continuum. For example, many of us have a slight visual impairment that glasses or contact lenses can compensate for the vision loss. Glasses allow the user to view instructional material previously not available. For some individuals, the visual disability is more severe, so glasses or contact lenses do not provide enough assistance. These students require alternate means of presentation of the material to see or hear instructional material. Another point to keep in mind is that any one of us can become temporarily disabled very quickly. If we break a bone, we can experience the same challenges that a person with a permanent mobility disability or an ear infection may experience temporary hearing lose. Addressing the needs of an individual with a disability can assist anyone that has a less severe form or a temporary disability.

Digital Divide

In the last decade, concerns have been mounting about differences in performance in school attributed to a growing digital divide. A disconnect occurs between those with access to technology and those without (Davis, Fuller, Jackson, Pittman, & Sweet, 2007). Overtime, the digital divide definition has changed from access to the frequency of technology use and the nature of the technology available for use in the home (Jackson et al, 2008). If children from lower socioeconomic status have access to technology, it is often outdated with inadequate software combined with limited access to the internet (Davis el al, 2007). This limited access attributes to fewer communication opportunities between parents and teachers, with parents less likely to use email or instant messaging (Lazarus & Lipper, 2005).

Primary language other than English is another factor that contributes to the digital divide. Most websites available on the internet are predominantly English (Zehr, 2001). The numbers available in

Chinese and Spanish are growing, but those available in other languages are limited. Because of the limited number of websites in non-English languages, families whose primary language is not English often do not value computers. As a result, Spanish-speaking homes are less likely to have internet access (Garland, 2009-2010).

The socioeconomic dynamic of the family is another contributor to the digital divide. As of May 2013, 9 out of 10 college graduates could access the high-speed internet from home as compared with 37% of adults who had not completed high school (Zickuhr & Smith, 2013). Income appears to be another divider with households under $50,000 less likely to have home broadband (Zickuhr & Smith, 2013). Wealthier families have the latest technology gadgets and faster internet speeds within their homes. The newer technology is easier to use, and older computers are not able to utilize the latest features when browsing the internet.

Students who have access to technology have definite advantages over those who do not. A series of studies have correlated the use of computer programming with improved test scores. For example, correlations were found with students who spent longer periods of time on computers at school, while those students who used computers at home for educational purposes scored better on the Programme for International Student Assessment mathematic assessment (Organisation for Economic Co-Operation and Development, 2005). Correlations were also found between the length of time children use information technology with grades and grade point averages. Jackson et al (2009) attributed the higher achievement to the increase diversity of activities students engaged in the longer they spend on the computer.

Slow network speeds make accessing some content online challenging. Web content frequently contains multimedia and video content which is difficult to view using low bandwidth. African Americans and Latinos view the lack of broadband at home as a major disadvantage in keeping up with local community events and news and information, using government services, improving or enriching their lives, obtaining health information, and finding jobs (Smith, 2010). With slow network speeds or no internet access, schools are the only place where these students are able to use technology.

With increased immigration into the United States, a growing number of students in the classrooms their primary language is not English. In 2011-2012, 9.1% of the students attended English as a second language, high intensity language training, or bilingual education classes (Kena, et al, 2014). The western states reported higher numbers, with 10.1% of students in these programs. These students fell into two at-risk categories for limited access to technology at home: minority and low socioeconomic status. With the lack of access at home, using technology at school is the only way for these students to develop digital media skills.

Mobile technology is beginning to reduce the digital divide gap because of the reduced cost of owning a cell phone or a smartphone over a computer. As of January 2014, 90% of Americans owned a cell phone, of which 58% were smartphones (Pew Research Center, 2014). However, the U. S. Census Bureau (2014) data indicated that 78.9% of households had a computer. For 7.3% of those living in the United States, the internet connection was too expensive. Although cell phones or smartphones are being used to access the internet, that access is much slower than connecting to the internet through a service. The content display is limited, causing some difficulty in multitasking across different programs and websites. As a result, access to information is still limited.

SOLUTIONS

Before the advent of the internet, individuals with disabilities were very dependent upon others to translate the world for them. For example, visually impaired individuals would need to have a friend to read those items that were not in braille or a deaf person would have needed a sign language interpreter. Although, they may still need these types of supports today, digital media can certainly substitute for many of these activities allowing greater independence. To gain access to the digital media, assistive technology is available to assist a students with a disability, special needs, or English as a second language to access digitized instructional material.

Assistive Technology

IDEA (2004) defines assistive technology as "any item, piece of equipment, or product system that increases, maintains, or improves the functional capabilities of a student with disabilities". Children identified in IDEA have a disability that interferes with their ability to learn have an individual educational plan (IEP) that is reviewed yearly. The classroom teacher participates as a member of the team of individuals who is providing services. In this role, the teacher is often asked to sit in on this yearly meeting to share how the child is progressing.

Process of Selecting Assistive Technology

Classroom teachers are often required to participate on an IEP team that decides on the educational program for a child with special needs. The IEP team is required to evaluate the need for assistive technology. The team examines the unique educational needs of the student. Then the team decides if a technology is available that will enhance the student's ability to access presentations of instructional material, provide alternate means of expression, or to increase motivation. Understanding how technology supports students with disabilities allows the teacher to become an active participant in the selection of the technology during IEP meetings for use in the classroom.

At the IEP meeting, the team uses a process to determine the need for assistive technology. As a part of that process, the team must consider the strengths of the child; the concerns of the parents to enhance the child's education; the results of the most recent evaluation of the child; and the academic, developmental, and functional needs of the child (Mittler, 2007). Five factors should be part of the process: (a) the needs of the child or youth, (b) an understanding of the technology or service, (c) the technological expertise of the student, parents, and teachers, (d) the match between the student's needs with his or her environment, and (e) the cultural values of the family (Jones, Hinesmon-Matthews, Lezlee 2014). These factors are important to ensure the adoption of the assistive technology by the student and by those who support the student. For example, using a smartphone would not be viewed by the students as different by the other students. The more ubiquitous the technology the more likely the student will adopt it. The closer the technology is to what the other students are using, the higher the adoption rate. The student's attitude is important in the acceptance of the technology solution (Carney & Dix, 1992).

As the team identifies the assistive technology required for the student to use the digital media, the teacher needs to have a process of organizing the classroom to provide opportunities to access the digital instructional material. The principles of universal design serve as a bridge between digital media, the assistive technology, and the student. Through the principles, students utilize digital literacy skills expanding their opportunities to learn new content, interact with that content, and demonstrate their new knowledge.

What is Universal Design?

Universal design for learning (UDL) allows all students, regardless of their strengths and weaknesses, to access the general education curriculum. The guidelines advocated in the model are based upon the latest cognitive research which allows the application of the model to extend beyond those with special learning needs. The central practical premise of UDL is that a curriculum should include alternatives and should be flexible enough to make it accessible and appropriate for individuals from different backgrounds, learning styles, abilities, and disabilities in widely varied learning contexts. The "universal" in universal design does not imply one optimal solution for everyone. Rather universal reflects an awareness of the unique nature of each learner and the need to accommodate differences, creating learning experiences that suit the learner and maximize his or her ability to progress. UDL provides a framework that helps teachers to differentiate their instruction through carefully articulated goals and individualized materials, methods, and assessments.

Within the global classroom, assistive technology in combination with universal design is used in two ways. The first way is to access the global curriculum by learners with diverse backgrounds and by students with disabilities. The second way is to use the technology to create a classroom that honors diversity within the global classroom and within the unique differences of students.

Cognitive Research

UDL is based upon the latest information available in brain research. The brain is a complex organism which converts sensory information into electrical impulses. The electrical impulses create pathways through the brain. The impulses actually cause our bodies to respond to the sensory information or it can store that information in different locations in the brain. To assist in understanding these brain functions, The Center for Applied Special Technology (now called the National Center on Universal Design for Learning) identified three systems which support the learning processes within the brain. The systems were described in The Universally Designed Classroom: Accessible Curriculum and Digital Technologies book (Rose, Meyer & Hitchcock, 2005). Below are the descriptions from that book.

- **Recognition Networks:** Specialized to sense and assign meaning to patterns which enables the identification and understanding of information, ideas, and concepts.
- **Strategic Networks:** Specialized to generate and oversee mental and motor patterns which enables the planning, execution, and monitoring of actions and skills.
- **Affective Networks:** Specialized to evaluate patterns and assign them emotional significance which enables engagement with tasks and learning about the world.

Educational Principles of Universal Design

Based upon the three networks for learning processes, the National Center on Universal Design for Learning (2012) developed three educational principles to base decision making in the classroom and provide guidelines for utilizing technology to enhance student performance. These principles used in a global classroom enhance the learning experiences of all children. Global classrooms are accessing the global communities and information using transformable digital media. Therefore, the digital media bridges the educational principles of universal design and the reaching out and connecting to the world. The principles are described below:

Multiple Means of Representation

The multiple means of representation principles is closely related to the recognition network. By using multiple forms of media, students are able to access information regardless of the source of disability. By offering combinations of audio and visual aids, understanding of text can be enhanced or can replace print-based text.

Multiple Means of Action and Expression

The multiple means of action and expression principle is closely related to the strategic network by promoting how students learn. Providing different means of interacting with the information gives alternatives to paper and pencil for students with physical challenges which affects the movement of those with challenges in strategic learning behaviors or poor organizational abilities. Replacing writing with audio files, movies, or pictorial representations allows the students to express themselves overcoming these challenges.

Multiple Means of Engagement

The multiple means of engagement principle is closely related to the affective network. Several factors can affect the willingness of students to engage with learning experiences, including their interest, ability to sustain effort and persistence, and to self-regulate their learning. Students' neurological makeup, cultural background, and knowledge base are examples of factors that can prevent or enhance students' willingness to interact with learning experiences. Providing choice for these students allows them to select how they are going to interact or increase their choice of topics within the content area. Choices are easier to provide when using digital material.

Advantage of Applying the Principles

Creating classroom instructional experiences using these principles provides the students with a wide variety of options. Students drive their learning by selecting instructional materials that meet learning needs, interacting with instructional materials, and engaging with relevant content. Keeping in mind that all disabilities are exhibited along a continuum, the variety of learning experiences benefit all the students.

Digital media has several advantages over traditional material. Digital media is versatile and transformable. Digital media can be marked or tagged in HTML and networked together. The result is in-

creased flexibility in the presentation, expression, and engagement with the learning material. Digital media are versatile, allowing content to be displayed in many formats: text, still image, sound, moving image, combinations of text on video, sound in text, video in text, and more (Rose et al, 2005). Students in a 21st century global classroom are using the media to analyze information, evaluate the relevance of information in order to understand, and produce with digital tools to create new knowledge. The flexibility of the digital media enhances the classroom activities in a global classroom, allowing greater access by the students.

Because digital media is transformable, both students and teachers have flexibility as they build the activities in the global classroom. Students are able to change the appearance of text or images, adjust sound volume, turn off graphics, and so forth, simply by selecting a different browser, changing browser settings, or using a different computer. Marking or tagging text allows teachers, trainers, and students (with only a small amount of training) to alter content, accommodating different needs or preferences. Markups made in text can be shown or hidden, amended, expanded, or deleted. The same store of information can be marked in different ways for different students. It can also be unmarked and re-marked to suit the evolving needs of any particular student (Rose et al, 2005).

Assistive Technology to Support Multiple Means of Presentation

One of the challenges students may experience is viewing the instructional materials, such as text and images. A variety of options are available to access printed text for students with visual disabilities. Converting printed material into digital text allows for modifications, and accommodations to be made to the text. Selecting the best options are dependent upon each student's unique strengths. Digital documents are easy to modify by enlarging or changing the font of selected text. This approach is frequently used to modify teacher-created materials and tests. Text readers added to a computer or to mobile devices read aloud any type of text on the screen, including websites and documents to the student. The National Instructional Materials Access Center (NIMAC) converts instructional material upon request to files that are accessible by individuals with disabilities, including braille, audio, and digital text. Finally, mobile devices have truly come a long way in providing options for students. The e-book software now comes with audio options built in so anyone can have a document or a book read aloud to them. Mobile devices offer convenience over and above any computer or laptop by providing mobility. Furthermore, any Word document can be read by using the text-to-speech options from the ribbon.

Some students have visual perception challenges with normal vision. As a result, these students are unable to follow text or lines. For these individuals, the ability to quickly modify e-text is highly beneficial. Adding white space by adjusting the line spacing in a paragraph or by increasing the character spacing of a font can increase readability on any document. Page backgrounds can also be changed in combination with font color to increase visual contrast.

Assistive Technology to Support Multiple Means of Interaction

Communication is important in the acquisition of information or knowledge and invaluable in education. However, students can experience challenges in hearing and in speaking. Communication tools are essential in assisting these children in both the alternative presentation and the expression. For individuals on the severe end of the spectrum, communication boards are very helpful. Communication boards have pictures or words (depending on the students' cognitive abilities) that the students can point indicating

what they wish to say. The boards have elaborate libraries of images, allowing the students to put together extensive sentences quickly. The boards also contain simple picture libraries that indicate basic needs, allowing the students to communicate food preferences, free time activities, or personal needs.

Broadmaker is a widely used tool to facilitate communication. Teachers can use a template with thousands of potential pictures displayed on a mobile device, computer, or paper. The created boards are used by the students to point at the pictures for visual communication with others. Visual schedules and calendars communicate the activities for the day with the students. The boards are useful for teaching vocabulary or making associations with the text representation of the word which encourages the development of basic reading skills.

Students who require visual materials for their communication needs can use a variety of technology to expresses themselves. Picture libraries found in Boardmaker, Kid Pix, or Microsoft Office promote the creation of personalized picture storybooks or animations to represent the students understanding of content. Nonverbal students, using multimedia, can create an animated model of a volcano exploding and label the parts of the volcano as a class presentation option or as a replacement for a traditional test. They might also benefit from paint programs or other creative expressions, such as Comic Creator (comic book creation software) or Voki which creates an animated speaking character.

Another group that benefits from communication support is those students with fine motor challenges. These individuals struggle with using pencils and pens to write clearly. An easy technology solution is to allow the students to create documents on a word processor. Using speech-to-text software, the students can dictate what they want to write, the software then creates a document with the words. Smartphones are coming out with many voice options, including the ability to dictate memos and text messages. Voicethreads allow students to participate in online discussions through recorded audio or video files. Additionally, students can create audio or video podcasts to post online rather than writing their responses.

Livescribe pen is helpful in taking notes. The pen has cameras and microphones embedded into the device. This allows audio to be recorded as the individual writes. The cameras records the writing or pictures simultaneously with the audio. The program then associates the audio with a location on dot matrix paper. A person with fine motor challenges can write only keywords or symbols during a lecture, then replay the portions of the lecture by tapping on the page. By posting the Livescribe files online, the student is able to easily share with classmates or replay the lecture.

Assistive Technology to Support Multiple Means of Action and Engagement

Engagement can take many different forms. Technology is reenvisioning interaction with content as a learning strategy. New tools allow teachers to quickly create instructional materials that allow students to interact. The students become actively involved with their learning rather than passively receiving information. Mobile devices put the learning power into the hands of the students.

Multimedia instructional development tools are evolving quickly. Teachers can quickly add multimedia and interaction to current lecture presentations. The interaction with these materials gives those students who struggle with attention the means to stay engaged with the material. The interactions motivate the students to continue working through difficult concepts. The development tools are responsive, allowing the products to display on computer screens, tablets, and smartphones. With the increased accessibility, the instructional products are available from home or school. Students can use the products for review and assistance with their homework.

Microsoft has just released an add-on, OfficeMix, for its popular presentation tool PowerPoint. The add-on allows the teacher to do two things. One feature inserts a voiceover using a webcam to the presentation as either audio or video. Through video or audio, teachers share insight about the material on the presentation, which is then embedded into the slides. This allows the students to see or hear their teachers explain the instructional material. OfficeMix also enhances the presentation by adding quiz questions which allowing the students to check their comprehension.

Interactions can also take the form of simulations. Brain-pop and GeoGebra are great examples of programs with animations for students to interact inside the lessons. Students can use the simple simulations to assist them in developing basic math and scientific principles. Furthermore, website searches can locate simulation content that is free on almost any topic. For example, a search for interactive water cycles will provide several simulation options.

Educational games are another great way to provide alternative means of engagement. Teachers can create crossword puzzles, hangman games, flashcards, or use premade games located on website. The games are available in the online textbook resources and the learning management systems or gradebooks. Students can make their own games to share with their classmates as another fun alternative.

Gamification is another way to engage students with learning. Gamification involves rewarding students as they proceed through a series of learning materials. Students can earn points for their learning accomplishments, which allows them to level up to more challenging material. Learning management systems are now including gamification reward systems through achievements, badging, and certificates. Students can earn achievements or badges for their Mozilla Backpacks. Many social media sites now display the badges that are earned.

Connecting Global Education to Universal Design

Classrooms that incorporate global education into their classrooms are learning about the interconnectedness of problems and issues across the globe. Digital media promotes this understanding by expanding the availability of different perspectives at the same time the giving alternative ways of learning the content and interacting with that content. At the same, time students need to use their digital literacy skills to evaluate and interpret the information they are accessing. Students are able to view those issues through the perspective of different groups of people involved in the issue (Tye & Tye, 1992). Technology advancement was very important in breaking down regionalism to create a seamless global commercial network (Friedman, 2005). We became aware of each other and how we can work across the world to create products and solve problems. Because some problems span across cultural and national borders, we need to become knowledgeable about issues and people from around the world (Xanthopoulos, 2005).

Classrooms that are using the principles of global education use digital media to implement and interact with the curriculum. Because of the forms of curriculum being used in the global classroom, the integration of the universal design principles are easily integrated into the classroom activities. Multiple means of presentation, action and expression, and engagement are the core of the instructional activities with the global classroom. Technology can be used to create an awareness of different cultures in three different ways. The first way is by exploring primary source material. The second is by connecting to individuals from around the world using social media. The third way is by creating content to share with the world. At the same time, universal design principles are being utilized.

Using Primary Source Information/Multiple Means of Presentation

Primary source information is readily available in ways that previous had not been accessible before. Banks (2006) suggested that the best way for us to develop an understanding of each other is by exploring different perspectives. Ethnic groups have created primary source content as a way to preserve their cultural heritage through digital storytelling. By searching the web, surfers can find rich accounts of personal experiences of individuals within different periods of time. Through these websites, students can explore historical events through the different perspectives of the ethnic groups involved creating deeper understandings of those events.

Using primary source information is an excellent way of applying the multiple means of presentation principle. Through primary source information, the students are able to use the computer to access information that is relevant to the topic being taught in the classroom. The primary source information is rapidly being converted into different forms of media. Paper is converted to digital text that is accessible by readers. Museums and organizations interested in preserving culture are creating online multimedia experiences for students to increase their reach. Students have options for developing an understanding of the context of the topics being taught.

The Irish Views of the Famine website is a rich example of personal accounts of past events brought to life through digitized primary sources. The website contains a simple compilation of resources, including personal diaries kept by Robert Whyte, 1847 Famine Ship Diary, and Gerald Keegan, Summer of Sorrow. Both diaries describe a typical journey across the Atlantic Ocean during the 1800s by immigrants from Ireland to the United States. The site also has links to newspapers detailing the effects of the potato famine. From these primary sources, students can develop an understanding of the social and political impact of the potato famine. The papers contain stories describing the food riots and massive death counts in Ireland. These simple links provide a context to the motives and the challenges the Irish faced as they began their new life in the United States. Because these resources are available on the internet, text readers can access the content and provide different formats for the information addressing multiple means of presentation. Students can develop an understanding of immigration issues to the United States outside of or instead of a textbook.

Museums are using a combination of technology and internet access to expand their reach beyond the physical displays. The result is highly interactive websites which simulate stories of immigrants to the United States. For example, the Tenement Museum New York is a restored tenement building. The virtual tour introduces the residents of the building and provides floor plans of their apartments. Students participate in simulations of the tenants' lives. The Smithsonian is another example of primary source material being made available with multiple means of presentation. The website provides an educator's tab. Through that tab, teachers have access to online exhibitions. The exhibitions have great visual appeal with both text and video embedded around digitized historical items. The online exhibitions extend the collections displayed beyond the museum itself. Most museums now have websites with multimedia that can enhance the students' knowledge about the topics within the classroom. The website provides alternative means of presentation and engagement and at the same time, promotes a deeper understanding of the subject.

Global Issues/Multiple Means of Action and Engagement

Staying connected to the global events is easy and accessible from mobile devices. For younger students, news stories are available from websites, such as DOGO news, National Geography, and Time for Kids. Major newspapers now have great websites for children to access, including CNN Student News, KidsPost, The Learning Network, and PBS News Hour for Kids. Deciding which news feeds to follow is more of a challenge than locating good ones for the older students. Most news outlets have places to post comments and observations for another level of interaction with the content. Remember, the websites are accessible with text readers for those students who struggle with reading or viewing the material.

Students can connect with each other to share their perspectives with each other in a safe online environments created by PenPal Schools or ePals. These websites allow classrooms of students to connect as pen pals with each other. The sites have a classroom matching tools to assist teachers in locating classes with similar size and interest. Space is available to post assignments for the students to work on together.

Pairing the pen pal experience with web-conferencing tools is another way for children to experience how they are part of a global world. Classrooms connect using webcam for face-to-face conversations. Skype or Google Hangouts function seamlessly allow children to share their work or to work collaboratively with each other. All of these tools work on mobile devices, so it is easier for small groups of children to interact in spontaneously building experiences they will remember. These visual methods of interaction eliminate the need for pencil and paper, allowing individuals with physical or writing disabilities to interact with these types of learning experiences.

Capturing and sharing cultural experiences are important in the global classroom. Digital storytelling enables the students to interact with cultural heritage and important background in understanding many global issues. Young (2010) described the experience of taking in digital cameras and printers into villages across Africa to capture daily life which the villagers shared with each other. The technology allowed them to preserve their lives and embrace technology. Digital storytelling allows the students multiple means to interact with content and multiple means of expression. Rather than reading a text-based account of the world around them, they are interacting and creating experiences at the same time, expressing what they are learning in creative ways.

Creating Content/Multiple Means of Engagement

Global classrooms are designed to engage students by allowing the students to create and share digital content. Digital literacy skills are very applicable for the universal design principle of multiple means of engagement. For students with special needs, the ability to create allows them alternative means of expression simultaneously. Microsoft is releasing an app called Sway. Sway allows students to gather content they may have written, movies they have recorded, or pictures they have taken into one place. The content is then easily formatted into an attractive presentation format viewed from any device. Students share the link to their Sway presentation through texting or email. The app makes the ability to communicate and to share ideas that are generated in a global class easily, creating an excitement about learning.

Valuing Diversity in the Global Classroom

Technology is a valuable tool for teachers in addressing diversity in the classroom. Through the vast resources available, students can explore their heritage using primary sources. Many websites are available about the different countries with rich descriptions of history and cultural traditions. Many museums now have websites that share electronic versions of historical documents which describe the passage from Europe or Africa to the United States. Other museums have ethnic focuses that share what life would have been like for individuals at different time periods. Through these vast resources, students can explore their own cultural heritages. These same resources can be used to develop an understanding of different viewpoints of ethnic groups about historical events. For example, what did the Indians think about the Great Expansion as the pioneers crossed the plains to build new homes in their hunting grounds?

Another way to value students' culture is to capture their family's stories through digital storytelling. The children can interview their family members about experiences growing up. Using audio or video, these stories can be captured in the native language of the family members. Treasured family pictures can be added to the stories to create a movie or slide show.

Technological Accommodations for Non-English-Speaking Students

Students who are unable to understand, speak, or read English are at an immediate disadvantage in an English-speaking classroom. Technology is available that can assist them in understanding what is going on in the classroom. The technology can promote learning the language in an immersive setting, allowing students using the tools to adapt to the learning environment.

Electronic text will be very helpful for students with a different primary language as they are learning English in two ways. First, students are able to listen to the audio files or podcast to develop conceptual understanding about the content as they are learning to read for comprehension from web-based information using text readers. Furthermore, audio recording assist in pronunciation of words (Scutter, Stupans, Sawyer, & King, 2010). Second, electronic text that is available on the computer can be converted to any language using internet-based translators. The programs are not perfect, but the results are better than not being able to learn the content at all.

Software applications, called apps, are coming onto the market for mobile devices that can translate words into and from any language. The apps allow the user to type in a word. The app then translates the word and pronounces it. Other apps will convert spoken words from one language to another language. These new tools will enhance the ability of teachers to talk with students who do not speak English. The new voice programs on the smartphones are able to go a step further. The translators can now "hear" a sentence and "speak" the translation, providing instant communication options. WordLens is an Android app that uses the mobile devices camera to "read" text. The text is then displayed in the desired language.

Teaching English

Technology is an invaluable tool in assisting children in learning a second language. Several tools are available online for teaching English. These online resources are great for children to learn English using the tutorials independently, while classroom teachers continue to lead the other students in other instruction. Through the use of these resources, the teachers is able to apply the concepts of multiple

means of presentation, interaction, action and engagement to assist children to learn regardless of their primary language within the classroom.

Conveying instructions to children who speak another language is difficult. The best accommodation is to pair the instruction with visual cues. Several programs are available for teachers to quickly design visual cueing guides. Expression of needs or knowledge can be difficult for students who do not know English. These students need alternative forms of expressing their thoughts or ideas. Again, technology can offer these children an outlet. The Inspiration products and the Kidspix are applicable for these purposes. Any program that will allow the use of images or movies to express ideas rather than words is appropriate.

Education Planning in a Universally Designed Classroom

The challenge in using universal design in the development of units and lessons is addressing alternative modes of presentation and expression while at the same time providing flexible methods of engagement. Traditional classrooms often offer one approach to the presentation of the material, paper-based interaction with the material, and pencil and paper assessments. With the increase of digital media in the classroom, these classrooms can begin to offer different options. A good model for delivering those options is project-based learning or problem-based learning often referred to as PBL.

PBL is a student-centered instructional approach that empowers learners to learn the content as they conduct research, integrate theory and practice, and apply knowledge and skills to develop a solution to a problem (Savery, 2006). PBL complements the global classroom. Global classrooms frequently research global problems, such as climate change, human rights, or socioeconomic issues. PBL is based on problems for which student develop research-based solutions. As the students design the solutions, they then present the solutions for those problems to classmates, other students, family, or friends.

Research has indicated that the integration of the PBL and technology promotes higher-order thinking skills and improves standardized test scores. Both of these skills are important as schools are being held accountable to standards. For example, fourth and eighth graders who experienced mathematics instruction based in higher-order thinking skills, project-based learning, and manipulatives were associated with higher performance on the mathematics National Assessment of Educational Progress (Wenglisky, 2008). Additional, students from classrooms that taught science through projects that took a high degree of initiative scored better on the National Assessment of Educational Progress (Wenglisky, 2008). After reviewing thousands of articles on PBL, Moursund, Bielefeldt, and Underwood (1997) determined that PBL increased student motivation, increased opportunities to use problem-solving skills, improved library research skills, increased opportunities for collaboration, and increased resource-management skills.

PBL is closely tied into the use of digital media. Students are able to use the digital resources available from the internet or from the media center to conduct their research. Students are using their 21st century communication skills as they connect to research partners. Then the students use their digital media skills as they produce products to share with classmates, families, or friends.

PBL is a learning process with the students moving through nine steps to complete the project. Because projects are extensive, implementing requires careful monitoring to ensure timely completion. Teachers using this instructional strategy should keep this in mind as they plan the curriculum throughout the year. The time spent on the projects are worth it. Students have the opportunity to use their decision making, deductive reasoning, and critical thinking skills throughout the project (Stix & Hrbek, 2006). Prepara-

tion to teach a PBL unit is also time consuming; however, the time in the classroom is better utilized as the students work on the project, the teacher is able to guide the students through the learning process.

The process within PBL has approximately nine steps. Depending on how extensive the project is or the age level of the students, the teachers needs to make decisions about using all of the different steps. Below are the nine suggested steps (Stix & Hrbek, 2006):

1. Set the stage the project.
2. Establish the forum for display or competition.
3. Accumulate and analyze the background information needed.
4. Negotiate the criteria for project evaluation.
5. Gather the materials required for the project.
6. Guide the students in the creation of the project.
7. Prepare to present their project.
8. Present the project.
9. Reflect on the process and the evaluation of the project

Combining these nine steps with technology potentially can produce results in improving academic outcomes. The Center for Applied Research in Educational Technology through research has identified six ways that technology influences positive student educational outcomes: (a) when the technology supports the curriculum objectives being assessed, (b) when technology increases the opportunity to collaborate, (c) when the program adjusts for the student ability and prior experience and then gives the teacher a report on the student's performance, (d) when the technology is integrated into the typical instructional day, (f) when student design and (g) implement projects on content that is being tested, when the educators of the school community support technology (International Society for Technology, 2005a)

By using PBL in the global classroom, students with disabilities and English as a second language are able to participate in the projects. Throughout the project, the students are being assessed on their progress toward achieving their academic goals of addressing flexible methods of engagement. Students can select the modes of presentation of the material used on the assessment. Finally, students will have alternate modes of expression as they present their projects that demonstrate what they learn throughout the unit of study. Throughout the project, students are engaging in the instructional materials in alternate ways as compared with a lecture situation. Students are actively conducting their own research, organizing, and presenting their findings.

Readymade projects are available on global issues through various platforms. Kids Go Global applies explore, act, inspire to projects on disaster relief to green projects. The organization provides participating schools safe places to post digital media online through webpages, blogs, project pages, and picture galleries. GlobalSchoolNet.org has online expeditions that can be used to start discussions about global issues in the classroom. The site provides resources to enhance the global classroom experiences, including accessibility tools. iPoPP, a worldwide e-learning platform for multi-lingual, project-drive collaboration, provides tools for connecting and evaluating global projects.

FUTURE RESEARCH DIRECTIONS

Emerging Technologies for Universal Design Classrooms

Understanding how the new technologies will be implemented into a global classroom that uses UDL and what features will enhance or create barriers for the students with disabilities or English as a second language to interact in a broader world will drive the research of the future. The new technology will continue to be more ubiquitous and intuitive. At the same time, it brings us together in personal and meaningful ways.

To predict the future of the assistive technology, the National Center for Technology pulled together thought partners to analyze patterns and identify key areas of growth in this field. The group identified four themes in the future considerations of assistive technology. The first is convergence of various systems or devices into a single platform, particularly into a mobile device. The convergence will create intuitive ubiquitous applications of technology for students with disabilities. The second theme is customizability and universal design. The mobile devices have applications and features that allow matching the students with their needs, creating the "I" experience. The third theme is portability in order to increase independence. The mobility of the devices offers flexibility. The students do not have to go to the technology; the technology goes with the student. The fourth theme, interoperability, is the ability for a device to move across platforms. This theme has emerged, but not exactly as predicted. Software solutions are designed to perform across the platforms. Responsive web designs and the use of HTML 5 have allowed for interoperability (Gray, Thomas, & Lewis, 2010).

Emerging Collaboration Technologies for Universal Design Classrooms

Future classes will have opportunities for collaboration in nature unambiguous ways. A variety of different tools for collaboration are available with different price points. A newer technology is the collaboration table. Groups of children, four to six, are able to gather around collaboration tables using touch technology. At the tables, children interact in creative ways as they combine their individual creations into larger projects or through predesigned learning experiences. The collaboration tables use touch technology on a flat surface. The tables act as giant tablets where students actually share at the same time as they create and interact with each other. Currently, this technology is targeting the early elementary grades (Blossom, 2010.). To enhance the touch screen technology, electovibrations are under development. As a finger moves across the surface, children will receive a rubbery, bumpy, or vibration sensation allowing them to feel textures on the screen (Johnson, Adams Becker, Estrada, & Freeman, 2014).

Another form of collaboration available for older students is screen sharing through the internet. A large flat screen has a device with software associated with it. The software allows students to connect using any device (laptops, tablets, or smartphones) to the screen. Because the device uses a URL to connect, students from other locations share what is on their device. The screen itself can display four different devices at one time. Right now, the best way to connect is to use video-conferencing tools si-

multaneously with the collaboration tools, such as Google Hangouts, or Skype. All of these programs are available for free. Through this type of software, students are able to work collaboratively with classmates from around the world in real time. For a detailed description of this technology check out AirMedia.

Collaboration walls are another great way of connecting global classrooms. These walls are giant tablets on a wall using gesture and touch screen technology for interactions. The large 84 inch, smartboards accommodate two individuals at the wall at the same time. Placing two of these boards at different locations expands the interactions to four students, two at each location. Projects are displayed in both classrooms with the class members quickly sharing their ideas in a real-time collaborative workspace.

Emerging Interfaces with Technology for Universal Design Classrooms

Interfacing with technology is advancing as well. Corning is developing glass technology based upon miniature hardware of the device reducing the visual interference with the display. This allows the user to look through the glass and interact with their environments using infrared technology. Glass also allows us to convert almost any surface into an interactive workspace. For a vision of this technology, check out the video "A Day Made of Glass 2" (Corning Incorporated, 2012) for the educational applications of this technology. The link is available in the online resources section at the end of this chapter.

Another possible interface with technology that is emerging is wearable technology. Sensors are imbedded into watches and jewelry. Right now the watches are being used to enhance healthy choices by tracking steps and other movements. Another wearable technology is glasses. Although Google has just pulled the Google glasses from the market, Google wanted time to rethink how the devices can be used. The product was not viewed as cool, had problems with battery life, and generated concerns about privacy (Eadicicco, 2014; Haque, 2015; Swearingen, 2015). HoloLens is a similar product by Microsoft. However, the lenses are not designed for outdoors, which may lead to successful adoption. The HoloLens is designed to allow the user to work and play more effectively by imposing three dimensions on objects and surfaces to create virtual experiences (Berinato, 2015). How these devices can assist individuals with disabilities will create many opportunities for research.

Opportunities for Research

Opportunities for future research in the universal design and the assistive technology to support students with disabilities will be interesting to explore. The assistive technology field is changing as rapidly. Whether it is working with available technology to adapt it to the needs of the students or creating software or devices that meet specific needs of students, research and development for these products will enrich the lives of these students. Through these new products, the students will have improved access to the digital information and higher demands on their digital media skills.

One example of new technology under development is electovibrations. Electovibrations will allow students with visual impairments to feel the interactions as they move their hands over an electronically enhanced surface. As the technology becomes ubiquitous, students with cognitive disabilities will also benefit as the vibrations will provide an alternative to interacting with the material multiple means of action and interaction. All students may be able to develop deeper understanding of content as they are able to feel the differences being created the technology. Students will be able to feel the typography of a map and changes in mathematical calculations to objects they are creating as compared with flat, paper-based worlds that require reading comprehension skills.

Other challenges will present themselves as new technology emerges. How will students with emotional disabilities and poor social skills successfully navigate the social demands of collaboration activities? Will they develop the social skills needed to interact and share at collaborative spaces? How will the visual nature of the displays be adapted to meet the needs of students with visual impairments? Will students learning a second language develop their language skills quicker in these language-rich environments which will contain visual cues about the conversations?

A continual challenge in conducting research on technology is the adoption cycle of an emerging technology. New technology is being created so quickly that researchers do not have time to truly research the impact of the technology before another new and improved product is on the market. Blogs by teachers and developers are often the best way to stay current on new technologies for the classroom. *Tech&Learning* is an online magazine that uses teacher language to evaluate new classroom technology with great ideas for how to use the technology in the classroom. More tech-savvy teachers may want to follow CNet, which is a combination of a blog site with online video channels. Experts share their insights of technology that is currently available. Flipboard is an app that has a technology online magazine that pulls in feeds from various blogs on the technology. It is a great app for busy teachers wanting a quick review of the latest tech news.

CONCLUSION

Friedman's (2005) description of a flat world gives us a vision of an interconnected world is which the children of the 21st century will live and work. Ensuring that these children learn within global classrooms promotes the development of the media literacy skills they need. Global classrooms include all children as universal design principles of multiple means of presentation, action and interaction, and engagement. Technology allows teachers to engage children using the media literacy skills. Although Friedman believed the world is flat, the world has many dips, valleys, and mountains. Through the communication and collaboration tools, students can explore the different cultures of the world and learn about students through connected classrooms.

Is technology the answer to all problems? No. However, technology can be the tool that allows us to engage one another. Students with disabilities or learning in a secondary language can use these new technology tools to access the information around them. As educators, we should continue to understand the benefits and the challenges technology brings to our classrooms.

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KEY TERMS AND DEFINITIONS

Assistive Technology: Technology tools that enable individuals with a disability to assist them to access curriculum or to accomplish daily activities with minimal assistance.

Collaborative Technology: Technology tools that allow individuals to work together on projects either in the same room or from different locations.

Digital Divide: Economic and social inequality created in society by the lack of access to or use of technology tools.

Digital Media: Information available in electronic formats, including text, images, video, and audio that allows it to be transformed, modified, and combined.

Primary Source: Documents, video, or other material created in the past at the time of events.

Universal Design: Carefully designed lessons that provide flexible presentation of materials, interactions with the information, and engagement with the content.

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Chapter 9
Networked Multimedia Communication Systems

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ABSTRACT

This Chapter simply contains multimedia - an integrated and interactive presentation of speech, audio, video, graphics and text, has become a major theme in today's information technology that merges the practices of communications, computing and information processing into an interdisciplinary field. The challenge of multimedia communications is to provide services that integrate text, sound, image and video information and to do it in a way that preserves the case of use and interactivity. A brief description of the elements of multimedia systems is presented. User and network requirements are discussed together with the pocket transfer concept. About Multimedia communication standards a general idea is also given. Multimedia transport over ATM and IP networks discussed in brief. The issues pertaining to multimedia digital subscriber lines are outlined together with multimedia over wireless, mobile and broadcasting networks as well as digital TV infrastructure for interactive multimedia services.

INTRODUCTION

The precedent years have seen an expansion in the usage and the field of digital media. Industry is making considerable investments to deliver digital audio, image and video information to consumers and customers. A novel infrastructure of digital audio, image and video recorders and players, on-line services, and electronic commerce is quickly being deployed. Abreast major corporations are converting their audio, image and video archives to an electronic form. Digital media offers several discrete advantages over analog media: the quality of digital audio, image and video signals is higher than that of their analog counterparts. Editing is easy because one can access the exact discrete locations that should be changed. No loss of fidelity happens while copying. A copy of digital media is alike to the original. Digital audio, image and videos are easily transmitted over networked information systems.

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These advantages have opened up numerous new possibilities. Multimedia consists of Multimedia data and set of interactions. Multimedia data are casually considered as the collection of three M's: multi-source, multi-type and multi-format data. The interactions among the multimedia components consist of intricate relationships without which multimedia would be a simple set of visual, audio and other data. Multimedia and multimedia communication can be seen worldwide as a hierarchical system. The multimedia software and applications offer a direct interactive environment for users. Whenever a computer in need of information from far-off computers or distant servers with that scenario, multimedia information must travel through computer networks. As the amount of information involved in the transmission of video and audio can be significantly huge, the multimedia information must be compressed before it can be transported through the network in order to lessen the communication delay. Limited delay and jitters like constraints are used to make sure a reasonable video and audio outcome at the receiving end. That is why, communication networks are undergoing constant up gradation and improvements in order to provide multimedia communication capabilities. In order to connect local terminal computers and other equipment with each other, Local area networks are used and wide area networks and the Internet connect the various local area networks together. Improved standards are constantly being developed in order to provide a worldwide information expressway over which multimedia information will travel. Multimedia communications is the field referring to the representation, storage, retrieval and dissemination of machine-process able information expressed in multiple media, such as text, image, graphics, speech, audio, video, animation, handwriting, data files. With the advent of high capacity storage devices, powerful and yet economical computer workstations and high speed integrated services digital networks, providing a variety of multimedia communications services is becoming not only technically but also economically feasible. In addition, the broadband integrated services, digital network (BISDN) has been given special attention as a next generation communication network infrastructure which will be capable of transmitting full motion picture and high speed data at 150 and 600 MB/s and voice as well as data throughout the world (Mouftah, 1992). At first, the concept of multimedia communication modeling will be described, together with user and network requirements, packet transfer concept as well as multimedia terminals. The second part deals with multimedia communication standards. Finally, we will concentrate on multimedia communications over networks. Multimedia transfer over ATM networks is described. This is followed by multimedia over IP networks. Special issues relating to multimedia over wireless will be discussed.

Improvement in the quality of video and audio is always being demanded. The increasing demands pose great challenges in developing multimedia applications in the areas of content creation, usage and sharing of media experiences. Additional challenges come from communication systems; handovers between different networks are especially challenging in mobile devices. We identify and analyze the requirements that a distributed multimedia application may enforce on the communication network. Due to the vastness of this field, we do not claim that this list is exhaustive, but we have tried to include all the important aspects (from our view point) that have significantly impacted the enhancements to the basic Internet architecture and its associated protocols. Recent advances in communications technologies have witnessed a growing and evolving multimedia content delivery market based on information gathering, manipulation, and dissemination. It is a fact that personal communications, computing, broadcasting, entertainment, etc. have turned into streams of multimedia content, and the various communication and network technologies have become the means to carry that content to a wide variety of terminals. Unlike traditional communication systems, a fundamental challenge for present and future communication systems is the ability to transport multimedia content over a variety of networks energy-efficiently at

different channel conditions and bandwidth capacities with various requirements of quality-of-service. There are many issues need to be addressed such as signal processing, collaborations, power management, flexible delivery, specialization of new content, dynamic access, telecommunications, networking, etc., due to the multi-disciplinary nature of the applications in advanced multimedia communications.

The objective of this chapter is to carry together the state of the art research contribution that describes original and unpublished work addressing the new emerging techniques on multimedia communications. Particularly, we solicit research papers on addressing challenging issues existing for enabling mobile multimedia communications over heterogeneous infrastructure for realizing next generation networking and computing. For example, ubiquitous multimedia is a requirement in next generation networks, such as multimedia adaption in wireless network; multimedia services in ubiquitous circumstance; improving distributed multimedia communication through location awareness, action awareness, user awareness, etc. On the other hand, due to the limited computational power, memory and battery energy in wireless and portable terminals, power efficient design also plays important role in next generation mobile multimedia applications. The table consisting of some of the frequently used acronyms in the field of Networked Multimedia communication is given below in table 1.

MULTIMEDIA COMMUNICATION

Multimedia Communication is simply the transfer of information or data over the network, in which the information or data may be, consist of one or more of the following types: Text, images, audio and video, etc. Applications in medicine, education, travel, real estate, banking, insurance, administration and publishing are emerging at a fast pace. These applications are characterized by large multimedia documents that must be communicated within very short delays. Computer-controlled cooperative work, whereby a group of users can jointly view, create, edit and discuss multimedia documents, is going to be characteristic of many transactions (Cox, 1998). Some glamorous applications in multimedia processing include: distance learning, virtual library access and living books. The students learn and interact with instructors remotely via broadband communication network in distance learning. Virtual library access means that we instantly have access to all of the published material in the world, in its original form and format, and can browse, display, print and even modify the material instantaneously. Living books supplement the written word and the associated pictures with animations and hyperlink access to supplementary material (Rosenberg, 1992). Applications that are enabled or enhanced by video are often seen as the primary justification for the development of multimedia networks depicted by figure 1.

Much of the work on packet video has considered fairly homogenous networking scenario (Bojkovic, 1996). It would be a proper if a single type of video service dominated in the networks. However, it is not a valid assumption for the traffic issues. First, video will not constitute a uniform service with easily determined behavior and requirements. Secondly, video will not share resources with streams of only the same type. This means that multiplexing in the network should be evaluated for a heterogeneous mix of traffic types. In business areas, there is a potential need for various kinds of new communication system, such as high-speed data networks between geographically distributed local area networks (LAN's) high definition still picture communication and TV conferencing or corporate cable TV services. The new paradigm of the BISDN application system as a result of the integration of multimedia processing by workstations and multimedia communication by BISDN is shown in Figure 2.

Table 1. Different Acronyms used in the field Networked multimedia communication

S.No	Acronym	Description
1.	ADPCM	Adaptive Differential Pulse Code Modulation
2.	ADSL	Asymmetric Digital Subscriber Line
3.	AE	Area Directors
4.	ATDM	Asynchronous Time-Division Multiplex
5.	ATM	Asynchronous Transfer Mode
6.	AV	Audiovisual
7.	BISDN	Broadband Integrated Services Digital Networks
8.	CATV	Cable Television
9.	CLEC	Competitive Local Exchange Carriers
10.	CTI	Complete Timing Information
11.	DBS	Direct Broadcast Satellite
12.	DDL	Description Definition Language
13.	DSL	Digital Subscriber Line
14.	DSM	Digital Storage Media
15.	GSM	GSM Global System for Mobile
16.	HDTV	High Definition Television
17.	HFC	Hybrid Fiber Coax
18.	IAB	Internet Architecture Board
19.	IEC	International Electro technical Commission
20.	IESG	Internet Engineering Steering Group
21.	IETF	Internet Engineering Task Force
22.	IPN	Integrated Packet Network
23.	ISOC	Internet Society
24.	JPEG	Joint Photographic Experts Group
25.	LMDS	Local Multipoint Distribution Service
26.	MBS	Mobile Broadband System
27.	MVPD	Multichannel Video Program Distribution
28.	NTI	Null Timing Information
29.	NTSC	National Television System Committee
30.	PAL	Phase Alternating Line
31.	PCM	Pulse Code Modulation
32.	PVR	Packet Voice Receiver
33.	PVT	Packet Voice Transmitter
34.	QoS	Quality of Service
35.	RFC	Request for Comments
36.	SHDSL	Single pair High speed DSL
37.	SIF	Standard Source Input Format
38.	TCP	Transmission Control Protocol
39.	TR	Technical Report
40.	UDP	User Datagram Protocol
41.	UMTS	Universal Mobile Telecommunication System

Figure 1. Multimedia communication

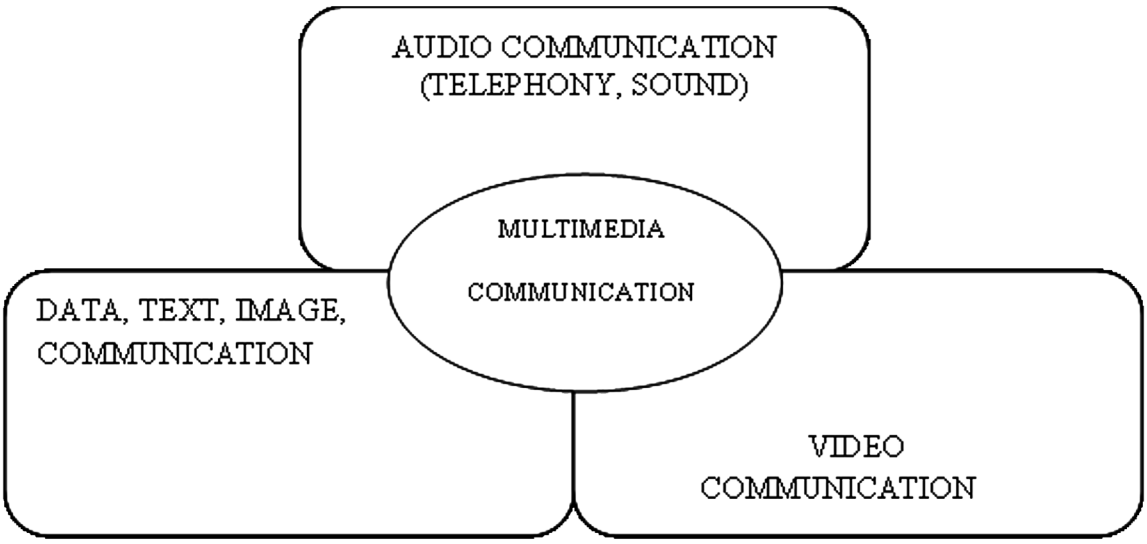
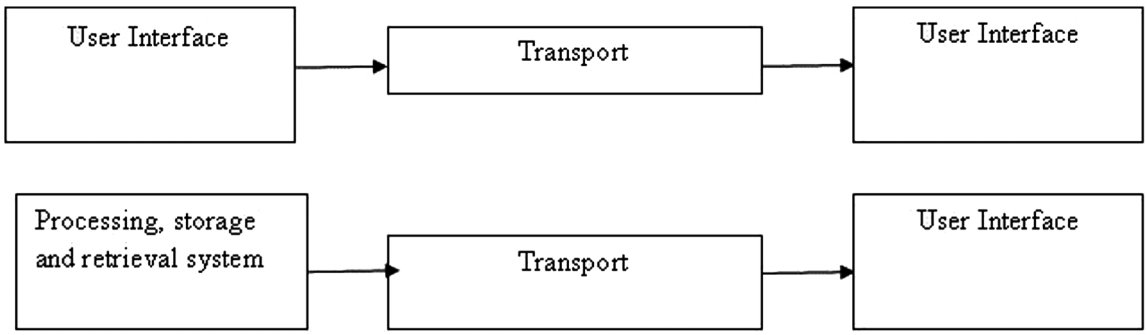


Figure 2. Elements involve in multimedia communication systems in person to person communication and person to machine modes



A multimedia communication model is strongly influenced by the manufacturer-dependent solutions for personal computers and workstations including application software on the one hand and by the intelligent network concept on the other (Jayant, 1993). A layered model for future multimedia communication comprises five constituents:

1. Partitioning of complex information objects into distinct information types for the purpose of easier communication, storing and processing. This comprises data, video or audio taking into account the integration of different information types not being excluded.
2. Standardization of service components per information type, possibly with several levels of quality per information type.
3. Creation of platforms at two levels: a network service platform, and a multimedia communication platform. The first level hides the transport networks and network building blocks from an application designer's or user's point of view. The second level provides communication support on

the basis of information structure and information exchange building blocks for a large number of applications.

4. The definition of "generic applications" for multiple uses in various multimedia environments and different branches meeting common widespread needs.
5. Specific applications: electronic shopping, tele training and remote maintenance, based on special information building blocks and utilizing the network service platform, the multimedia communication platform as well as including generic applications.

With regards to the capability of the available resources in each case, the multimedia communication applications must be scalable in order to run in a constant manner across different network and terminal types and capabilities.

There are two key communication modes in which multimedia systems are generally used: person-to-person communications and person-to-machine communications. The key elements of multimedia systems are presented in Figure 2. As it can be seen both these modes have a lot of commonality, as well as some differences.

In the person-to-person mode shown in Figure 2, there is a user interface that provides the mechanisms for all users to interact with each other and a transport layer that moves the multimedia signal from one user location to some or all other user locations associated with the communications. The user interface creates the multimedia signal and allows users to interact with the multimedia signal in an easy-to-use manner. The transport layer preserves the quality of the multimedia signals so that all users receive what they perceive to be high-quality signals at each user location. Examples of applications for the person-to-person mode are teleconferencing, video phones, distance learning and shared workspace scenarios. In the person- to-machine mode, shown in Figure 2, there is again a user interface for interacting with the machine, along with a transport layer for moving the multimedia signal from the storage location to the user, as well as a mechanism for storage and retrieval of multimedia signals that are either created by the user or requested by the user. The storage and retrieval mechanisms involve browsing and searching to find existing multimedia data. Also, storage and archiving in order to move user-created multimedia data to the appropriate place for access by others. Examples of applications for the person-to-machine mode include creation and access of business meeting notes, access of broadcast video and document archives from a digital library or other repositories.

MULTIMEDIA COMMUNICATION OVER NETWORKS

There are basically nine types of communication networks that are used to provide multimedia communication services. With the increase in transfer of multimedia information over the past few decades has resulted in many new multimedia processing and communication systems, being put into service. The increasing availability of optical fiber channels and rapid advancement in VLSI circuits and systems has fostered a tremendous interest in developing sophisticated multimedia services with an acceptable cost. Today's fiber technology offers a transmission capacity that can easily handle high bit rates. This leads to the development of networks which integrate all types of information services. By basing such a network on packet switching, the services (video, voice and data) can be dealt with in a common format. Packet

switching is more flexible than circuit switching in that it can emulate the latter while vastly different bit rates can be multiplexed together. In addition, the network's statistical multiplexing of variable rate sources may yield a higher fixed capacity allocation.

1. Packet Video

Asynchronous transfer of video signals which often is referred to as "packet video" can be defined as the transfer of video signals over asynchronously time-division multiplex (ATDM) networks, such as IP and ATM. The video may be transferred for instantaneous viewing or for subsequent storage for replay at a later time. The previous case has requirements on pacing so that the received video data can be displayed in a perceptually continues sequence. The last case can be seen as a large data transfer with no inherent time-constraints. Apart from the requirement on pacing, there may also be bounds on the maximum transfer delay from camera to monitor, if the video is a part of an interactive conversation or conference. These limits are set by human perception and determine when the delay starts to the information exchange. Parts of the signal may be lost or corrupted by errors during the transfer. This will reduce the quality of the reconstructed video and if the degradation is serious enough, it may cause the viewer to reject the service. Thus, packet video common topics are to perform coding and make sure the asynchronously transfer of video signals under quality constraints.

The synchronous transfer mode combines the circuit switched routing of telephony networks with the asynchronous multiplexing of packet switching. This is accomplished by establishing a connection (fixed route) through the network before accepting any traffic. The information is then sent in 53-octet long cells. The switches route calls according to address information contained in each cell's 5 -octet header. Traffic on a particular link consists of randomly interleaved cells belonging to different calls. The network guarantees that all cells of a call follow the same route and hence, get delivered in the same order as sent. The intention is that ATM networks should be able to guarantee the quality of service in terms of cell loss and maximum delay, as well as maximum delay variations.

The internet protocol differs in two major respects from ATM as there is no pre-established route and the packets are variable length (up to 65535 octets). IP does not give any guarantees on the delivery of the packets and they may even arrive out of order if the routing decision changes during the session. These issues will be addressed by the introduction of IP in conjunction with the resource reservation protocol RSVP. IP often called Internet Protocol (version 6), packets contain a 24-bit flow identifier in addition to the source and destination addresses which can be used in routers for operations like scheduling and buffer management to provide service guarantees. Delay and some loss are inevitable during transfers across both ATM and IP networks. The delay is chiefly caused by propagation and queuing. The queuing delay depends on the dynamic load variations on the links and must be equalized before video can be reconstructed. Bit errors can occur in the optics and electronics of the physical layer through thermal and impulsive noise. Loss of information is mainly caused by multiplexing overload of such magnitude and duration that buffers in the nodes overflow.

2. Multimedia Transport over ATM Networks

As previously stated, multimedia it denotes the integrated manipulation of at least some information represented as continues media data, as well as some information encoded as discrete media data (text and graphics). Multimedia communication deals with the transfer, protocols, services, and mechanisms

of discrete media data and continues media data (audio, video) in/over digital networks. Such communication requires that all involved components be capable of handling a well-defined quality of services (QoS). The most important QoS parameters are required capacities of the involved resources, compliance to end-to-end delay and jitter as timing restrictions, and restriction of the loss characteristics. A protocol designed to reserve capacity for continuous media data, transmitted in conjunction with the discrete media data over, for example an asynchronous transfer mode - local area network (ATM-LAN) is certainly a multimedia communication issue (Orzessek & Sommer, 1998). The success of ATM for multimedia communications depends on the successful standardization of its signaling mechanisms, its ability to attract the development of the native ATM applications, and the integration of the ATM with other communications systems. The integration of ATM into the Internet world is under investigation. If there will be ATM applications such as video on demand, then there is also the need for a "side-by-side" integration of ATM and Internet protocols. It can be very well understood that the ATM/BISDN in wired networks is behind the success of wireless ATM (WATM). When ATM networks become a standard in the wired area, the success of WATM will be realized.

3. Video Over Wireless ATM Networks

Wireless ATM (WATM) has become the direct result of the ATM "anywhere" movement because of the success of ATM on wired networks. WATM can be seen as a solution for next-generation personal communication networks, or a wireless extension of the BISDN networks. There has been a great deal of interest recently in the area of wireless networking. Issues such as bit error rates and cell loss rates are even more important when transmitting video over a wireless network. A very high performance wireless local area network which operates in the 60 GHz millimeter waveband can experience cell loss rates of 10^{-4} to 10^{-2}. To provide adequate picture quality to the user, some form of error correction or concealment must be employed. One option is to use the MPEG-2 error resilience techniques and to modify the MPEG-2 standard slightly when it is used over wireless ATM networks. This technique is known as macro blocker synchronization (Zhang, 1997). In macro block resynchronization the first macro block in every ATM cell is coded absolutely rather than differentially. This allows for resynchronization of the video stream much more often than would be possible if resynchronization could only take place at the slice level. It would be relatively simple to incorporate this method with the existing MPEG-2 coding standard by adding an interworking adapter at the boundary between the fixed and wireless network (E. Ayanoglu). A second proposal for improving error resilience in wireless network is to use forward error correction (FEC) methods. In addition, improve performance can be achieved by using a two layer scalable MPEG-2 coding scheme rather than one layer (Ayanoglu, 1993).

4. Multimedia Over IP Networks

Multimedia has become a major subject or theme in today's information technology that combines the practices of communications, computing, and information processing into an interdisciplinary field. In this Internet era, IP based data networks have emerged as the most important infrastructure, reaching millions of people anytime, anywhere. They serve as an enabling technology that creates a whole new class of applications to enhance productivity, reduce costs, and increase business agility. Anticipating

that multimedia over IP will be one of the major driving forces behind the emerging broadband communications of the 21st century; we address the challenges facing the delivery of multimedia applications over IP in a cost effective, ubiquitous, and quality guaranteed manner.

5. Packet Voice

In Packet voice, the phenomenon of packets witching offer several potential advantages in terms of performance when compared to circuit-switched networks. Major advantage is efficient utilization of channel capacity, particularly for "bursty" traffic. Well not as bursty as interactive data, speech exhibits some burstiness in the form of talks parts (Brady, 1990). It is actually on the sensitivity of the speech detector average talk's part duration depends but it is well known that individual speakers are active only about 35-45 percent in typical telephone conversations. Although by sending voice packets only during talk's parts, packet switching offers a natural way to multiplex voice calls as well as voice with data. Another major advantage is that call blocking can be a function of the required average bandwidth rather than the required peak bandwidth. In addition, packet switching is flexible. For instance, packet voice is quite capable of sustaining priority traffic and point to multipoint connections. Network capabilities in traffic control, accounting and security are enhanced as the packets are processed in the network. Continuous speech of acceptable quality must be reconstructed from voice packet that experience variable delays through the network. Imposing an additional delay is all required for compensating of the variable delay component in the reconstruction process. Hence, packet should be delivered with low average delay and delay variability. Speech can tolerate a certain amount of distortion (e.g., compression, clipping) but is sensitive to end-to-end delay. The exact amount of maximum tolerable delay is subject to debate. It is generally accepted to be in the range of 100-600 ms. For example, the public telephone network has a maximum specification of 600 ms. In order to minimize packetization and storage delays, it has been proposed that voice packets should be relatively short, on the order of 200-700 bits, and generally contain less than 10-50 ms of speech (Listanti, Villani & Gold, 1983). Network protocols should be simplified to shorten voice packet headers (e.g., on the order of 4-8bytes), although timestamps and sequence numbers are likely needed. Since a certain amount of distortion is tolerable, error detection, acknowledgements, and retransmissions are unnecessary in networks with low-error rates. Flow control can be exercised end-to-end by blocking calls. In addition, network switches can possibly discard packets under heavy traffic conditions. In this case, embedded coding has been proposed whereby speech quality degrades gracefully with the loss of information (Bially, 1980).

6. Integrated Packet Networks

The economies and flexibility of integrated networks make them very attractive and packet network architectures have the potential for realizing these advantages. However, the effective integration of speech and other signals such as graphics, image and video into an integrated packet network (IPN) can rearrange network design properties. Although processing speeds will continue to increase, it will also be necessary to minimize the nodal per-packet processing requirements imposed by the network design. Data signals must generally be received error-free in order to be useful. The inherent structure of speech and image signals and the way in which they are perceived allows for some loss of information

without significant quality improvement. This presents the possibility of purposely discarding limited information to achieve some other goal, such as the control of temporary congestion. One of the goals in integrated packet network is to construct a model which considers the entire IPN (transmitters, packet multiplexers and receivers) as a system to be optimized for higher speeds and capabilities (Patr, DaSilva & Frost, 1989).

In summary, the advantages gained by taking a total system approach to integrated packet network are as follows:

1. A powerful overload control mechanism is provided.
2. The structure of speech is effectively exploited.
3. Extremely simple per-packet processing for overload control is allowed.
4. Only one packet per speech segment is required.
5. Receiver speech synchronization is simplified.
6. Reduced per-packet error processing at packet multiplexers is possible.

7. Video Transmission over IP Networks

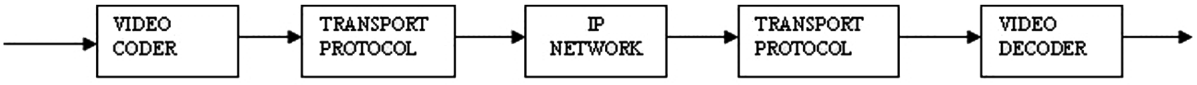
The problem of sending video over IP has essentially two main components: video data compression and design of communication protocols as illustrated in Figure 3 (Servetto & Nahrstedt, 2001).

One approach consists of designing a low bit rate coder, protecting the resulting bit stream with channel codes and using one of the standard Internet transport protocols to transmit the resulting data stream. If the source bit rate is low enough and the channel is not too congested, then it is possible to use TCP, in which case no errors occur and therefore there is no need for channel codes. Otherwise, user datagram protocol (UDP) is used with a constant packet injection rate, and low-redundancy channel codes are used to protect against infrequent lost packets.

8. Multimedia Over Digital Subscriber Lines

The Internet is responsible for changing the way we work, live and spend time with all its applications. However, today the Internet is confronted with a major problem. Increasing demand for access has produced bottlenecks and huge congestion, which resulted degraded internet speed. These restrictions has simply forced the existing technology of traditional telephony to new and innovative heights with the emergence of Asymmetric Digital Subscriber Line (ADSL) technology. With the advent of the High speed ADSL simply eliminate bottlenecks, granting all subscribers quick and reliable access to Internet content. Telecom service providers have yet to realize the full potential of ADSL. Traditional telephone and Internet services are only the beginning, while the ability to offer broadcast video services is a reality.

Figure 3. Structure of a video streaming system



Cable TV operators are beginning to offer voice and data services. There is increasing competition from Competitive Local Exchange Carriers (CLEC) and other carriers, making it imperative that traditional telecom service provides video services. By offering a range of services, established service providers can generate additional revenue and protect their installed base. Direct Broadcast Satellite (DBS) providers, particularly in Europe and Asia, are offering a compelling Multichannel Video Program Distribution (MVPD) service (Merriman, 2000).

A key factor contributing to the successful deployment of Asymmetric Digital Subscriber Line (ADSL) access systems has been the facility for overlying data services on top of existing voice service without interfering with the voice service. For the users this basically offers:

1. Always-on service capability. There is no need to dial up as the Internet Protocol (IP) connection is always available and the office networking model in which network resources are available all the time.
2. Virtual second voice line. Unlike when the user is connected through a modem, the voice line remains available for incoming and outgoing calls. For the operator, the service overlay allows ADSL to be installed throughout the network, irrespective of what types of narrow band switches are installed. After the initial success of ADSL, it became apparent that it could be used to offer multiple phone lines together with a greater range of services (e.g., Virtual Private Networks VPN) targeted at specific markets. This has been made possible by the high bandwidth of ADSL, backed up progress in voice compression, echo canceling and digital signal processing technologies. ADSL offers a high data bandwidth, of which a portion can be used to offer additional voice services integrated with the data services. Symmetric Digital Subscriber Line (DSL) techniques, such as Single pair High Speed DSL (SHDSL) cannot be deployed as an overlay to existing analog telephone services, so the delivery of voice and data services using asingle facility requires voice to be carried directly on the DSL link. The techniques used to transport voice and data in an integrated way over DSL-whether ADSL or SHDSL - are referred to as Voice over DSL (VoDSL). With VoDSL, two main market segments are of interest to service providers. The first is small to medium sized businesses, a significant percentage of which need to be able to send and receive data of around 500 kbit/s. The voice needs of these customers are typically met by 4 to 12 outgoing plane lines. Using, for example, Adaptive Pulse Code Modulation (ADPCM) voice coding, at peak times these phone lines consume only 128 to256 kbit/s of the ADSL bandwidth, which is typically in excess of 2 Mbit/s downstream and more than 500 kbit/s upstream. The second market interested in VoDSL services is residential users who will appreciate the extra two to four voice lines that VoDSL offers (Verhoeyen, 2000). ADSL will be delivering multimedia services to millions of users. The transmission of digital multimedia data requires the existing systems to be augmented with functions that can handle not only ordinary data. In addition, the high volume of multimedia data can be handled efficiently only if all available system services are carefully optimized.

9. Internet Access Networks

Asymmetric digital subscriber line (ADSL) offers asymmetric rates of transfer of data to and from the Internet. The uplink rates can go up to 768 Kbit/s and down links rates are 6-8 Mbit/s, depending on the length and condition of the local loop - the wiring between the customer's premises and the telco central office. Cable companies bring analog TV signals over optical filters to their neighborhood distribution

points, a head ends, whence the signals are distributed to residences by coaxial cables. The combination of fiber and coaxial cable, which can carry high-speed data as well as TV signals, is known as hybrid fiber coax (HFC). Each distribution point typically serves 200-500 residences. The extent of the network of a cable TV operator is measured in terms of homes passed - that is, the number of homes adjacent to which the operator's cable passes, regardless of whether those homes have been signed up as customers. Realistically, cable modems are capable of passing data upstream at speeds of 200 kbit/s to 2 Mbit/s, and downstream at speeds up to about 10 Mbit/s. Cable modems, capable of operating at higher speeds than ADSL, have some serious drawbacks. The cable link to a residence is shared among many users, so that if many of them decide to log onto the Internet at the same time, achievable communications speeds may plunge. Because the lines are shared, a hacker may be able to drop on a neighbor's connection to the Internet or on an intranet - a security problem that may be serious to some users. Consequently, a customer who happens to be a road warrior will be unable get access into the Internet at airports or hotels through his laptop computer at his usual data rate. If he is able to connect at all, it will be through a dial-up modem at a much lower speed.

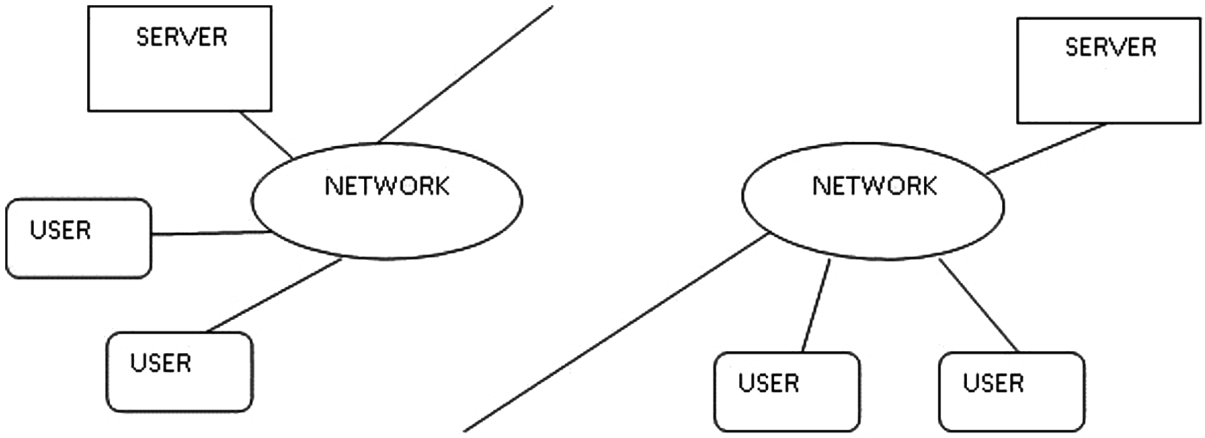
MULTIMEDIA COMMUNICATION SYSTEM ARCHITECTURE

A multimedia communication system consisting of both the communication protocols which are used to transport the real-time data and also the distributed computing system (DCS) within which any applications using these protocols must execute (Constantine & Papandreou, 1998). The presented architecture attempts to integrate these communications protocols with the DCS in a swift fashion in order to ease the writing of multimedia applications. Two issues are recognized as being necessary to the success of this integration: namely the synchronization of related real-time data streams and the management of heterogeneous multimedia hardware. The synchronization problem is solved by defining explicit synchronization properties at the presentation level and by providing control and synchronization operations within the DCS which operate in terms of these properties. The heterogeneity problems are addressed by separating the data transport semantics (protocols themselves) from the control semantics (protocol interfaces). The control semantics are implemented using a distributed, typed interface, scheme within the DCS (i.e., above the presentation layer), whilst the protocols themselves are implemented within the communication subsystem. The interface between the DCS and communications subsystem is referred to as the Orchestration interface and can he considered to lie in the presentation and session layers. There are three types of Multimedia Communication System Architecture depicted in figure 4.

AUDIO-VIDEO CONFERENCING

The emergence of videoconferencing as a new means of communication with many applications such as tele meeting, remote education or telemedicine is quite evident. When two or more people communicate synchronously by means of audio, video and very often, using data applications such as electronic whiteboards or chat then it is known as a videoconference. Videoconferencing plays a very significant role in the various application fields as it is a direct way of supporting co-operation. It allows simultaneous communication for geographically dispersed participants, and it accomplishes this task without imposing a rigid structure on the communication, thus leading to interactions that resemble as close as

Figure 4. Types of multimedia communication system architectures



possible natural communication in a face-to-face situation. Videoconferencing communication is thus a key issue in multimedia cooperative systems (Bellido, Fernández & Pastor, 1996).

The mounting facilities available in videoconferencing systems are also important. From systems that allowed a uni-directional communication between two sites, we are now in a situation where it is possible to have several users engaged in a N to M communication. The potential utility of videoconferencing has increased with the help of systems electronic whiteboards, transfer of documents and window sharing. The term multimedia conferencing has been proposed to illustrate the merging of the different data applications to basic audio and video communication. In the project LEVERAGE [Lev01], for instance, a multimedia conferencing system has been developed, to support task-based foreign language learning, collaboration and interaction between students present in Paris, Madrid and Cambridge. The EDUBA project (Pastor, Fernández & Bellido, 1995) is another example where Videoconferencing is used in learning scenarios.

Till recently, the finest way to access to videoconferencing (or multimedia conferencing) has been the use of equipment based on the H.320 standard [H.320]. The equipments and protocols needed to support videoconferencing over narrowband ISDN (Integrated Services Digital Networks) is simply defined by the H.320 is an ITU (International Telecommunications Union) standard. The quality of videoconferencing (Okubo, 1997) is improving day by day with the deployment of broadband network technologies and advances in the techniques for audio and video compression. Below there is a analysis and comparison among different alternatives available to support videoconferencing over broadband networks is given. Specifically, the ITU recommendations H.321, H.310 and H.323 ([H.321], [H.310] and [H.323].

1. First Standard

The standard H.320 has been considered as the very starting point for the current development of videoconferencing systems. It is the first standard ("Recommendation" in ITU terminology) to provide a total system for videoconferencing, allowing the interoperation of equipment built by different manufacturers. H.320 is supported by narrow-band ISDN (N-ISDN), which provides digital channels with different bandwidths: 64 kbit/s (B channel), 384 kbit/s (H0 channel) and 1536/1920 kbit/s (H11/H12 channel) [27]. The Recommendation stipulates several other Recommendations in which constituent elements,

such as audio coding, video coding, multimedia multiplexing and system control, are defined. For audio coding, G.711 [G.711] is the basic standard, but other Recommendations define different qualities with different bandwidth requirements. For video coding and compression, ITU-T defines the H.261 standard, which can work from 64 kbit/s to 2 Mbit/s in multiples of 64 kbit/s.

2. ATM for Videoconferencing Systems

The advent of broadband network technology has created the requirement to use these technologies to support videoconferencing which requires high bandwidth. As ATM is the chosen technology for future broadband ISDN, therefore the ITU-T concentrated on the standardization of videoconferencing systems in ATM environments. Some characteristics of ATM make it an excellent supporting infrastructure for videoconferencing systems, among them (S Okubo, 1997):

1. Flexibility in bandwidth usage.
2. Availability of high bandwidths.
3. Service integration.
4. Variable bit rate capability.
5. Use of Cell Loss Priority.
6. Multipoint distribution.
7. Flexible multiplexing.

However, there are also some drawbacks:

1. Cell loss.
2. Cell delay variation (Jitter).
3. Packetization delay.

3. Adapting to Broadband Networks

The H.321 simply defines the technical specifications for adapting H.320 terminals to broadband ISDN environments. This recommendation allows the interworking of terminals over broadband ISDN and terminals over narrowband ISDN. To facilitate interworking, the basic technologies used for audio and video codification and compression are also G.711 and H.261, the same as in H.320 (*ITU-T Recommendation H.320, ITU-T Recommendation H.321*).

4. Taking Full Advantage of Broadband

Recommendation H.310 has been recently approved. H.310 covers the requirements for systems and terminals to carry out audiovisual communications over ATM networks. These recommendation defines uni-directional and bi-directional terminals and classifies different types of terminals, depending on the ATM Adaptation Layer used (AAL1 or AAL5). H.310 standard apart from covering conversational services such as videoconferencing does also covers retrieval, messaging, video-on-demand, broadcast TV, video transmission and surveillance services (*ITU-T Recommendation H.310*).

H.321 is integrated in H.310 as one of the operating modes, providing interworking with other networks. H.310 also solves some of the limitations of H.321 by defining a Native ATM mode. Though it keeps the basic H.261 and G.711 as the coding for interoperability in video and audio respectively, it also defines the use of MPEG audio and video, which will provide a better quality in Native Mode operation (*ITU-T Recommendation G.711*). The H.310 protocol reference model, which consists of the following protocol, stacks (*ITU-T Recommendation G.711, ITU-T Recommendation H.261*):

1. Out-of-band network access signaling stack for DSS2 signals.
2. In-band communication control stacks for H.245 messages [H.245], in charge of logical channel signaling and capabilities exchange.
3. H.320/H.321 interoperation mode stack using H.221 multimedia multiplex.
4. H.310 native mode stack using H.222.1/H.222.0 multimedia multiplex.
5. T.120 stack for data applications.

MULTIMEDIA COMMUNICATION STANDARDS

A multimedia standard is likely to provide support for a large number of applications. These applications render into specific set of requirements which may be very different from one another. One theme common to most applications is the need for supporting interactivity with different kinds of data. Communications mean standards but the production of standards for multimedia communications is beset by the problem that the many industries having a stake in it have radically different approaches to standardization. Standards play a major role in the multimedia revolution because they provide interoperability between hardware and software provided by multiple vendors. Some of the multimedia communication standards are discussed below:

1. MPEG-1 (Coding of Moving Pictures and Associated Audio)

The MPEG-1 is actually the first standard developed by the group and was the coding of the combined audio-visual signal at a bit rate around 1.5 Mbit/s. This was aggravated by the hope that was becoming apparent in 1988 to store video signals on a compact disc with a high quality comparative to VHS cassettes. Coding of video in 1988 at a such low bit rates had become possible all because of the decades of research in video coding algorithms. The video coding algorithms however, had to be applied to sub sampled pictures – a single field from a frame and only half of the samples in a line - to show their effectiveness. Also coding of audio, as separate from speech, allowed reduction by 1/6 of the PCM bitrate, typically 256 Kbit/s for a stereo source, with virtual transparency. When audio and video streams are encoded with the constraint of having a common time base, resulted into a single stream by the MPEG system layer. MPEG-1 formally known as ISO/IEC 11172 is standardized in five parts. The first three parts as Systems, Video and Audio. Two more parts complete the suite of MPEG-1 standards. Conformance Testing, which specifies the methodology for verifying claims of conformance to the standard by manufacturers of equipment and producers of bit streams, and Software Simulation, a full C-language implementation of the MPEG-1 standard (encoder and decoder) (ISO/IEC IS 13818-1).

2. MPEG-2 (Generic Coding of Moving Pictures and Associated Audio)

The MPEG-2 families of standards simply summarize the compression technologies and bit stream syntax that enables transmission of audio and video in broadband networks. Although these standards also describe the aspects needed to multiplex programs, enable clock synchronization and setup logical network links carrying video and audio content. MPEG-2 is, in many cases, associated only with video compression, which is certainly one of the most important parts of its functionality (Tseng & Anastassiou, 1996). In total, there are eight different parts of the MPEG-2, covering the different aspects of digital video and audio delivery and representation. Table 2 contains the different MPEG-2 parts.

MPEG-2 can be seen as a superset of the MPEG-1 coding standard and was designed to be backward compatible to MPEG-1 and every MPEG-2 compatible decoder can decode a valid MPEG-1 bit stream. Many video coding algorithms were integrated into a single syntax to meet the diverse applications requirements.

3. MPEG-4 (Coding of Audio-Visual Objects)

Multimedia communication is the possibility to communicate audiovisual information that is natural, synthetic, or both, is real time and non real time, supports different functionalities responding to user's needs, flows to and from different sources simultaneously, does not require the user to bother with the specifics of the communications channel, but uses a technology that is aware of it, gives users the possibility to interact with the different information elements, lets the user to present the results of his interaction with content in the way suiting his needs.

In order to reach its own target, MPEG-4 follows an object based representation approach where an audio visual scene is coded as a composition of objects, natural as well as synthetic, providing the first powerful hybrid playground. Therefore, the objective of MPEG-4 is to provide an audiovisual representation standard supporting new ways of communication, access, and interaction with digital audiovisual data, and offering a common technical solution to various service paradigms -Telecommunications, broadcast, and interactive – among which the borders are disappearing. MPEG-4 will supply an answer to the emerging needs of application fields such as video on the Internet, multimedia broadcasting, content-based audiovisual database access, games, audiovisual home editing, advanced audiovisual communications, notably over mobile networks, teleshopping, remote monitoring and control (ISO/IEC JTC1/SC29/WG11). The fully backward compatible extensions under the title of MPEG-4 Version 2 were frozen at the end of 1999, to acquire the formal International Standard Status early 2000. Some work, on extensions in specific domains, is still progress. MPEG-4 builds on the proven success of three fields:

1. Digital television,
2. Interactive graphics applications (synthetic content),
3. Interactive multimedia (World Wide Web, distribution of and access to content).

4. MPEG-4 VTC and JPEG-2000 Image Compression Standards

The rising use of multimedia communication systems and image compression requires higher performance and new features. JPEG-2000 is an emerging standard for still image compression. It is not only intended to provide rate distortion and subject image quality performance superior to existing standards, but also

to provide functionality that current standards can either not address efficiency or not address at all. The compression advantages in JPEG-2000 are a direct result of the inclusion into the standard of a number of advanced and attractive features including progressive recovery, lossy /lossless compression, and region of interest capabilities. These features lay the foundation for JPEG- 2000 to provide tremendous benefits to a range of industries. Some of the applications that will benefit directly from JPEG-2000 are: image archiving, Internet, Web browsing, document imaging, digital photography, medical imaging and remote sensing (Koenen & Pereira, 2000).

Functionally, JPEG-2000 includes many advanced features:

Image compression must not only reduce the necessary storage and bandwidth requirements, but also allow extraction for editing, processing and targeting particular devices and applications. JPEG-2000 allows extraction of different resolutions, pixel fidelities and regions of interest, components, and more, all from a single compressed bit stream. This allows an application to manipulate or transmit only the essential information for any target device from any JPEG-2000 compressed source image.

1. Component precision: 1 to 127 bits/sample (signed or unsigned).
2. Each component may have different precision and sub sampling factor.
3. Image data may be stored compressed or uncompressed.
4. Lossy and lossless compression.
5. Progressive recovery by fidelity or resolution.
6. Tiling.
7. Error resilience.
8. Region of interest coding.
9. Random access to image in spatial domain.
10. Security.

Some of the technology highlights for JPEG-2000 are:

1. Wavelet sub-band coding.
2. Reversible integer-to-integer and nonreversible real to real wavelet transforms.
3. Reversible integer-to-integer and nonreversible real to real multi component transforms.
4. Bit-plane coding.
5. Arithmetic coding.
6. Code stream syntax similar to JPEG.
7. File format syntax.

5. MPEG-7 Standardization Process of Multimedia Content Description

MPEG-7 formally named “Multimedia Content Description Interface” is the standard that describes multimedia content so users can search, browse and retrieve the content more efficiently and effectively than they could by using existing mainly text-based search engines (ISO/IEC JTC1/SC29/WG11, Doc.N3752). It is a standard for describing the features of multimedia content. The word “features” or “descriptions” represent a rich concept that can be related to several levels of abstraction. Descriptions vary according to the types of data. Furthermore, different types of descriptions are necessary for different purposes of categorization. MPEG-7 will specify a standard set of descriptors that can be used to

describe various types of multimedia information. Also, MEPG-7 will standardize ways to define other descriptors as well as structures for the descriptors and their relationships. This description will be associated with the content to allow fast and efficient searching for material of user's interest. A language to specify description schemes i.e. a description definition language (DDL) will be standardized, too. Audiovisual (AV) material that has MPEG-7 data associated with it can be indexed and searched for. This material includes: still pictures, graphics, 3D models, audio, speech, video and information about how these elements are combined in a multimedia presentation. Special cases of these general data types may include facial expressions and personal characters (ISO/IEC N4041, *MPEG-21*). There are people who want to use the audiovisual information for various purposes. However, before the information could be used, it must be located. At the same time, the increasing availability of potentially interesting material makes this search more difficult. This challenging situation led to the need of a solution to the

Problem of quickly and efficiently searching for various types of multimedia material of interest to the user. MPEG-7 standard wants to answer to this need, providing this solution (Okubo, 1997). MPEG-7 is rather different from the other MPEG standards, because it does not define a way to represent data with the objective to reconstruct the data as faithfully as possible, like MPEG-1, MPEG-2 and MPEG-4 did. The increasingly pervasive role that audiovisual sources are destined to play in our lives and the growing need to have these sources further processed make it necessary to develop forms of audiovisual information representation that go beyond the simple waveform or sample-based, frame-based (such as MPEG-1 and MPEG-2) or even object-based (such MPEG-4) representations. This necessitates forms of representation that allow some degree of interpretation of the information's meaning, which can be passed onto, or accessed by, a device or a computer code. The people active in defining MPEG-7 standard represent broadcasters, equipment and chip manufacturers, digital content creators and managers, telecommunication service provides, publishers and intellectual property rights managers as well as researchers.

6. MPEG-21 Multimedia Framework

The objectives behind initiating MPEG-21 are as follows:

1. In order to understand if and how various components fit together.
2. To discuss which new standards may be required, if gaps in the infrastructure exist and, once the above two points have been reached.
3. To actually accomplish the integration of different standards.

The digital market place, which is founded upon ubiquitous international communication network such as the Internet, rewrites existing business models for trading physical goods with new models for distributing and trading digital content electronically. In this new market place, it is becoming increasingly difficult to separate the different intellectual property rights which are associated with multimedia content (ISO/IEC JTC1/SC29/WG11, Doc.N3752).

The latest MPEG project MPEG-21 Multimedia Frameworks has been started with the prime objective to enable transparent and augmented use of multimedia resources across a wide range of networks and devices. The basic elements of the framework are:

1. Digital Items, structured digital objects with a standard representation, identification and metadata within the MPEG-21 framework.

2. Users of all entities that interact in the MPEG-21 environment or make use of MPEG-21 Digital Items.

The meaning of User in MPEG-21 is very broad and is by no means restricted to the end user. Therefore an MPEG-21 user can be anybody who creates content, provide content, archive content, rates content, enhances or delivers content, aggregates content, syndicates content, sells content to end users, consumes content, subscribe to content, regulate content, facilitates or regulates transactions that occur from any of the above. The work carried out so far has identified seven technologies that are needed to achieve the MPEG-21 goals. They are (ISO/IEC JTC1/SC29/WG11, Doc.N3752):

1. Digital Item Declaration: a uniform and flexible abstraction and interoperable schema for declaring Digital Items.
2. Content Representation: how the data is represented as different media.
3. Digital Item Identification and Description: a framework for identification and description of any entity regardless of its nature, type or granularity.
4. Content Management and Usage: the provision of interfaces and protocols that enable creation, manipulation, search, access, storage, delivery, and reuse of content across the content distribution and consumption value chain.
5. Intellectual Property Management and Protection: the means to enable content to be persistently and reliably managed and protected across a wide range of networks and devices.
6. Terminals and Networks: the ability to provide interoperable and transparent access to content across networks and terminal installations.
7. Event Reporting: the metrics and interfaces that enable Users to understand precisely the performance of all reportable events within the framework.

DISTRIBUTED MULTIMEDIA SYSTEMS

Distributed Multimedia Systems is an area of active commercialization and research. This technology can be seen as the next generation technology for computers and communication networks. A distributed multimedia system combines a variety of multimedia information resources over a network into an application used by the client. In this manner, the user can access different remote information sources and services. The system is based on the interaction between the user and the application. The user can control the data flow. Which means that multimedia system is made interactive as if it were on the same system? Therefore this type of system is different from the conventional broadcast system. In such services typified by Cable television, clients can neither control the programs they view nor schedule the viewing time of the programs to suit their preferences. The user in such systems is flooded with irrelevant information, without a possibility to choose only the information of the interest. This kind of distributed environment is capable of serving a large number of end users to concurrently access a large number of repositories of stored data and also with the option of manipulating the environment by making the broadcast interactive. The enormous communication bandwidth required, the Quality of Service (QOS) demanded a careful design of the system in order to maximize the number of concurrent users while minimizing the cost needed to obtain it. The main component of a distributed multimedia system consists of major 3 components: Information (content) providers, a wide area network, and a

multimedia client. There are many design issues in building each of the components. The breakthrough achieved in Digital Information Compression has helped to transmit the digital information in real time.

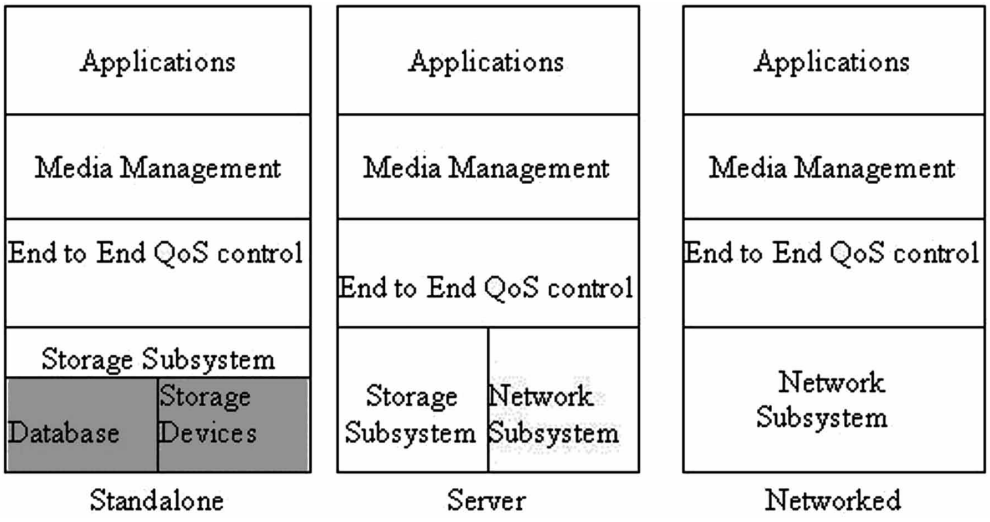
1. Architecture of Distributed Multimedia System

A distributed multimedia system consists of three different basic components: an Information server, a wide area network and a multimedia client on the user site. The user interface or the multimedia client deals with the issues related to presentation and manipulation of multimedia objects and the interaction with the user. The network provides the communication mechanism between the user and the server. The server is responsible for managing multimedia databases and also composing general multimedia objects for the user. The composition of the object is a complex process of integrating and synchronizing multimedia data for transport, display and manipulation. The system usually consists of multiple users, servers and networks as depicted in the figure 5.

2. User Terminal

A Multimedia terminal consists of a computer with a special hardware such as a microphone, high- resolution graphics display, stereo speakers, and a network interface. The user interacts with the system via a computer keyboard, mouse or a hand held remote control. Many of the user terminals still resemble traditional computers. Because of this, additional development work is required before the terminals can meet the requirements of the multimedia data and the user. Because of the large size of the multimedia objects and real - time requirements the multimedia terminal or the network should include large data buffers. To restore the temporal relationship of a data stream, stream handlers should be connected to the data buffers. To synchronize the possible multiple data streams and to control the stream handlers, synchronization and streaming manager is required. Since multimedia data objects are large, the termi-

Figure 5. Architecture of distributed multimedia system



nal should also include compression and decompression hardware. Well some of these issues would be discussed later on.

3. Network and Communication

Multimedia communication differs from the traditional communication. The multimedia traffic requires transfer of large volumes of data at very high speeds, even when the data is compressed. Especially for interactive multimedia communication the network must provide low latency. Continuous media as video and audio require guarantees of minimum bandwidth and maximum end-to-end delay. The variation in delay referred to as jitter, and loss of data must also be bound. Traditional networks are used to provide error-free transmission. However, most multimedia applications can tolerate some errors in transmission due to corruption or packet loss without retransmission or correction. In some cases, to meet real-time delivery requirements or to achieve synchronization, some packets are even discarded. Some of the differences in the traditional and multimedia communication are given in table 2.

The increasing popularity of the Internet and the fact that the infrastructure already exists suggest that the Internet could be used for distributed multimedia systems. The telephone and common antenna TV (CATV) cable networks are also a possibility to support interactive multimedia at user homes due to their wide deployment. From the above discussion we have noted that the Traditional networks do not suit multimedia communication. Transmission characteristics of existing Ethernet and Internet Protocols (CSMA/CD, TCP/IP) do not support the low latency, high bandwidth requirements of the audio video based applications. Ethernet only provides a bandwidth of 10 Mbps. This is inadequate for most multimedia applications. Moreover its access time is not bound and its latency and jitter are unpredictable. New protocols which are considered for carrying multimedia data include the 100 Mbps Ethernet Standard, Distributed Queue dual bus (DQDB), Fiber Distributed Data Interface (FDDI) and Asynchronous Transfer mode (ATM). The first three have bandwidths of the order of 100 Mbps. ATM enables a bandwidth of 155 – 622 Mbps depending on the characteristics of the network.

FDDI in its synchronized mode has low access latency and low jitter. FDDI also guarantees a bounded access delay and a predictable average bandwidth for synchronous traffic. However, Due to its high cost FDDI is at the moment used primarily for the backbone networks. Asynchronous Transfer Mode (ATM) is rapidly emerging as the future protocol for multimedia communication. ATM provides great flexibility in the bandwidth allocation by assigning fixed length packets called cells, to support virtual connections. ATM can also increase the bandwidth efficiency by buffering and statistically multiplexing

Table 2. Comparison in between the traditional and multimedia communication

S.No	Characteristics	Data Transfer	Multimedia Transfer
1	Data rate	Low	High
2	Traffic pattern	Burst	Stream oriented, highly burst
3	Reliability requirements	No loss	Some loss
4	Latency time requirements	None	Low (for example: 20ms)
5	Mode of communication	Point to Point	Multipoint
6	Temporal relationship	None	Synchronized transmission.

burst traffic at the expense of cell delay and loss. For the Internet, the Internet Engineering Task Force (IETF) is working on a TCP/IP interface for ATM.

4. Multimedia Server

Current personal computers, workstations and servers are designed to handle traditional forms of data. Their performance is optimized for a scientific or transaction – oriented type of workload. These systems do not perform well for multimedia data, requiring fast data retrieval and guaranteed real time capabilities. The I/O capacity is usually a severe bottleneck. Some of the requirements for Multimedia Server are as follows:

1. Minimal Response time: A crucial factor for the success of multimedia services is the response time seen by the client. The server must be able to minimize response time to live unto the expectations of the user.
2. Fast Processing Capability: To guarantee fast response time, clients should be processed fast and data access rates should be minimized.
3. Reliability and availability: Like any other server, multimedia server must be reliable. The larger the number of users and volume of data handled by the server, the more difficult is to guarantee reliability. To provide fault tolerance special hardware and software mechanisms must be employed. Since client requests may arrive at any time, the time the server is unavailable should be minimized.
4. Ability to sustain guaranteed number of streams: Another important factor is the maximum number of data streams the server can simultaneously handle. This affects the total number of clients the server can serve.
5. Real-time delivery: To be able to deliver multimedia data, the server should support real-time delivery. This poses profound requirements on the resource scheduling at the operating system level. The server should be able to guarantee real-time delivery for individual streams as well as for all the streams combined together. For this accurate real-time operating systems have to be developed.
6. High storage capacity: To be able to store multimedia data and a large variety of information the server must have a large storage capacity. To sustain the delivery requirements of multimedia data, the server may be required to compress and encode video and image data prior to transport or storage. The performance of compression and signal processing should be optimized. This might require special hardware.
7. Quality of Service (Qos) requirements: The Quality of Service (Qos) is a set of parameters describing the tolerable end-to-end delay, throughput, and the level of reliability in multimedia communication and presentation. Qos requirements of clients are an important factor that affects the usage of the server. The server should be able to provide and adapt itself to different QoS requirements, according to the characteristics of the client's terminal, the network connection and the requested data type.
8. Exploit user access patterns: The server should also be able to trap and exploit dynamic user behavior, minimizing system load and network traffic. For example, by analyzing data access rates and times, popular data could be distributed closer to users in periods of low network load.
9. Ability to handle different types of traffic: A multimedia server should be able to serve multiple real-time data streams simultaneously, but it must also be able to provide satisfactory service to non-real-time data. It should be able to handle control data encountered when loading new data

from other servers or storage repositories, billing and accounting data and communication between intelligent personal agents. Agents are autonomous programs selecting and managing data according to user preferences.

10. Cost effectiveness: A very important requirement governing the future of multimedia servers is the cost effectiveness. The server must be affordable.

5. Current Trends in Distributed Multimedia Systems

Some of the Distributed Multimedia Systems are as follows:

1. Video on Demand: The consumer can select a video or any program on demand. The application consists of Interactive features like forward, rewind and pause.
2. News and Reference Services: News on Demand is similar to VOD but it provides sophisticated news retrieval and reference services that combine live and achieved video, access to textual data and still photography from various sources. The information is delivered based on a filtering criteria kept by the user.
3. Interactive shopping and electronic commerce: Home shopping will provide a customizable shopping environment. Customers will be effectively and rapidly focus on the products and services that are of interest to them.
4. Entertainment and games: Interactive entertainment may become a frequently used service. Games will consist of simple applications that will be downloaded to the set top device thus not incurring the significant cost associated with the use of server and network facilities.
5. Distance Learning: Educational interactive programming and distance learning are areas where the research is going on. Current indications are there that these may become popular but not have sufficient commercial use to the providers.

SOME OF THE ADVANCE PROJECTS IN THE WORLD CREATING A REVOLUTION IN THE FIELD OF NETWORKED MULTIMEDIA SYSTEMS

Research programs on future Internet architecture in the United States are administrated by the National Science Foundation (NSF) directorate for computer and Information Science and Engineering (CISE). The Future Internet Architecture (FIA) program of the National Science Foundation (NSF) is built on the previous program, Future Internet Design (FIND). FIND funded about 50 research projects on all kinds of design aspects of the future Internet. FIA is the next phase to pull together the ideas into groups of overall architecture proposals. Some of the Advance Projects are as follows:

1. Named Data Networking (NDN)

The Named Data Networking (NDN) project is led by the University of California, Los Angeles with participation from about 10 universities and research institutes in the United States. The initial idea of the project can be traced to the concept of content-centric networks (CCNs) by Ted Nelson in the 1970s. After that, several projects such as TRIAD at Stanford and DONA from the University of California at Berkeley were carried out exploring the topic. In 2009 Xerox Palo Alto Research Center (PARC)

released the CCNx project led by Van Jacobson, who is also one of the technical leaders of the NDN project (*Named Data Networking Project*).

2. Mobility First

The Mobility First (Mobility First Future Internet Architecture Project) project is led by Rutgers University with seven other universities. The basic motivation of Mobility First is that the current Internet is designed for interconnecting fixed endpoints. It fails to address the trend of dramatically increasing demands of mobile devices and services. The Internet usage and demand change is also a key driver for providing mobility from the architectural level for the future Internet. For the near term, Mobility First aims to address the cellular convergence trend motivated by the huge mobile population of 4 to 5 billion cellular devices; it also provides mobile peer-to-peer(P2P) and info station (delay-tolerant network[DTN]) application services which offer robustness in case of link/network disconnection. For the long term, in the future, Mobility First has the ambition of connecting millions of cars via vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) modes, which involve capabilities such as location services, geo routing, and reliable multicast. Ultimately, it will introduce pervasive system to interface human beings with the physical world, and build a future Internet around people. The challenges addressed by Mobility First include stronger security and trust requirements due to open wireless access, dynamic association, privacy concerns, and greater chance of network failure.

3. NEBULA

NEBULA (NEBULA Project) is another FIA project focused on building cloud-computing-centric network architecture. It is led by the University of Pennsylvania with 11 other universities. NEBULA envisions the future Internet consisting of a highly available and extensible core network interconnecting data centers to provide utility-like services. Multiple cloud providers can use replication by themselves. Clouds comply with the agreement for mobile "roaming" users to connect to the nearest data center with a variety of access mechanisms such as wired and wireless links. NEBULA aims to design the cloud service embedded with security and trustworthiness, high service availability and reliability, integration of data centers and routers, evolvability, and economic and regulatory viability. NEBULA design principles include, reliable and high-speed core interconnecting data centers, parallel paths between data centers and core routers, secure in access and transit, policy-based path selection mechanism, authentication enforced during connection establishment. With these design principles in mind, the NEBULA future Internet architecture consists of the following key parts:

1. The NEBULA data plane (NDP), which establishes policy-compliant paths with flexible access control and defense mechanisms against availability attacks.
2. NEBULA virtual and extensible networking techniques (NVENT), which is a control plane providing access to application selectable service and network abstractions such as redundancy, consistency, and policy routing.
3. The NEBULA core (NCore), which redundantly interconnects data centers with ultrahigh-availability routers.

4. *4WARD*

4WARD (The FP7 4WARD Project) is an EU FP7 project on designing a future Internet architecture led primarily by an industry consortium. The funding is over 45 million dollars for a 2-year period. The key 4WARD design goals are:

1. To create a new "network of information" paradigm in which information objects have their own identity and do not need to be bound to hosts (somewhat similar to the goal of the NDN project).
2. To design the network path to be an active unit that can control itself and provide resilience and failover, mobility, and secure data transmission.
3. To devise "default-on" management capability that is an intrinsic part of the network itself.
4. To provide dependable instantiation and interoperation of different networks on a single infrastructure.

Thus, on one hand, 4WARD promotes the innovations needed to improve single network architecture; on the other hand, it enables multiple specialized network architectures to work together in an overall framework.

5. Future Internet Research and Experimentation (FIRE)

FIRE (FIRE: Future Internet Research and Experimentation)is one of the European Union's research projects on test beds and is like a counterpart of GENI in the United States. FIRE was started in 2006 in FP6 and has continued through several consecutive cycles of funding. FIRE involves efforts from both industry and academia. It is currently in its "third wave" focusing on providing federation and sustainability between 2011 and 2012. Note that the FIRE project's research is built on the previous work on the GEANT2 (Gigabit European Academic Networking Technology) project [11], which is the infrastructure test bed connecting over 3000 research organizations in Europe. FIRE also expects not only to change the Internet in technical aspects but also in socio-economic terms by treating socio-economic requirements in parallel with technical requirements.

SUMMARY

In the field of telecommunication network, research is focused on post ISDN architectures and capabilities such as an integrated packet network and broadband ISDN. The economics and flexibility of integrated networks make them very attractive, and above all the packet network architectures have the potential for realizing these advantages. However, the effective incorporation of speech and other signals such as graphics, image and video into an integrated packet network (IPN) can rearrange network design priorities. Although processing speeds will continue to increase, it will also be necessary to minimize the nodal per-packet processing requirements imposed by the network design. This is a motivation for new switching concepts like fast packet switching and ATM. Data signals must generally be received error free in order to be useful, but the inherent structure of speech and image signals and the way in which they are perceived allows for some loss of information without significant quality impairment. This allows the possibility of purposely discarding limited information to achieve some other goal, such as the control temporary congestion. Multimedia communication standards have to depend on compromises

between what is technologically feasible and what is theoretically possible. The success of the Standards in the market place is possible only if the cost performance ratio is well balanced. This is specifically true in the field of audio/video coding where a large variety of innovative coding algorithms exist, but may be too complex for implementation. Over the Internet, streaming of video faces many technological as well as business challenges and new codec's, protocols, players and subsystems are developed and came into existence to address them. Since its inception in early 1990s, the concept of streaming media has gone through a dramatic growth and transformation from a novel technology into one of the mainstream manners in which people experience the Internet today. The arrival of concept of streaming media comes at a time when basic multimedia technologies have already established themselves on desktop PCs. Streaming media is a technology that enabled the user to experience a multimedia presentation on-the-fly while it was being download from the Internet. The provision, bandwidth on demand with strict QoS guarantees is a fundamental property of ATM networks that makes them especially suitable for carrying real time multimedia traffic. Statistical multiplexing of VBR connections within the backbone network allows effective aggregation and capacity engineering. Anticipating that multimedia over IP will be one of the major driving forces behind the emerging broadband communications, addressing the challenges facing the delivery of multimedia applications over IP are a great importance. In order for the Internet to allow applications to request network packet delivery characteristics according to their needs, sources are expected to declare the offered traffic characteristics. Admission control rules have to be applied to ensure that requests are accepted only if sufficient network resources are available. Moreover, service-specific policing actions have to be employed within the network to ensure that nonconforming data flows do not affect the QoS commitments for already active data flows. One generic framework that addresses both the video coding and networking challenges associated with Internet video is scalability. Any scalable Internet video coding solution has to enable a very simple and flexible streaming framework. The fine-grained scalable framework strikes a good balance between coding efficiency and scalability while maintaining a very flexible and simple video coding structure.

With the advent of common uses of the Internet, the demands for real-time and low-rate voice over IP applications are growing rapidly. Since the delivery of packets is not guaranteed in the IP networks, it is necessary to deal with the audible artifacts, which are caused by burst packet losses. Packet loss degrades the speech quality of the analysis-by-synthesis coders seriously since the loss parameters not only affect the current speech frame, but also produce the so-called error propagation problem resulting from corrupted filter memory. This packet loss problem can be solved by using different model parameters. Digital Subscriber line (DSL) technology offers unprecedented scalability for interactive video services. Itis the basis for the point-to-point architecture that is the key to providing a combination of interactive video and broadcast services. The implementation of video services is a high priority for telecom providers. Delivering voice services over digital subscriber line offers a lucrative opportunity for both established and emerging services. Data broadcasting in support of multimedia applications requires efficient use of bandwidth resources in order to maximize the availability of play out content. From the data delivery point of view, the digital TV infrastructure provides a broadband digital distribution network, data transport protocols and digital terminals on the user premises. A number of advances in the network technology have proved a boon to the advances in Distributed Multimedia Systems. Some of the Advance Projects related to the development of the Networked Systems are discussed in the last section of the chapter.

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KEY TERMS AND DEFINITIONS

Asynchronous Transfer Mode: *ATM* is a high-speed networking standard designed to support both voice and data communications.

Internet: Global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols.

Multimedia: Multimedia means that computer information can be represented through audio, video, and animation in addition to traditional media (i.e., text, graphics drawings and images).

Network: A of interconnected (cable and/or wireless) computers and peripherals that is capable of sharing and between many.

Protocols: Protocol is the special set of rules that end points in a telecommunication connection use when they communicate.

Terminal: In data communications, a terminal is any device that terminates one end (sender or receiver) of a communicated signal.

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Chapter 10
Developing Digital Competences of Vocational Teachers

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ABSTRACT

In the context of corporate learning digital media and digital tools have become more accepted than in the field of education systems. Particularly vocational schools are obviously under pressure to deal with changes due to digitalization in many sectors and professions. One reason why technology-based learning is still underdeveloped in schools could be the insufficient digital competences of teachers. Presently most teachers gain their knowledge on how to use digital media for learning and teaching informally. In the implementation of formal educational efforts, a low practical feasibility in specific working context as well as time and financial aspects are criticized. Present research shows that non-formal and informal learning should be better linked in order to develop teachers' digital competences sustainably. The present contribution introduces a necessary framework to include informal learning processes in teacher education at vocational schools and furthermore fosters a school culture of learning together and from each other.

1. INTRODUCTION: DIGITAL COMPETENCES IN VOCATIONAL EDUCATION

Digital competences have become interdisciplinary and cross-generational cross-functional skills (Weiss, 2012), which employers usually already require of trainees and employees during and at the latest after their training. For this reason, there are growing calls to ensure sufficient media literacy for young people in the education sector. The aim of media education is to enable learning in schools with and through media and, through their integration in the curriculum and the development of technical and interdisciplinary skills, to contribute to constructively-oriented learning (Mayrberger, 2007, 2012). In

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addition, digital media provide ways to strengthen hands-on learning approaches in the classroom and integrate informal modes of learning into formal learning. In this sense, digital media perform a bridging function through their direct relevance to the students' lifestyles and serve "as a cultural resource enabling them to participate and become involved in social processes [...] and develop personal world views and their identity" (Herzig & Grafe, 2009, p. 193, quoting Mayrberger, 2012, p. 401). The aim of media education is therefore to help individuals, in general and in a professional context, to use media knowledgeably, self-responsibly and critically (Seufert & Scheffler, 2014) and shape training rooms as well as learning and educational processes independently based on digital media (Mayrberger 2012, p 403; Spanhel, 2009). In this context, (vocational) schools and teachers play a key role.

2. PROBLEM AND RESEARCH QUESTION

Digital media have established themselves far more quickly and effectively in work and everyday life than in education (Weiss, 2012, p. 3). It is hoped that the use of media will improve learning efficiency, facilitate greater orientation to the future professional needs of learners and accompanied personality development in a digital society, etc. Digital media therefore are already part of vocational training at different levels: as part of the everyday life and work of students and teachers, as a method or as content in vocational school teaching. Especially the methodological and didactic use of digital media, often subsumed under the term eLearning, dominates public debate. Overall, however, the use of digital media and eLearning in vocational schools has only played a minor role to date (Wilbers, 2012, p. 38).

However, due to the growing importance in companies and thus the commercial part of the training, vocational schools are coming under increasing pressure to also address the implications of digital media for education and training. "In this area, vocational schools are facing a permanent and extremely differentiated need to adapt that is not seen in this scope or diversity in any other kind of school" (Wilbers 2012, p 40). Common teaching practices are seen as a central barrier to innovation. This is because whether or not media enter the classroom depends not only on the technical prerequisites, but also on the skills and the willingness of the individual teachers to try out new forms of teaching. So far, however, school routine is dominated by traditional forms of teaching, in which the tutorials, smaller individual and group work and lectures are predominant (Euler, 2012, p. 21). New teaching concepts, such as media-supported, problem-based learning or project forms featuring wikis or weblogs can only be integrated into such models to a limited extent.

Moreover, teachers addressing new digital skills such as the competent handling of online information are often entering uncharted territory in their respective fields (media education). In this context, teachers are increasingly demanding the teaching of media-specific qualification goals. However, what skills teachers need to acquire remains rather sketchy and is largely limited to the use and operation of the ICT (Blömeke, 2005). Furthermore, it is obvious that formal seminars, such as one-day training workshops in how to use ICT, are not sufficient and effective to develop teachers' digital competences. In order to be able to plan and design suitable education training measures for teachers initially requires a systematic approach for the professional development of teachers at vocational schools. The main research question of this paper focuses on this critical issue:

How to design a systematic approach for digital competences development (rather than the planning of selective training measures) from the perspective of both teachers and the school management?

In order to pursue the leading research question, the following questions structure the acquisition of knowledge:

- What skills do teachers in schools require when using digital media?
- What fundamental approaches to organising the skills development of teachers exist when dealing with digital media?
- How can formal and informal learning approaches be interlinked to facilitate the competence development of teachers in vocational schools, in particular in order also to promote the self-organisation of teachers?

The next section explains the applied research methodology; the fourth section provides an overview of the findings: 1) the required skill-set for teachers in digital times 2) general approaches to define and pursue digital competence frameworks and 3) forms of competence development by combining informal and formal learning (emerging alternatives to the dominant "training model" of teachers' professional development); and the last section concludes the paper by discussing the results and providing recommendations for future research.

3. RESEARCH METHODOLOGY

The main goal of the research presented in the paper at hand is to develop a conceptual framework for teachers' professional development focused on digital competencies in vocational schools. In order to achieve this goal a two-year research project has been established in cooperation with a secondary school in the German speaking part of Switzerland. The project is based on a methodological combination of literature analysis, model development and empirical model testing with focus on information literacy (IL) as part of digital competencies:

1. To get an overview of existing IL research a systematical literature analysis has been performed by focusing on the following research questions: Which terms exist associated with IL and how is IL defined in the literature? Which are the salient conceptualizations and measurement models of IL? Which methods are applied in order to examine IL?
2. Based on the findings of the literature research, and by combining and extending existing models, the 7i Framework for measuring IL has been created.
3. The 7i Framework for measuring IL has been tested in five classes at a Swiss secondary school involving 10 teachers.

The results of the literature analysis and model development are presented in detail in Stanoevska et al. (2015a) and Stanoevska et al. (2015b). A parallel research stream connected to the project was devoted to the analysis, design and evaluation of the necessary skills development of the involved teachers following a method mix:

1. Further literature analysis has been conducted in the field of teacher education with focus on digital competences. One main model to develop digital media skills of teachers represents the TPACK

model developed by Koehler and Mishara (2009). This model offers a framework to further specify the required skills to integrate IL in teaching practice.
2. The teachers have been involved as practitioners in the design research process by sharing their knowledge and expertise from a subject-specific perspective.
3. At the end of the project, an intensive focus group discussion has gained more insights in the question on what are necessary skills and support offerings for teachers to develop and permanently update their digital skills.

In summary, empirical practice reflection within the mentioned research project as well as a profound literature analysis provide the main research methods for the design of teachers' professional development.

4. RESULTS

4.1. Vocational Teachers in the Digital World: Competence Requirements and Dimensions

Teachers are increasingly demanding the teaching of media-specific qualification goals. However, what skills teachers need to acquire remains rather sketchy and is largely limited to the use and operation of the ICT (Blömeke, 2005, p. 76). In order to be able to plan and design suitable media education training measures for teachers initially requires a concrete discussion and formulation of the required skills (Petko & Döbeli Honegger, 2011, p. 157).

According to Blömeke (2005), media education skills encompass two core tasks, derived from the basic tasks of "teaching" and "educating": the use of media or media didactics (learning with media) and media education (learning about media). When performing media education tasks, it is necessary to take into account both the media-specific requirements of the learners on the one hand and, on the other hand, the respective school environment, infrastructure and support structures. In summary, five dimensions of media education skills can be deduced (Blömeke 2005, p 77-79).

1. **Media Teaching Competences:** Teachers are able to address the subject of media in the classroom and can teach the learners to approach the subject of media critically.
2. **Media Pedagogy Competences:** Teachers are able to meaningfully use media as a method in terms of content and objectives and support teaching and learning processes with the aid of media.
3. **Socialisation-Related Competences in the Media Context:** Teachers take into account the media-specific learning requirements of the learners when preparing the lessons, are able to identify learning progress and can adequately assess and evaluate this. This includes understanding the media learning and living environments of the learners.
4. **Teacher's Own Media Competences:** Teachers are able to competently use and actively shape media for themselves. The teacher's own media skills form the basis for all subsequent tasks.
5. **School Development Competences in the Media Context:** Teachers are able to help shape and develop the institutional framework for media education and advise students and parents on media education issues.

The first core task describes the ability to "use media in appropriate teaching-learning forms in a circumspect way" – in other words the ability to shape lessons using media. Vocational training serves as link between theory and practice. Therefore, it seems to be relevant to link a digital medial practice with a significant vocational content. Media teaching skills, as one of the core areas of media education competences (Blömeke, 2005, p. 91) thus builds on the experiences of the learners and teachers with digital media in the context of the living, learning and working environments. The understanding of media didactics illustrated here is supplemented by Mayrberger (2012) by a further aspect, namely "the delimitation of formal teaching and learning processes using digital media". Following Blömeke (2000), a person skilled in media didactics is, according to Mayrberger (2012), capable of using (digital) media in the classroom to create and reflect on student-centred learning environments, exploiting their specific potential to the full, and to critically assess the impact of integrating digital media on the formal and informal learning, and address the delimitation" (Mayrberger 2012, p 405).

Table 1 illustrates how learning processes in school-based vocational training can be supported using digital media and Web 2.0 applications.

4.2. Generic Approaches to Developing Digital Competences of Teachers

Schools face the challenge of how to organise the permanent upskilling of teachers in the use of digital media. Basically, there are two ideal approaches: subject-based approach vs. action-based approach or product- vs. process-oriented curriculum models.

4.2.1. Subject-Based Approach or Product-Oriented Curriculum Models

Using this system, learning offers are structured according to subject-specific or thematic structures. Thus, "technology courses" are often offered in schools to train teachers in the use of new learning platforms or tablet PCs.

In terms of the promotion of media didactic skills of teachers, one example of a product-oriented model is the TPACK model developed by Koehler and Mishara (2009). The model offers a framework for concretising a required knowledge base for teachers for using technologies meaningfully for teaching and learning. Based on the observations in Shulman's pedagogical content knowledge (PCK) model (Shulman, 1986, 1987), the authors assume that the development of both technological pedagogical knowledge (TPK) and technological content knowledge (TCK) (together TPACK) is a prerequisite for successful technology-based teaching. The knowledge base (content, pedagogy and technology) form the core of the "technological, pedagogical and content knowledge" (TPACK), whereby the focus is particularly on the interaction and interfaces between the areas. The authors extend Shulman's model by the requisite technological knowledge and defined altogether the seven Knowledge Areas (Table 2).

In so doing it becomes clear how complex the model is to apply in practice. The relevant context varies depending on the teacher, students, technological conditions, subject, content, and the teacher's understanding of teaching and requires a constant readjustment of teaching concepts. As already mentioned, this is generally the case but is further enhanced by the use of technologies. It is not possible to derive generally-valid standard solutions for teaching with technology as a subject of further training. Rather, skills are required that allow teachers to solve everyday problem situations flexibly and appropriate to the situation and to promote an understanding of teaching with technology. "There is no 'one best way' to integrate technology into curriculum. […] Teaching successfully with technology requires continually

Table 1. Learning with digital media in vocational training. (Adapted from: Seufert, 2012, p. 37)

Areas of vocational training	Pedagogical perspective	Examples	Exemplary facets of a Web-application
Media experiences of students and teachers			
Digital media as a part of students' living environments	Dealing with media mainly takes place in informal contexts (In interaction with peers)	Computer gambling addiction, smartphone, classroom disturbances	Facebook (Cybermobbing, teacher as a "friend")?
Digital media as a part of teachers' working and living environments	Dealing with media usually informally	Media use for preparation of classes	Yammer as a community platform
Digital media as a method of teaching and learning in classes			
Enrichment of classes through integrating forms of e-learning	Integration of media elements as a teaching / learning method in classes	Electronic text books, e-Exams, educational videos	Open Resource educational videos (such as "Explainity")
Using Learning Management Systems (LMS)	Using digital media as an opportunity for communication in class	Placing learning tasks, communication across learning places	Facebook as a learning platform
Pedagogical „redesign" of courses in general	Designing media-based educational courses	Information-based problem solving, project-based learning forms	Preparation of a wiki as joint project work, Blogs as an reflection tool
Digital media as content, intentions and methods in classes			
Development of media literacy	Critical and reflected use of digital media	Information literacy: dealing with internet resources, Net-Guidance-measures	Facebook: how to stay safe online
Training how to use digital media in profession	Active and creative design of digital media, assessing and questioning media developments and trends critically	Using application software for professional specific tasks, reflection changes in the world of work by digitalization critically	Social Media platforms as a marketing tool
Training experts within the field of digital media	Professional competences: creating digital realities and productive activity	Programming languages, ARIS-process-modelling	Facebook Development, e.g. API, Debugging
School-development competencies in dealing with digital media			
Framework for competent use of digital media	Teachers design and develop institutional frameworks for working with digital media in the fields of education	Developing curricular modules to integrate information literacy: active exchanges between teachers	collection of examples for use blogs as reflection method and tool
Consulting relevant Stakeholders	Advise students, parents and teaching operations in media pedagogical terms	„Netiquette" or the guidelines in use of Social Media, development of "digital self-competence"	Social Media guidelines to coordinate efficiently among learning places

Table 2. TPACK model - knowledge area, guiding questions, mastery and limitations

Knowledge Area	Description	Guiding Questions	Mastery and Limitations
Content Knowledge (CK)	Knowledge about the teaching subject and topic (theories, concepts, ideas etc.) of the respective subject area.	What content is relevant to understand the topic and should be treated in this lesson?	Master of the content in the specific subject area to reach a high level of quality.
Pedagogical Knowledge (PK)	Knowledge about processes and methods of learning and teaching as pedagogical principles and indicative targets. This means an understanding about processes how students gaining new insights or how they could be stimulated or motivated.	What kind of pedagogical principles should be used in this lesson?	Master of classroom strategies, use of learning theories, different types of methods, evaluation methods.
Technological Knowledge (TK)	Knowledge, which is more than a pure application knowledge. Rather it means a broad understanding of possibilities for technology-based communication, information processing and problem solving.	Which technologies should be used in this lesson?	Master of different kind of technologies and capable to provide use technologies for learning processes.
Technological Content Knowledge (TCK)	Knowledge about the way how technologies and content interact which each other. Furthermore teacher need to know which specific tool is the most adapted to convey the content or otherwise how the content determined a useful technology.	Does the use of technologies will support representing the content on multiple ways or will they help for a better understanding?	Use technologies to enhance the understanding of content but neglected learning theories. So it is modern but limited.
Pedagogical Content Knowledge (PCK)	Knowledge about different opportunities to teach a specific content and with taking into account the students' prior knowledge, education guidelines on curricula and requirements.	Does the underlying pedagogical principles foster the understanding of the topic or stimulate a deeper learning?	A 20th Century classroom with strong content and well implementation of pedagogical theories. But in the 21th Century it is obsolete because of neglect technologies.
Technological Pedagogical Knowledge (TPK)	Knowledge how teaching and learning could change and influence each other. It needs an understanding about the restrictions and affordance of technologies as well as the resulting pedagogic-didactic consequences within a disciplinary context.	Are the pedagogical principles and selected technologies well matched?	Focused using technologies for learning and helps learners to use it in different ways. But the learning activities could take them away from the actual learning content.
Technology, Pedagogy, and Content Knowledge (TPACK)	Knowledge of the interaction and interfaces of content, technology and pedagogy in terms of the specific context (like previous knowledge or legal and technological conditions). It needs an understanding in how these domains and contextual parameters interfaces.	Does the selected technologies foster the underlying pedagogical principles and can the interaction of both contribute to a better understanding of the content?	A masterful 21th Century classroom, which considered the learning contents, based on good learning theories provide by technologies.

creating, maintaining, and re-establishing a dynamic equilibrium among all components. […] This is the kind of deep, flexible, pragmatic, and nuanced understanding of teaching with technology we involved in considering TPACK as a professional knowledge construct" (Koehler & Mishara, 2009, p. 67).

Based on the defined areas of knowledge of the TPACK model, the corresponding educational goals can be derived for describing a skills profile. The respective knowledge must be put in an application-specific context. The advantage of such an approach lies in the exact definition of the necessary knowledge

base, the necessary skills and attitudes. This enables overlaps in the basic knowledge base to be avoided. The disadvantages include in particular the fact that teachers may not be able to derive any practical relevance for their lessons. Thus, for example, courses are often not geared towards the integration of technical knowledge in specific teaching situations, which therefore makes it difficult for teachers to apply a hands-on approach.

4.2.2. Action-Based Approach or Process-Oriented Curriculum Models

While product models are structured according to a substantive, subject-based structure, process-specific models favour an action-based approach. Process-oriented curriculum models are process-oriented and geared towards accomplishing a process, in the sense of complete action. A process-based model emphasises especially learning from work and life experience and aims to enable learners to independently cope with professional situations. Here, learning objectives are open and contents relate more to empirical knowledge and knowledge that is to be newly generated in the specific situations (Sloane, 2002, p. 9). Based on a process curriculum, requirements, objectives, content and skills development measures are recorded and derived from reconstructed areas of activity - from the situations encountered by the learners in their living environments.

Euler, Hasanbegovic, Kerres, & Seufert (2006) illustrate an example of such an action-based approach in their evaluation report for the determination of measures for the development of e-training skills for lecturers. Following Kerres, Euler, Seufert, Hasanbegovic, & Voss (2005), a competence analysis was performed for ten exemplary e-learning scenarios and the requirements determined arranged in a skills/competence grid as an analytical tool (TARGET state). The CURRENT state was determined by means of questionnaires and interviews. The difference between the CURRENT and TARGET state served as the basis for deriving suitable skills development measures (see Table 3).

In the first column of the table above (Table 3), three possible areas categorise the use of digital media. Within these areas, it is possible to deduce specific learning scenarios and required competences. In the process-based or action-based approach, application situations are defined at the outset, to which the content to be taught, the required knowledge or the skills to be developed etc. must be assigned.

The aim is to create a comprehensive media education skillset and to enable teachers to apply and address digital media meaningfully and appropriately in the classroom in different situational contexts. Knowledge itself is only the basis for successfully doing so (Euler & Hahn, 2004, 2014; Euler et al., 2006). That is to say, teachers need a complex system of knowledge (know what), skills (know how) and attitudes (know why) to be able to successfully employ digital media in teaching. In addition to the knowledge and skills required by the teachers and organisational support structures, the extent to which technologies will be able to establish themselves in learning and in the classroom depends fundamentally on a positive basic attitude on the part of the teachers (Petko & Döbeli Honegger, 2011, p. 157). Therefore, the attitudes and beliefs of the teachers play an equally important role. Although Koehler & Mishara (2009, p. 61) point out: "Moreover, this knowledge is unlikely to be used unless teachers can conceive of technology uses are consistent with their existing pedagogical beliefs," a corresponding skills development is not apparent in their model. In an action-based approach, the necessary attitudes are explicitly highlighted.

In addition to product- and process-oriented models, curricula can be developed on the basis of more flexible models that can be understood as a further form of an action-based model. In this context, informal learning opportunities are especially important. This aspect will be discussed in more detail below.

4.3. Forms of Competence Development: Combining Informal and Formal Learning

Common teacher training practices are in themselves a major barrier to why the digital media teaching skills of teachers are only developing to a limited extent. Like their students, most teachers learn how to use digital media less in formal learning situations, but rather informally in practice. Teachers often simply lack the time to attend a course or to work on a self-learning programme every time (Weiss, 2012, p. 3). As numerous studies show, teachers generally seem to develop their skills predominantly informally in the context of their teaching practice, in exchange with colleagues and through critical, individual reflection (Hoekstra, Korthagen, Brekelmans, Beijaard, & Immants, 2009; Meirink, Meijer, Verloop, & Bergen, 2009) Learning in informal contexts takes place alone or with others outside of institutionalised teaching environments. In contrast, learning under formal conditions takes place in training and further education institutions where professional teachers endeavour to learn how to teach, assess and if necessary even to certify. At voluntary further education events for teachers the fact that the individuals who generally attend usually already have a certain level of expertise is often criticised and they often return to school disappointed because what they learn is difficult to put into practice for lack of time and money. In addition, school-based training courses (SBT) that are tailored to the needs

Table 3. Competence requirements derived from technology-based learning (Adapted from Euler et al. 2006)

Use of media	Technology-based Learning		Required competences
Digital media … in „in-class training“	1	Teacher-centered lessons with use of media	For the presented scenarios, competences are specified for the following action areas: • Professional competences • Social competences • Self-competences And for activities: • Knowledge • Skills • Attitudes
	2	Cooperative learning with digital learning resources and tools	
	3	Testing of learning success with e-assessment	
… as a **supplement** to „in-class training“ … as a significant **extension** to „in-class training“	4	Self-regulated learning by e-tutoring	
	5	Reflective learning in discussion forums	
	6	case-based learning with web resources	
	7	Discovery learning with computer-based simulations	
… as a **replacement** for „in-class training“	8	project-oriented learning with digital media	
	9	Online learning with video conferencing system	
	10	Dialogue-based learning with virtual classroom	

of a school are very widespread. However, some research studies show that even here formally organised school-based events also have a limited impact (Jurasaite-Harbison, 2009; Richardson, 2003). Therefore, the international research literature on the education and training of teachers increasingly focuses on workplace-integrated learning, which takes informal learning into account more (Hoekstra et al., 2009; Zwart, Wubbels, Bolhuis, & Bergen, 2008), One key finding is that formal and informal learning should be more closely interlinked for the skills development of teachers. A promising approach would in particular appear to be the search for interfaces between learning in formal and informal contexts (Engestrøm, 2004).

The following section focuses on the importance of the skills development of teachers in this context. Heise (2007) particularly emphasises the importance of largely self-directed further education in this professional field. To support and strengthen these desired informal learning activities, it would appear absolutely essential to create an environment conducive to communication within the school organisation. The targeted encouragement of professional discussions before classes begin or during breaks and the use of free periods for detailed reflection, for example on critical practical situations, can make an important contribution to triggering and promoting informal learning among teaching staff (Heise, 2009). However, not all teachers will be willing or able to collaborate with their colleagues on the preparation and follow-up of the classes. On the contrary, a certain proportion of teachers usually work alone, which might make a different kind of support necessary than would be required for teachers that already cooperate or collaborate with one another (Hoekstra et al., 2009). A concept to promote informal learning *tailored individually to the aims and objectives of teachers* could therefore generate added value for curriculum and school development.

In the field of media literacy, for example, the pressure on teachers to seek further education has increased immensely due to the constant and rapidly advancing technological development.

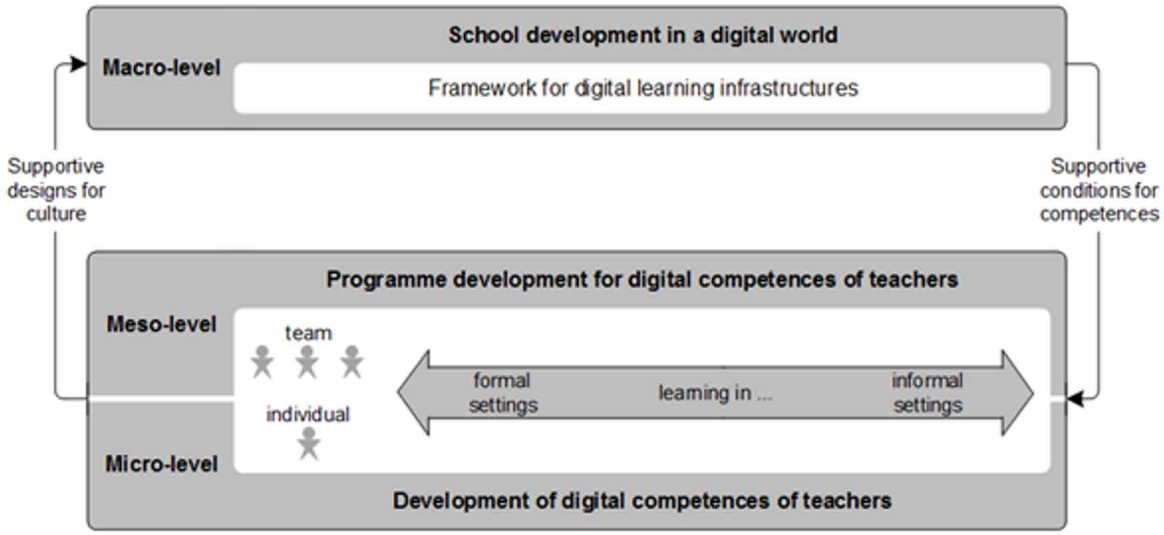
4.3.1. Skills Transfer

How might skills development measures for teachers which integrate learning in informal contexts be structured in practice? As explained above, "standardized" training programs have little impact on teacher education. In order to change teaching practice alternative training formats should be integrated into the portfolio. Some examples are outlined below (see illustration in Figure 1).

4.3.2. Transfer-Oriented Training

School-based training (SBT) is basically nothing new. However, it is now often combined more than was the case in the past with measures that support the transfer of what has been learned (such as preparatory phases and follow-ups). Effective results can for example also be achieved with more open learning environments, such as Engestrøm's Change Laboratory® (2004). In such a framework it would be possible to re-design courses in a professional association and hence combine the skills development of teachers with innovative strategies for curriculum development in schools (Engestrøm 2004, p 12). Whether or not the transfer of training or further education into the everyday life of teachers succeeds largely depends on individual factors (Hoekstra et al., 2009). An open mind towards new ideas and the willingness to adopt and implement innovative proposals is the prerequisite for initiating and implementing change processes in school routine. How teachers learn informally differs from one individual to the next (Hoekstra et al., 2009). This aspect should be borne in mind when developing further education

Figure 1. The integration of digital media to foster teacher's competences using the example of the TPACK-model



concepts and should lead to a sense of openness with respect to the curriculum, so that it is possible to adapt learning processes to the individual needs. One significant added value provided by the required openness is the ability to obtain feedback on the learning progress. For example, Zwart et al. (2008) suggest providing teachers with a "peer coach", who can help them reflect upon what has been learned (Hoekstra et al., 2009).

4.3.3. Moderating the Reflection Processes Regarding Teaching Practice

Critical, individual reflection upon one's own teaching basically represents a central impetus for the skills development of teachers (Meirink et al., 2009). A change in thought structures and hence upskilling is possible especially when the teacher experiences cognitive dissonance, i.e. inconsistencies between their own perception and how they actually experience critical teaching phases (Lipowsky, 2011, p. 410). This raises the question as to what extent such learning options can be promoted in order to initiate appropriate reflection processes. The findings of the group led by Zwart et al. (2008, p 990) show that informal talks with students from the perspective of an observer offer a valuable learning option. Other examples involve mentoring programmes in which students act as trained mentors and assist the teacher in teaching with notebooks. "Reverse mentoring" is currently enjoying growing popularity even in business. Trainees who are familiar with and able to use digital media critically act as mentors for senior managers and help them find their way in the new digital world. It remains to be seen whether this is merely a short-term fad, or whether it will become established as an element of a changing learning and management culture. Reverse mentoring could also be an approach for the school learning environment to compensate for any lack of media skills on the part of teachers by using the potential of the *digital natives*. In this way the students' resources could contribute to the informal skills development of the teachers.

Furthermore, other forms of mentoring, such as near-peer shadowing, are capable of triggering reflection processes among teachers and thereby promoting the informal skills development (Meirink et al.,

2009) Experimenting with new teaching methods (whether adapting a theoretically recognised concept, copying a colleague's method or developing one's own new idea) and even the immediate feedback from a colleague contributes substantially to the informal learning of teachers (Hoekstra et al. 2009; Meirink et al. 2009, p 90). In this regard, mentoring programmes can be orchestrated in different ways, i.e. the proportion of informal and formal elements of the learning process vary greatly (Colley, Hodkinson, & Malcolm, 2003). The degree of refinement of the framework, such as the concrete *learning setting, the place of learning or the general process,* influences the "predictability of chance" in the further education for teachers and generates an added value for the school organisation and the learners.

4.3.4. Self-Initiated Learning in Communities of Practice

The idea of the near-peer mentoring entails a practice-oriented community of people (community of practice according to Wenger (1998), who are informally linked with each other, are faced with similar tasks, and shape the practice in this community through a self-organised exchange. "Professional Learning Communities" in the teaching profession have long been a popular research field (Hord, 1997; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006), but the effects of professional learning communities have yet to be researched in detail (Lipowsky, 2011, p. 408). The basic consensus in the literature seems to be that community-internal characteristics – such as high motivation for self-development and student focus – are required in order to address a deeper level of reflection in teachers as compared to a conventional training seminar (Lipowsky, 2011, p. 408). The literature on collegial reflection illustrates the added value of such working relations (Hoekstra et al., 2009; Meirink et al., 2009). Communities of practice increase the circle of possibilities for reflection and, provided the aforementioned conducive group characteristics exist, are another instrument of informal skills development of teachers. A beneficial environment for the successful interplay within the community of practice, such as the time window for the professional exchange, must be provided by the school.

Not only networking internally within the teaching staff, but also the search for forms of more intensive cooperation between learning locations, is a field that is still relatively young in Switzerland and has yet to be implemented systematically (Dubs, 2003). Schneider & Mahs, (2003) provide one example of a concept of continuous self-qualification and cooperative self-organisation for the skills development of teams of trainers (trainers, teachers, professional services). Here, team meetings represent an important measure in the course of which training modules and further education per se can take place in a self-organised way through the multiplier principle (Schneider & Mahs, 2003, p. 300). More recent examples support learning cooperation using Web 2.0 to bridge the gap between learning locations (Beiling, Fleck, & Schmid, 2012). However, experience with knowledge forums (Kremer, 2003, p. 416) reveals that work within the forum has so far encountered considerable problems; there is often a lack of motivation to cooperate at the various locations. The formation of networks in relation to the outside world thus also has a bearing on the internal relationship between the participating organisations, ("which is why knowledge forums cannot become bridges between the organisations, yet bridges are built without ensuring the access," (Kremer, 2003, p. 416). Even when using Web 2.0 applications, the relevant prerequisites for success are therefore not so much technological as cultural factors that represent incentives for participation in the community of practice. The above-mentioned promotion of a climate that is conducive to cooperation within the school influences the informal learning activities of the teachers (Heise, 2009). The availability of time and virtual and real rooms fosters proactive action by the practical community (Overwien, 2009).

Based on the above examples, it is clear that the combination of formal and informal learning is possible in particular using two different approaches. "This can be done independently by the learner (e.g. through documentation, checklists, learning diary) and/or with support (e.g. learning process support, group discussions). By means of constructive and critical reflection on one's own experiences, the mere "gaining of experience becomes an effective learning experience that supports one's own skills development" (Rohs, 2007, p. 77). Alternatively, however, significance is attached to the *structuring* of the self-organisation of learning processes on the continuum between formal and informal. With this approach, self-organised learning is promoted in daily school routine through staffing, methodological or medial structuring aids. This makes it possible to tap experience of organised forms of learning gained in the course of everyday teaching practices for the acquisition of skills (for example through the parallelisation of project and learning tasks or observational tasks to focus the attention of the students).

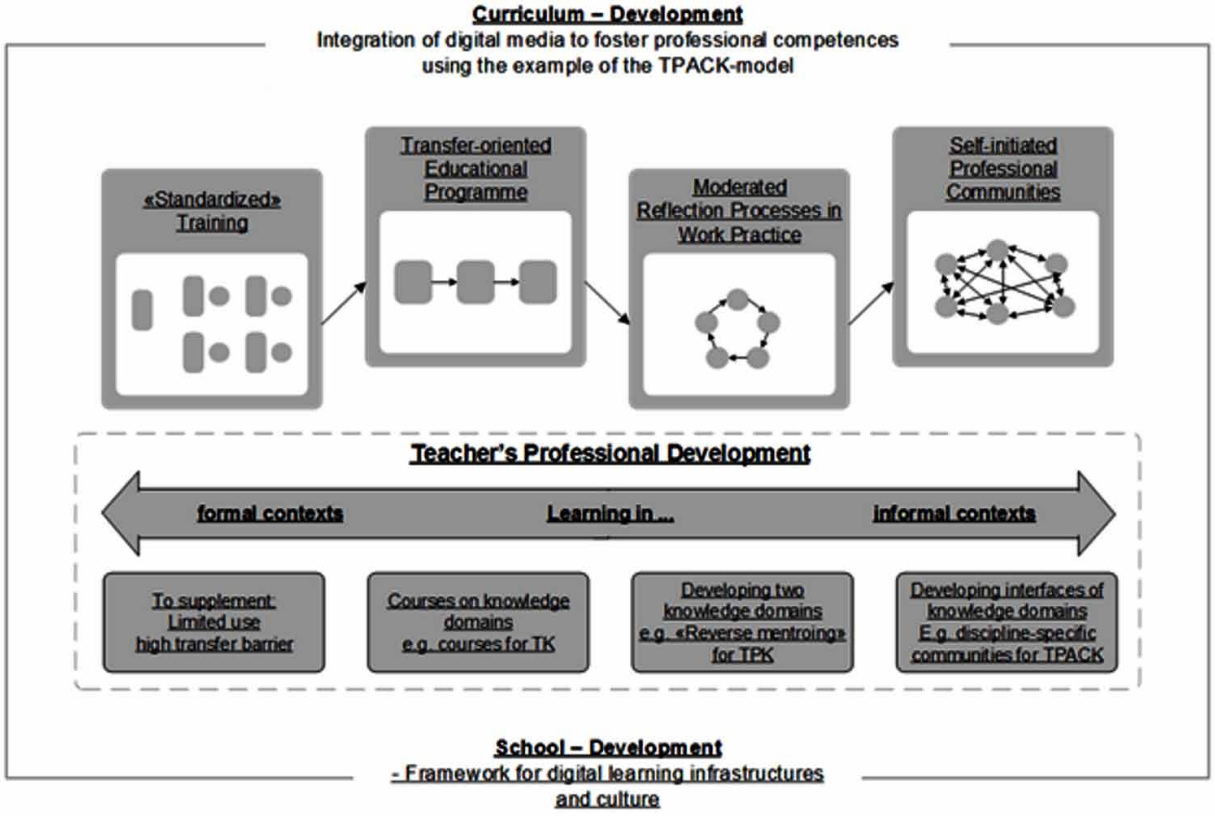
5. CONCLUSION AND FUTURE TRENDS: SYSTEMATIC COMPETENCE DEVELOPMENT: CREATION OF BASIC CONDITIONS FOR LEARNING OPPORTUNITIES

The skills development of teachers, in particular in order to test and learn new teaching concepts, is inextricably linked to curriculum and school development. As already stated in the introduction, school routine is currently dominated by more traditional forms of teaching, in which innovative educational approaches are almost impossible to realise. "Such teaching practices are therefore the central impediment to the integration of e-learning in everyday school life" (Wilbers, 2012, p. 38).

The skills development of teachers for vocational training in the competent use of digital media therefore requires considerable efforts in the schools. Consequently, it is doubtless not enough to organise a new blended learning course as a further education offer for teachers, which is usually held as a one-time event. Hence the new further education course will continue to be out of place in the school. On the contrary, it appears all the more important that support initiatives for the skills development of teachers are based on this context and are simultaneously embedded in innovation strategies and quality development processes in schools (Schneider & Mahs, 2003; Seufert, Lehner, & Tödtli, 2013). As a result, curriculum development, staff training and school development measures must be coordinated in order to implement education reforms (Stoll et al., 2006). The development of a school culture in which students and teachers alike attach great importance to learning together and from each other is of central importance (Hord, 1997; Stoll et al., 2006). In this context, based on the learning organisation by Senge (1996), Hord (1997, p. 1) stresses the importance of community building for continuous learning ("communities of inquiry and improvement", p 120.) In the context of a comprehensive literature review, Hord (ibid.) identified in particular the following five success factors for promoting conditions conducive to learning in a school: 1) supportive and participative management, 2) shared vision and values, 3) collective creativity, 4) shared, personal practice, 5) supportive conditions that determine when, who and how the teachers meet regularly as a unit in order to initiate learning processes, take decisions, solve problems and work creatively, which is ultimately what characterises a professional learning community.

For a sustainable integration of digital media in a vocational school-system it needs besides a digital competences development program – in teams or individual, in informal or formal settings (Micro-level and Meso-level) – also a comprehensive school development and a framework for digital learning infrastructures. Figure 2 illustrate that both school development and digital competences programs should

Figure 2. Connection between skill, school and programme development. (Seufert, 2013, p. 294)



be mutually supportive. The usage of digital media in vocational schools has a strong disruptive effect: students bring their own devices in schools. It is natural for them to use it as instrument for learning, working and living. Schools and their teachers are not prepared yet for the necessary radical change in acquiring knowledge and bridging the gap between schools and the working environments in companies. Radical changes are needed to think over existing practice in teacher education at the school workplace. Therefore, the future perspective should focus on school and curriculum development supporting teachers as a professional learning community.

Developing a learning-conducive school culture can be regarded today as one of the key challenges for the successful implementation of educational innovation and continuous quality improvement processes. To enable technology to become firmly established as a method and subject in school routine in the long term, appropriate framework conditions are required at the organisational level. At the macro level, schools must create conditions that allow learning with digital media. On the one hand, this involves providing the technological infrastructure, and on the other, rooms in which the personal training (both formal and informal) of teachers is possible. In this context, an appropriate learning culture must be established, which promotes learning with and from each other as well as the testing of new forms of teaching with digital media. According to Kerres & Heinen (2012, p. 28), in addition to the creation of "digital learning infrastructures", a shared vision and accompanying internal communication structures need to be established by the stakeholders, with the school management playing a pioneering and leading role.

At the same time, learning takes place not only in the school context, but also at home, in the workplace, or in interaction with peers. Following Blömeke (2005), teachers who have school development skills, contribute to the development of institutional digital conditions and educate students and parents in digital media education terms.

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Chapter 11
Interactive Multimedia:
Increasing the Study in Primary Education

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ABSTRACT

One of the important characteristics to be considered when developing multimedia educational materials is interactivity. The purpose of this study was to check whether the proposed multimedia's interactivity influenced the performance of 5th graders in a controlled environment and using Portuguese questions from the Brazil Test (Prova Brasil) as inputs. Those assignments were given to two groups of students, where one group had access to activities implemented via software featuring different interactive resources and a second group carried out the same activity in a plain environment, without the aid of multimedia resources. As a result, this chapter compares the performance of each group of students and relates them to the levels of interactivity, thereby demonstrating the latter's influence over the number of correct answers in the activities. Additionally, this chapter provides elements for the preparation of a second study phase.

INTRODUCTION

It is widely known that education is one of the cornerstones in the construction of a society. Based on such assertion, it is plausible to take a more in-depth look into the activities involved in our educational context. The evolution of technology has enabled significant progress in teaching practices, as well as

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influenced the development of teaching materials, which have moved on from linear printed media to digital ones with the introduction of computers in school environments.

An increasingly more popular trend is the use of multimedia resources as a tool to support the teaching and learning process. Several movements in Brazil have been encouraging teachers to get training so they may have theoretical subsidies and tacit knowledge to reframe their teaching practices following this line of action, and take digital materials and resources to the classroom.

Institutions of higher education have a relevant role in the formation and development of skills and abilities of professionals to interact in a multicultural market, also marked by globalization and information technology and communication (ICT). These professionals, in turn, may also prepare other professionals to work in the various levels of education.

As examples of such movements we have the creation of UAB (Open University of Brazil - http://uab.capes.gov.br/index.php), an education system comprising a group of public universities that takes higher education to people who might otherwise not have access to a university education.

The system UAB was created to answer to the local high education requirements. Once a need is detected this system works as a linking agent among the high educations institutions, the estate and county governments. Establishing which qualified institution will be responsible for a defined seminar at any certain county or micro region through the support of remote educational presential centers. Following are some of the different types of courses and seminars offered by the Brazilian UAB:

1. **Bachelors, Graduate Degrees, Technical and Specialization Seminars:** These courses are intended for initial and continued formation for teachers of public education network or general public (social needs).
2. **Specialization Courses in Program of Media in Education:** Courses offered for the purpose of providing continuing education focused on the pedagogical use in distance education, different technologies of information and communication.
3. **Librarian Degree:** Bachelor's program for the training of staff to support the implementation of the courses at the attending supporting poles supporting attendance of the UAB system.
4. **Specialization Courses for Teachers, in Partnership with the Department of Continuing Education, Literacy and Diversity (SECAD / MEC):** Courses offered at post-graduation courses, lasting 360 hours and certification for graduates. Given the current legislation, this program is intended to prepare teachers for cross-cutting themes of the basic education curriculum.
5. **National Training Program in Public Administration - (PNAP in Portuguese):** Courses offered at the undergraduate level - Bachelor's degree, and post-graduation courses - expertise for the creation of a national profile of the public administrator, providing management training to use a common language and understand the specifics of each public sphere: local, state and federal.

In the context of this discussion, UAB contributes to the offer of specialization programs such as Media in Education and Specialization in Information and Communication Technologies, both dedicated to training basic education teachers in the use of media and different technologies in the classroom.

In the on-site or virtual classroom, the multimedia educational materials (MM) provided may comprise a combined variety of media, such as: text, images, audio, animations etc. We believe the sensible use of various media, when combined with different forms of interactivity, may positively contribute to learning (Schwier & Misanchuk, 1993; Mayer, 2002). In this context, the multimedia proposed must be part of a teaching plan that considers the particularities of the student group.

Some studies provide evidence of the value of interactivity in the teaching and learning process. According to Domagk, Schwartz & Plass' research (2010, p. 1025), depending on the field of application, which includes the educational one, interactivity is a word carrying different meanings and taxonomies. Through the concepts they adopted, some studies, such as Piaget's (1974), Schwier & Misanchuk's (1993), Sims' (1997), Lemos' (2002) and Primo's (2005) are a great help to set the words interaction and interactivity apart.

The main goal of using educational materials is to encourage students to learn. Using efficient subsidies for that purpose bolsters the design of quality education, where a multimedia material can carry different media styles, formats, and concepts. Regarding multimedia materials, "active-learning hypothesis (Jonassen, 1996; Mayer, 2001) predicts that learning should increase when learners use interactive as opposed to non-interactive multimedia systems," according to Evans & Gibbons (2007). In that aspect, a question remains implicit: how much using these resources or not helps students understand and assimilate the contents studied.

This chapter narrates the results of a pilot study included in the second phase of a doctoral research project and some of the developments taking place after that study. Based on the design of an interactive multimedia material, the goal of this study was to check whether the proposed multimedia influenced student performance in a school environment, using Brazil Test (Prova Brasil) questions as subsidies (PDE, 2008). The following options were outlined as specific goals of the pilot study: 1) testing the levels of reactive and proactive interactivity with a multimedia material; 2) checking whether such levels influence the correct and wrong answers in the activities; 3) getting the students' feedback about the material proposed.

This pilot study on interactive multimedia is based on research by Evans & Gibbons (2007); Domagk, Schwartz & Plass (2010), and Wang, Vaughn & Liu (2011). It is different from the aforementioned research in terms of the audience it is meant for, its application site, and type of content proposed. It was carried out in a public school context with 5th graders aged 10 to 16. Our pilot study uses the word interactivity and the guidance from authors who consider the words interactivity and interaction to be synonymous, that is, they refer to the exchanges taking place between person and computer.

This chapter is organized as follows: section 2 provides the background and a literature review encompassing the topic of multimedia and interactivity, in addition to an explanation about the Brazil Test and briefly introducing the school through its political pedagogical project. Section 3 addresses the methods adopted to carry out the study. Section 4 describes the pilot study implementation and presents the decisions for the second study. The pilot study results are presented in section 5. Finally, section 6 describes our final considerations.

This study is part of the Doctoral Thesis of the author of this chapter and is developed through the Post Graduate Program in Computer Education, at the Federal University of Rio Grande do Sul, Brazil. The author is an active teacher in basic and high Education (UAB - Open University of Brazil). The study involves a long period of data collection with students in activities at the computer room, respecting the school routine, and the program proposed by the teacher. This work is done with hypotheses that require analysis of the use of interactive multimedia and their effects, when used in educational activities of reading and writing with fifth year students of elementary school.

BACKGROUND

This section presents the literature review that supported our pilot study, which encompasses research into the use of multimedia and interactivity. This section also discusses relevant issues regarding the Brazil Test (PDE, 2008) and the choice of the activities used in our study.

Interactive Multimedia

Digital educational materials may be presented in multimedia (MM) form. Such MM stimulates some human senses (for instance, hearing and sight) given the fact it comprises a variety of media (such as text, images, audio, animations etc.). However, each medium "has particular strengths and limitations" (Schwier & Misanchuk, 1993, p.3).

Through his cognitive theory of multimedia learning, Mayer (2002) presents eight principles (multimedia, contiguity, coherence, modality, redundancy, personalization, interactivity, and signaling) that guide the design of teaching materials. The multimedia principle (Mayer, 2002) states that, people learn more deeply from words and pictures than from words alone. The principle of interactivity states that when learners control the multimedia presentations, they learn more (Mayer, 2002).

In his practical contributions, Mayer's study (2012) once again points out that images and charts should not be randomly incorporated to texts in multimedia educational materials. Words may be narrated or written and images may be animated or static. The assumptions in the cognitive theory of multimedia learning include: the dual-channel (visual and auditory), limited capacity, and active processing. According to the dual-channel assumption, humans process visual and auditory information through different channels. The limited capacity assumption states that each of these channels (visual and auditory) has a limited capacity to assimilate information at one time, averaging 5 to 9 chunks of information. The active processing assumption predicts that active learning is processed as humans select and organize relevant information in coherent mental representations that are integrated to other knowledge. Sensory memory, working (short-term) memory, and long-term memory are the three types of memory considered in multimedia learning: through a multimedia representation that may include images and/or words, the sensory memory is engaged through the ears and/or eyes of those interacting with the multimedia material. The working memory is short-term. For learning to be meaningful, the information sent by the sensory channels (hearing and sight) through words and images are sent to the working memory, providing a verbal and pictorial model. Sensory memory selects the relevant words and images. Those selected images and words are organized into models by the working memory. When the verbal and pictorial models (sensory and working memories) are integrated to preexisting knowledge, the long-term memory is engaged.

In addition to the principles proposed by Mayer (2002 and 2012), we consider that the instructional design of educational multimedia can be to different levels of interactivity which, along with the other elements making up such multimedia, constitute interactive multimedia (IMM). Activities which include more than one type of media and allow students the ability to choose, select and/or write, among others, are interactive possibilities for multimedia digital educational materials.

Many studies dedicated to interactivity and aimed at the teaching and learning process bring several concepts and taxonomies for interactivity, such as research by Wang, Vaughn & Liu (2011); Domagk, Schwartz & Plass (2010); Primo (2005); Sims (1997); Lemos (1997); and Schwier & Misanchuk (1993).

Based on the interactivity classifications researched by Thompson & Jorgensen (1989), Lucas (1992) and Hannafin (1989), should be mentioned as Schwier & Misanchuk (1993) proposes an interactivity taxonomy for instructional multimedia. In this taxonomy, interactivity is presented in three levels (reactive, proactive, mutual), five functions (confirmation, pacing, navigation, inquiry, elaboration) and transactions (these are directly connected to the type of hardware/technology used for which the MM is meant). The levels are hierarchical and may show up combined in interactive multimedia (IMM). According to the author, "in order to fully describe an interactivity taxonomy, we must also consider the transactions used to interact with the program. Transactions are the physical actions carried out by a learner during interaction" (Schwier & Misanchuk, 1993, p.13).

Evans & Gibbons' study (2007) provides evidence about the use of interactivity. The researchers' purpose was to establish whether there is evidence that interactivity improves the learning process, using computer-based multimedia systems. To define interactive system, the authors adopted the computer-based interaction model designed by Evans & Sabry (2002) and which involves three actions: initiation, response, and feedback. They applied the multimedia learning principles (Mayer, 2001) and Mayer & Anderson's experiments (1991) with animated narrated lessons on tire pumps and narrated lessons about lightning designed by Mayer & Moreno (1998). Evans & Gibbons' study (2007) used a multimedia lesson on how a bicycle tire pump works using text and images. The multimedia has an interactive version and a non-interactive one. The non-interactive version featuring little or no interactivity to complete the lesson is a computer-based version of the experiment described by Mayer & Gallini (1990). However, Evans & Gibbons (2007) added two additional stages to approach the creation of vacuum and air compression in the cylinder, thereby differing from the original proposal. The interactive multimedia features text, image, and sound effects. The study conducted before-and-after knowledge tests, besides statistically treating the data. That study's results showed that students using the interactive lesson delivered significantly higher performance in the knowledge transfer test than those using the non-interactive lesson.

The results obtained by the studies of Wang, Vaughn & Liu (2011) expanded Evans & Gibbons's theory (2007) about the effects of interactive instructional materials. As they studied the effects of the program's animation, interactivity and complexity, they considered the need to provide students with other supports, such as using instructional strategies for better learning. In the case of educational interactive animations, greater caution should be exercised as they believe greater interactivity increases the program's complexity and may decrease the students' ability to use the program (Wang, Vaughn & Liu, 2011, p. 310).

The study by Domagk, Schwartz & Plass (2010) presents a unifying model named INTERACT (Integrated Model of Multimedia Interactivity). This model integrates the influence of the environment and the learner's activities, a system of connections and concepts that make up interactivity. In the given context, the interactivity process is represented by the cycle of feedback messages that connect its six components in a learning environment. That study and the proposed model highlight the importance of the instructional project and supply an interactivity basis for digital educational material designers. It offers a process approach that enables the design and evaluation of specific interactive components for their multimedia applications. However, according to the authors, the study requires future research into the dynamics of relationships taking place between the six components of interactivity.

In his studies, Primo (2005, p. 13) advocates the interaction between individuals. Based on the interaction between the interactants, he proposes two major groups of computer-mediated interaction: the mutual interaction stemming from the relational negotiation between the subjects ("the interactants come together around continuously proposed problems" – free translation) and the reactive interaction

that "depends on exchange predictability and automation" (free translation), depending on the resource or software used.

From Piaget's perspective (1974), knowledge depends on the actions between the subject and the object, which lead to the interactions between them. In the cyberculture context, according to Lemos (1997), digital interactivity is not inscribed in the physical form of the object but in the microelectronic supports that constitute the technological objects. In such context, interactivity can be seen from the perspective of the dialogue between human and technological object (Lemos, 2002).

Sims (2000) gives interactivity its pedagogical dimension. In his study, the author relates the approach to interactive constructs and learning theories, and proposes a classification that confirms interactivity as a viable mechanism to support learning. He presents four dimensions – learners, content, pedagogy, and context – and connects them to the prescriptions of interactivity. However, the pedagogy dimension, which may suggest interactive constructions, was the chosen one, given it fits the purpose of this section. Sims (2000, p. 48) says the pedagogical dimension is also critical, "as it will determine the extent to which the learner is able to move (navigate), test (explore) and maneuver (self pace) through the product."

For the pilot study reported in this chapter, we adopted the interactivity concept proposed by Schwier & Misanchuk (1993), who consider it a result of the actions between user and system. To that end, we created an interactive multimedia educational material based on the multimedia and interactivity principles presented by Mayer (2002). The interactivity levels proposed in the multimedia were defined according to Schwier & Misanchuk's taxonomy (1993) and encompass the reactive and proactive levels.

Later on, the interactivity levels initially proposed in the pilot study, including Sims' taxonomy (1997), were further looked into to set up a new array of interactive multimedia created to be used in a second study.

The multimedia created present activities based on some of the contents included in the studied school's curriculum and some previous Portuguese questions in the Brazil Test (PDE, 2008), relative to the 5th grade.

Assessments, Brazil Test *(Prova Brasil)*, and the Questions Chosen

PISA (Programme for International Student Assessment) is the largest study in the field of public and private education, and its main focus is to gauge student performance in Reading, Math and Science. Some of the countries assessed include Italy, England, Portugal, the US, Brazil, Chile, France, Switzerland, Canada, Finland, Peru, Ireland, Argentina, and others. The study is meant to assess 15-year-old students, assess their readiness for real-life situations, and gauge their Math, Science and Reading skills. Brazil is among the participating Ibero-American countries. This international study has shown the wide differences in educational outcomes by students from different countries, and also the students' reading difficulties in other countries.

According to the PISA assessment (2009, p. 106) of the main factors associated to Brazil's performance, Brazilian students "have great problems with language skills, and that affects school performance in all areas, etc.". Hence, one of the goals in Brazilian education must be to improve reading skills.

Although the Brazilian PISA score remains low, it has improved. However, the challenges to be tackled in a country the size of Brazil are massive. The Brazilian Government has proposed different targets and actions in an attempt to improve performance in education assessments.

The "Anísio Teixeira" National Institute for Education Studies and Research (INEP) coordinates the Brazilian education assessments at the different levels. Pursuant to information contained on the INEP

website, the Basic Education Assessment System (SAEB) comprises two processes: the National Basic Education Assessment (ANEB) and the National Academic Performance Assessment (ANRESC), according to Ordinance # 931 of March 21, 2005. ANEB reports are published under SAEB's name. The assessment corresponds to a sample of public and private schools in every unit of the Federation and focuses on education system management. ANRESC is published under the Brazil Test *(Prova Brasil)* name and is more extensive and detailed than ANEB, while focusing on every school unit.

The Brazil Test (ANRESC) is held every two years in all public schools with more than 20 students enrolled in the grade, in printed form, and aimed at:

1. Helping improve education quality, decrease inequalities, and democratize public education management;
2. Developing an assessment culture that encourages society's control over education processes and outcomes (PDE, 2008, p. 8).

This assessment is split into two major targets: the subjects of Portuguese (Reading) and Mathematics (Problem Solving). With respect to the Portuguese Language, as published by INEP:

The fact that we assess reading only does not diminish the importance of these evaluations, considering reading is essential for students to develop other fields of knowledge and consequently exercise their citizenship. – free translation (PDE, 2008, p. 21)

In the 5th grade, the Portuguese language matrix of the Brazil Test comprises two dimensions: the subject-matter of knowledge (with six topics or themes) and competence (with descriptors that indicate the abilities to be assessed in each theme or topic). This test exclusively assesses reading skills, divided into five content blocks: reading procedures; implication of the support, gender and/or enunciator in text comprehension; relationship between texts; coherence and cohesion in text comprehension; relationship between expressive resources and effects of meaning and linguistic variations.

This assessment requires knowledge to be constructed in different levels of comprehension, analysis and interpretation. Multiple-choice questions comprise three parts: the text, the statement that necessarily poses a problem or consists of a problem-situation, and answer alternatives for the problems, considering only one of them is correct and the others, incorrect, albeit plausible. The students' reading proficiency is assessed through their performance. The pedagogical interpretation of those results by managers and teachers is essential to overcome the difficulties evidenced by this assessment (PDE, 2008).

In 2011, the early grades in the school studied obtained a score of 189.4 in the printed standardized evaluations of the Brazil Test of Portuguese language.

Some Portuguese language questions from the previous 2007 and 2009 Brazil Tests were selected for the pilot study to be included in the proposed multimedia. The study presented in this article did not mean to compare digital materials (interactive multimedia) against paper-printed materials. The chosen questions were previously analyzed by the 5th grade Portuguese Language teacher from the school studied. According to the teacher, the students had not worked on the questions selected from the Brazil Test.

Briefly Knowing the School through its Political Pedagogical Project

According to the information contained in the researched School Policy Project (PPP), their community is located in a neighborhood in the outskirts, most are poor workers, unemployed or underemployed, have no professional qualification, performing duties related to domestic services and civil construction. Many families receive some type of government assistance. The villas occupy a mainly invaded land and are precariously built by the residents themselves. Children and young people are exposed to situations such as unemployment, lack of security, lack of monitoring by parents or guardians, lack of values, boundaries and discipline.

In this context, full of social problems, the school seeks to adapt its program. Teachers need time to study and planning. The knowledge base is considered the most important and aims to provide conditions for the student to be an agent of change. The school believes that the curriculum must always be committed to the practice of democracy and associated with the social context of the learner, expanding their knowledge through activities that encourage cooperation, participation, collective learning and citizenship, in this sense, cite Paulo Freire and the Pedagogy Autonomy (1996).

Each shift school is organized according to their characteristics. The early years, from the first to the fifth year, work on the morning shift and the classes have a dedicated teacher dedicated. The final years, from the sixth to the ninth year, work in the afternoon. The program is based on disciplines with modules of 60 minutes each. Youth and adults education (EJA) is done at night, the program is a discipline developed in stages, with modules of 65 minutes, offering reclassification and a module with semi-weekly attendance.

The activities in the computer room are understood as another learning strategy. In this context, the technologies of computerization serve to broaden the didactic action in the process, serving as an instrument of inclusion and quality of higher education. The School believes computer science is important to the lives of students in a competitive world, but computer science in education works with technology in a context, not as something stationary and isolated. Incorporating the technologies of computer science and communication in school is an action that requires for its implementation, of the mobilization of the whole school, covering the area of pedagogy in the classroom and extends to the different approaches existing in diversity school integration in the administrative and educational sectors.

In addition to the municipal and national legislation aimed at the Brazilian education in his Political Project (PPP), the School research highlights the works of Saviani (1983), Gadotti (1994), Freire (1996), Libâneo (2001), Nóvoa (1995) Perrenoud (2000) and Vasconcellos (2002).

METHODS

This qualitative and quantitative study examines the data collected and the observations made by the researchers during their analysis of 5th grade classes from a public city school. The purpose of the investigation was to set a parameter and identification by relating learning to a given level of interactivity. The students were analyzed based on their work on interactive multimedia activities in a computer science room, the scores obtained in them, and the data collected from an opinion poll. For the pilot study

we selected questions from the Brazil Test related to the Portuguese Language. Later on, we proposed new interactive multimedia related to 5th grade and Brazil Test contents.

Our research lab was a public school in the city of Santa Maria, Rio Grande do Sul, Brazil, located in an underprivileged area in the outskirts of town. This school serves students from kindergarten to 9th grade, besides Youth and Adult Education, and has approximately 400 students. The Computer Science Room is equipped with 37 computers using the Educational version of the Linux operating system, and 1 laser printer. The educational activities carried out in the computer science room are previously scheduled and planned by class teachers (generalists and specialists) and the teacher who coordinates the computer science room. The subjects selected for this study are morning-shift students from four 5th grade groups, in a total of 92 students between 10 and 16 years of age. The experiment was approved by the school's Ethics Committee and the parents authorized their children to participate. Fifth grade teachers signed the informed consent form.

IMPLEMENTATION

In 2011, we conducted our exploratory research and pilot study (implementation phase 1). In 2012, we met with 5th graders on a weekly basis for activities in the computer science room. Phase 2 of our research is being implemented in 2013.

Exploratory Research: Surveying Indicators

We conducted an exploratory study with teachers and students in the first semester of 2011. With the teachers, among other things, our purpose was to check the possibility of using interactive multimedia in the educational context and learn about the students' difficulties to master (reading and writing in) Portuguese in the 5th grade. With the students, our exploratory study was meant to determine the presence and use of technologies in their everyday school and home lives. For this study, we prepared questionnaires containing open-ended, semi open-ended, and closed-ended questions.

The results of our exploratory survey with teachers showed that, among other things, computers are seldom used in teaching activities dedicated to the audience studied. The teachers stated they mostly use printed and mimeographed materials and printed-out copies supplied to students, and the use of digital educational materials is the last alternative. The teachers said students have trouble reading and writing. The teachers consider that the use of interactive multimedia (IMM) as a teaching tool can bolster learning when the MM provides means of interaction that encourages students to learn. It is a viable activity, provided it is well planned and sets defined goals.

In turn, our exploratory survey with students revealed the media they see the most at school are, in order, sound equipment and computers, followed by TV and DVD. At home, the media the students use the most are: TV, DVD, CD, sound equipment, computers, cell phones, PlayStation, cameras, the radio, Game Boys, MP4 and video games.

Once we had such data, we established the multimedia contents for the experiments and moved on to the first phase of implementation and use of interactive multimedia.

Implementation: Phase 1

The first implementation phase was called pilot study. That study was conducted in October 2011 with four 5th grade groups in the aforementioned school, and its purpose was to test our research model. After designing an interactive multimedia (IMM) material, this study was meant to check whether the proposed multimedia's interactivity influenced student performance in a school environment, and was carried out over a total of four hours.

In this phase of our research, the basis of the multimedia contents provided to students in a proactive and reactive manner was carefully selected from Portuguese Language (PL) questions included in the Brazil Test for 5th grade students. The school's Portuguese Language (PL) teacher took part in this pilot study, helping us choose the questions and analyze their format to ensure the textual contents corresponded to the cognitive level of the students participating in this study.

We sought to encompass Mayer's (2002) principles of multimedia and interactivity in the activities we planned. We created a multimedia material classification taxonomy adapted from the one proposed by Schwier & Misanchuk (1993). In this study, the interactivity level of the material used in the classroom with the students was characterized as either Reactive or Proactive, and we discarded the Mutual level described in the author's original proposal.

For the Reactive Multimedia (control group), we defined characteristics such as instruction based on a simple text, which may contain a scroll bar. Practice through the multiple-choice activity, where the correct answer was to be selected (practice defined according to the type of interactivity proposed). Simple navigation in the application, through (next and back) buttons. The Proactive Multimedia (test group) had the following characteristics: instruction based on a text containing hyperlinks, images, bookmarks, and buttons. An initial menu for choosing the activity. Practice through the multiple-choice activity, where students had to select the correct answer. Immediate feedback at the end of the activity, including a performance report. Access to internal and external help pages.

The two types of interactive multimedia defined (Figure 1 and Figure 2), with different levels and characteristics, were provided to four 5th grade groups, identified as Blue, Orange, Yellow, and Green. On the day the experiment was conducted, 62 students were present. The Yellow group was represented by 8 boys and 5 girls; the Green group was also represented by 8 boys and 5 girls. The Blue group was represented by 11 boys and 6 girls, and the Orange group was represented by 11 boys and 8 girls.

The software tool we used to conduct our study was BrOffice version 3.3.0, implemented on an array of previously developed macros to provide the participants with the desired level of interactivity.

Before the students began their activities, the multimedia was presented to each class. At that time, upon request, we provided explanations about the questions and use of the tools. Each class was given 50 minutes, equivalent to one class period, to carry out the activity proposed. The classes were randomly separated, and the first two groups (Blue and Orange), with a total of 36 students present, received the Proactive material including an interactive framework which assisted them in different ways in their completion of the assignment. The second group of students (Yellow and Green), with 26 students, received the same assignment as the previous group. However, the material supplied did not contain interactive resources, this material was called Reactive.

Figure 1 shows the Proactive multimedia interface, allowing us to analyze the first question in the assignment given. Each student answered three questions similar to the one illustrated in the Figure. For this book chapter, we chose to keep the images of multimedia created with text in Brazilian Portuguese. The colors of the images have altered, according to rules of publishing.

Figure 1. Presentation of the interactivities available in the proactive question (reading and interpretation)

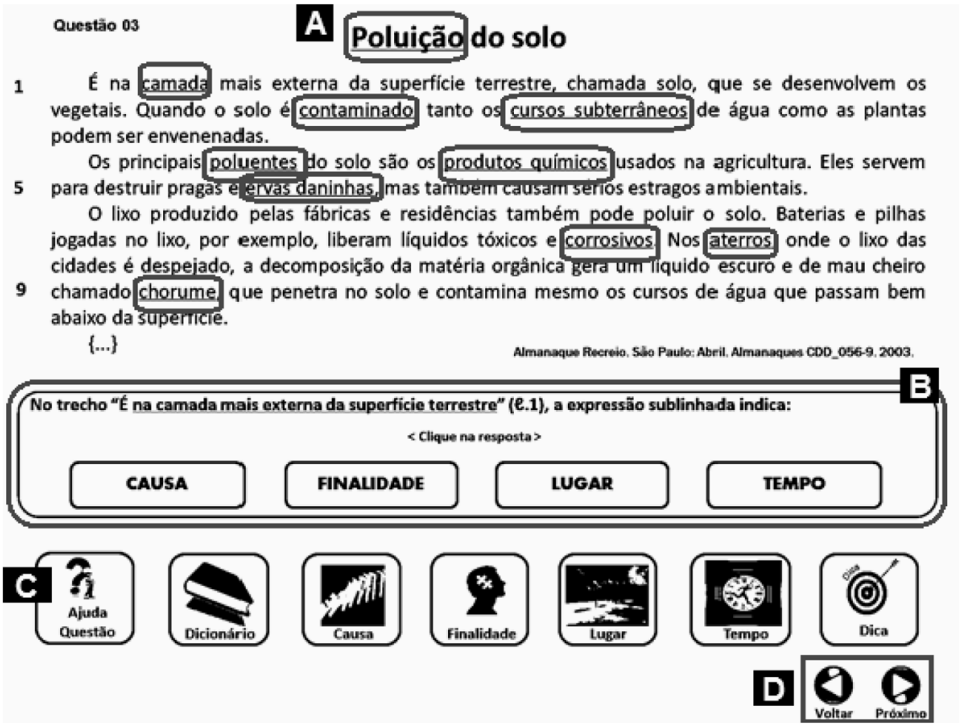


Figure 2. Reactive question (reading and interpretation)

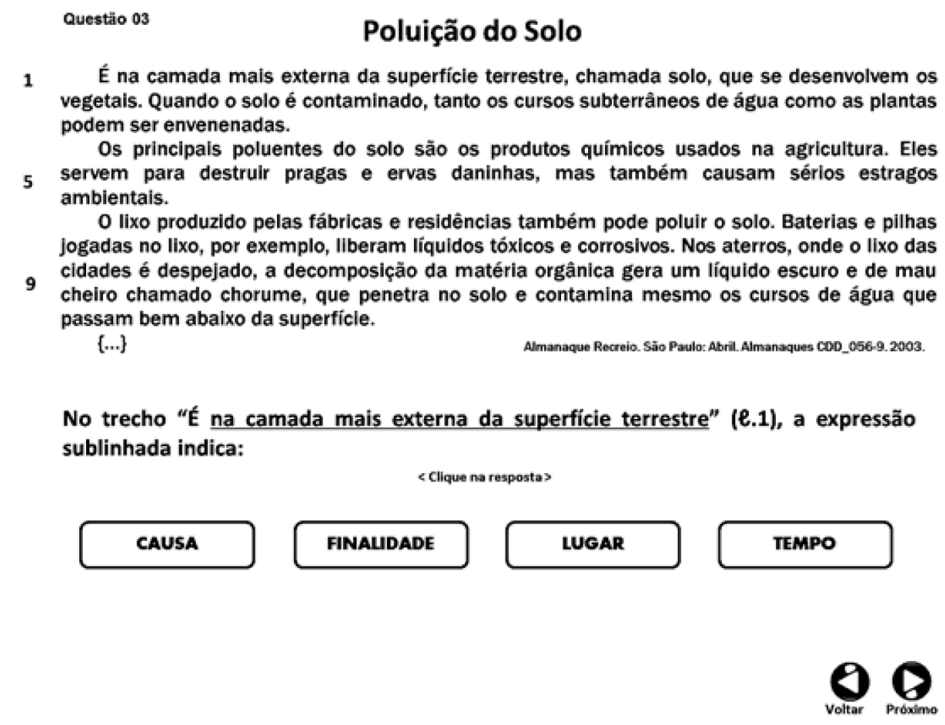


Figure 1 also highlights the array of interactivity solutions available for the assignment.

A. Hyperlinks to external pages – Internet.
B. Buttons for answer selection.
C. Set of multimedia resources – encompassing help about the questions, available from the very application, external links, dictionaries, and tips.
D. Navigation buttons.

With respect to the Reactive multimedia, the students answered the questions through their interaction with a simple material based on running text with no type of multimedia resources to help them complete the assignment. Figure 2 shows the screen containing the interface used by this group.

At the end of their reading comprehension activities, the students were asked to answer an Opinion Poll available via Google Docs in order to clarify important points for the evaluation of the assignment results. Some of the items in that questionnaire included: Do you have a computer at home?; Do you have Internet access at home?; How many times do you use a computer in the week?; Did you feel confident using the computer to complete the assignments?; and others.

After the end of the experiment with the students, we collected the data from the computers used by the students for subsequent analysis. We conducted our qualitative and quantitative analyses based on the results obtained from the multimedia activities and the opinion questionnaire made available through Google Docs.

Implementation: Phase 2

The studies and data collected until then were used as the basis to propose a second study phase encompassing the expansion of the contents and a new group of interactive multimedia (IMM). The participants are the new groups of students enrolled in the 5th grades at the school studied, upon authorization from their parents or guardians. This new group of multimedia is being applied in 2013.

For this phase we created two study groups (Evans & Gibbons, 2007): the control group (Reactive multimedia, similar to that in the first experiment) and the test group, which gets multimedia with some of the interactivity levels (Proactive multimedia). The interactivity levels proposed now encompass the taxonomies by Sims (1997) and Schwier & Misanchuk (1993).

Researchers such as Wang, Vaughn & Liu, 2011, recommend prior multimedia training for students to understand how to use them. Based on that idea, in 2012 and part of 2013 we conducted weekly educational activities in the computer science room with the students from the school studied, using different types of websites and interactive media other than the ones used in this study.

The different types of interactivity in each MM have been extracted from a taxonomy based on studies by Sims (1997) and Schwier & Misanchuk (1993). The eight cognitive principles proposed by Mayer (2002) constitute important guidelines for our interactive multimedia project.

For this second phase, we planned other multimedia encompassing some of the contents defined by the teachers from the school studied. We are also going to use once again multimedia containing Brazil Test questions related to reading.

Given the large number of readily available MM, there is the possibility of selecting and using media (such as video, for instance) from repositories and reference libraries to design an IMM.

We planned three groups of multimedia using different types of media, contents, and interactivity (Table 1). The multimedia groups are undergoing construction and testing.

The software used to create the interactive media is Macromedia Flash 7, belonging to company Adobe Systems Incorporated. Figure 3 shows the posting dates for the different versions of multimedia created and corrected, as well as the image of a new version of the multimedia addressing the syllable division content and posted to a website created for testing.

The final versions of the tested, approved multimedia will be made available on an open page for students to access them on the day of the final experiment. In this second phase of our study, the multimedia experiments are once again going to be conducted in the computer science room, which is part of 5th graders' weekly routine activities. We will also be administering before-and-after knowledge tests (Evans & Gibbons, 2007, Wang, Vaughn & Liu, 2011, and Mayer, 2012). Educational activities making use of educational multimedia will be planned along with 5th grade generalist teachers and the teacher coordinating the computer science room. The activities in the computer science room are carried out in 50 minute lessons for each class and are aided by student monitors. Computer science room student monitors are students from the opposite school shift that volunteered to help their peers learn how to use computers and Internet tools. Those students are selected and advised by the teacher coordinating the computer science room. In 2013, the final experiment will be conducted on several dates, given the

Table 1. List of contents, interactivity levels, and type of media for the second experiment

Contents	Type of interactivity Sims (1997); Schwier & Misanchuk (1993)		Type of media
Reading and interpretation (Brazil Test)	Hyperlinked	Reactive (control group)	Simple text
		Proactive (test group)	Text and images
	Object	Reactive (control group)	Simple text
		Proactive (test group)	Video and text
Syllables	Object	Reactive (control group)	Simple text
		Proactive (test group)	Text and images
Adjectives	Non-immersive contextual	Reactive (control group)	Simple text
		Proactive (test group)	Text and images
			Video and text

Figure 3. Image representing the site where the new multimedia versions are hosted for analysis – multiple-choice proactive question (syllables)

computer science classes take place every two weeks. After finishing using the multimedia, the students are going to answer an opinion poll.

The data collected from the before-and-after tests and the activities proposed via the interactive multimedia will also undergo qualitative and quantitative analyses.

PILOT STUDY RESULTS AND DISCUSSION

Once the computer science room activities included in the pilot study were completed, the data from the students' answers were collected by means of a script and grouped for a detailed analysis of said students' performance. Hypotesis h0 and h1 were established for the analysis of data gathered from pilot study. According to h0, proactive multimedia was not more successful than reactive multimedia, but proactive multimedia did showed more successful than reactive multimedia as per h1.

At first, we conducted a descriptive statistical analysis based on the numbers of hits and misses by the groups of students making up the proactive and reactive groups. The results from that analysis are given in Table 2.

By comparing the results shown in Table 2 we see that the average hits by students using the interactive multimedia material (Proactive) to help them complete the activity was 0.65 point higher than the score

obtained by students who were given the interaction-free assignment, called Reactive. In both groups there were students who did not get any of the answers right; however, several cases were found where students got all of them right. The Proactive group's standard deviation was 0.09 higher compared to the Reactive group, that is, the former group showed greater performance variability.

Upon a simple chart analysis, we can find the percentage of hits by Proactive and Reactive students. Students given access to the Proactive material answered 64% of the questions correctly, against the 42% of hits by students given the Reactive material. Such representation allows us to infer that students working with the Proactive material learned more from their assignments.

A more specific analysis of the students' results shows a few differences within inside the participating groups. Chart 1 presents the hit and miss percentages of students working on the Proactive materials. We see that the orange group (79% hits), performed considerably better than the blue group (47% hits). Chart 2 shows the group working on the Reactive material was more even, with the yellow group getting 41% of the answers correctly and the green group, 44%. Such representation allows us to infer that students working with the Proactive material learned more from their assignments.

Table 2. Pilot study descriptive statistics

	Proactive		Reactive	
	Hits	Misses	Hits	Misses
Average	1.920	1.080	1.270	1.730
Standard Deviation	1.052	1.052	0.962	0.962
Standard Error	0.175	0.189	0.189	0.175
Minimum	0	0	0	0
Maximum	3	3	3	3

Chart 1. Proactive group's hit/miss percentages

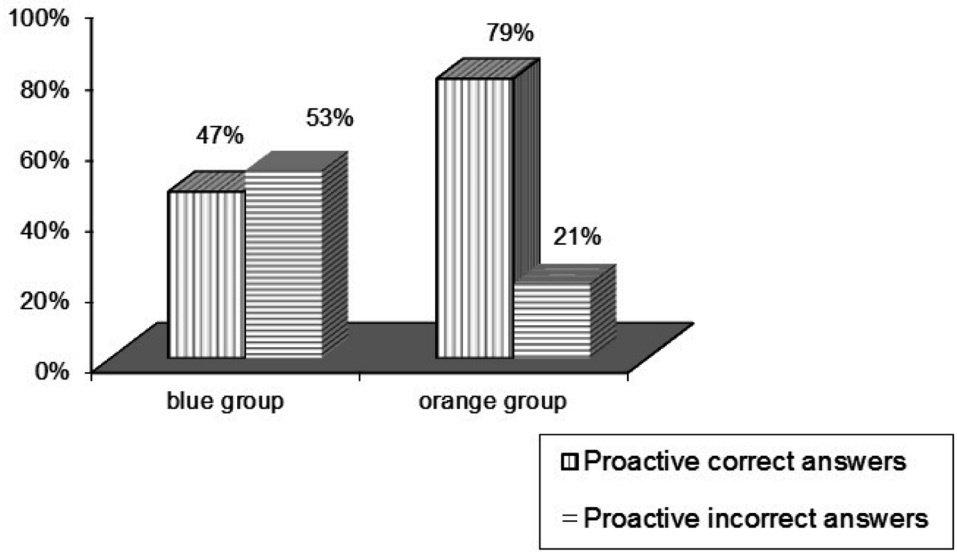
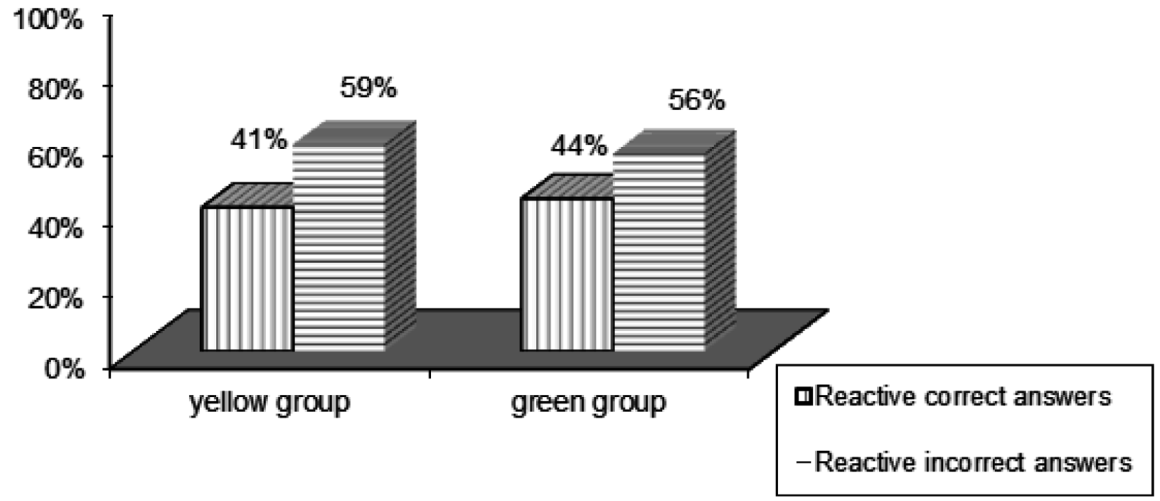


Chart 2. Reactive group's hit/miss percentages



The frequency histograms for each group of students showed that five students missed all the questions, a sharp contrast to the rate of Proactive group students who got two and three answers right, 12 and 13 students, respectively. In the Reactive group, that number drops to three students who got two questions right and four students who "aced" the assignment, that is, three questions.

Via the Kolmogorov-Smirnov test we found that the data do not follow a normal distribution, considering the test's statistics showed significant results ($p=0.00$) at the 5% level for both hits and misses. Based on those results, we chose to conduct a non-parametric test to compare the hit and miss averages obtained by Proactive and Reactive groups. Therefore, to ensure this study's statistical treatment, we decided to replace the student's t-test with Mann Whitney's U test.

The statistic result of the Mann Whitney's U test for the difference between the two samples' averages, both for hits and misses, was $p= 0.014$, that is, the samples showed a significant difference ($p<0.05$). Hence, the pilot study statistical analysis also confirms our study's hypotheses (h0 and h1).

An important fact to be considered when evaluating the results obtained is the criteria that may influence such results, such as the students' familiarity with computers and the Internet, that is, how confident they are using the equipment. In such context, a quantitative analysis of the opinion questionnaire the groups filled out may bring relevant contributions. In that sense, two important issues were evaluated.

We found that 54% of the students in the Proactive group have a computer at home, while 47% in the Reactive group do. It is plausible to assume that the great disparity between the groups was not the product of that factor, considering that a difference of a mere 7 percentage points was seen in that analysis. On the other hand, we found a balance in the percentage of students who have Internet access at home. That observation shows that using virtual environments is not something new for the students in both groups.

CONCLUSION

At the end of this research phase, we concluded that the students' assessed performance showed considerable discrepancies between the groups that completed assignments with or without the aid of interactive multimedia resources. The discussion of the results in the previous section- confirms such statement. The various multimedia elements made available for proactive assignments served as efficient aids for students to achieve greater success in their tasks. The selected media options such as text & images, only text and interactivity proposed for the digital activities will also contribute to the results obtained. The activities described as reactive, i.e. running text, required a higher degree of concentration and prior knowledge from students regarding the topic addressed in each question, considering running text was the only aid the students had to complete the activity. A few factors that might have influenced the results were discarded after an evaluation of the opinion questionnaire filled out by the students at the end of the activities.

The results obtained so far are compatible in some aspects with those indicated in the studies by Evans & Gibbons (2007) and Wang, Vaughn & Liu (2011), and confirm the principles of interactivity and multimedia proposed by Richard Mayer. Based on Evans & Gibbons' work (2007), we chose to split the research groups and the statistical treatment adopted. We also followed the authors' guidelines regarding the statistical treatment and therefore adopted the student's t-test. As explained in the previous section, we felt the need to expand the study and change the statistical treatment, and studies are being conducted in that respect. The purpose is to explore the effects of interactivity in a real-world classroom along with teaching strategies, instead of in a lab, respecting the students' prior knowledge regarding a specific subject (Wang, Vaughn & Liu, 2011).

The use of the BrOffice tool with programming resources (macros) allowed the researchers to develop an interactive material according to the standards deemed pertinent by the authors mentioned in this article, in the first part of our research: the pilot study. We are currently working on the design of new Macromedia Flash-based educational materials. We have expanded the types of multimedia and the interactivity levels to be studied.

The results achieved up to this point reinforce the need to present and explain the multimedia material before the experiment. The fact the researcher was frequently at the school brought positive aspects to this study. For instance, the students are more familiar with the activities being carried out in the computer science room and use the materials included in the research more naturally.

One of the negative aspects detected so far is the issue that regular teachers hardly ever use technology in their classes. Technology-wise, we have found the extremely slow speed of the Internet connection provided by the government to the school and the lack of regular equipment maintenance and software updates. The computers are no longer under warranty. At this time, there are no plans to replace or recycle them, and the hardware will soon become technological scrap.

Finally, we consider that the greater contact by the audience studied with computers and the Internet, as shown by the opinion poll, and the fact of planning and giving assessments such as the Brazil Test (INEP/MEC) using multimedia resources thoroughly related to the subject of study may be motivating factors and help students perform better. We would like to point out that it is important for the audience studied that activities be prepared and explained in an intelligible manner that considers the students' age and cognitive level.

In the next phases of this study, we are going to look deeper into our statistical analysis by using data from the new experiments encompassing the new types of educational multimedia, before-and-after knowledge tests, and the opinion questionnaire filled out by the students.

Technologies exist at the school with some limitations. Due to the geographical location, Internet connection has low speed. This Internet low speed was a limitation for the study since it was not possible to use multimedia material with videos or animation.

The study is not finished yet and the data gathering within the school will continue until 2013 end. The study is rich in information about the students' usage of technologies, in spite the economical and social limitations of the population inhabiting the outskirts area. The investigation time and work within the school is very important and revealing.

It was found in the public school searched that most higher education teachers, do not demonstrate sufficient knowledge or skills for planning and pedagogical use of ICT in their teaching and learning dynamics. This reality implies not only the lack of use or wrong use of ICT in educational activities with students by teachers. However, this perspective in particular, is not exclusive of the School researched (ICT Education in 2010 and 2011) and drives greater attention from institutions, especially of Higher Education ones, to correct any faults that may be in the teachers formation programs. Here is another important contribution of this study.

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KEY TERMS AND DEFINITIONS

Grade School: Is one of the Basic Education levels in Brazil. The Primary Education is mandatory and free. It is divided into Early Years (from first to fifth year) and Final Years (from the sixth to ninth grade).

Interactive Multimedia: Material that carefully combines different media types and levels.

Interactivity: In this study, interactivity is the result from the actions between the user and the multimedia.

Multimedia: Term that refers to media mix.

Multimedia Educational Material: Expression including educational materials combining different media, eg: text, images, audio, animations.

Multimedia Learning: A term which refers to learning that results from the careful selection of media combination.

"Prova Brazil" (Brazil Test): Is a diagnostic evaluation in large scale, aiming to evaluate the quality of education in Brazil. It is base on standardized tests and socioeconomic questionnaires. Developed by the National Institute of Educational Studies Anísio Teixeira (INEP/MEC).

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Chapter 12
Transforming Digital Literacy with Culturally Diverse, Personalized Learning

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ABSTRACT

The chapter reports on the research and efforts of two faculty members in an Instructional Technologies (ITEC) Master's program to transform their undergraduate and graduate courses into culturally sensitive personalized learning experiences in media literacy education. The 20-year-old ITEC program needed upgrading to meet the paradigm shift in new technologies and global education that its students would enter on graduation. Cultural and social justice issues have been the mission of the University for 40 years and that dimension of media literacy education was missing from the ITEC curricula. Researchers found that introducing techniques of gamification, heutagogical methods, and universal design for learning principles into their online and blended-learning courses provided a way to help students personalize their learning experience and interact more engagingly with each other, and to master the media literacy skills being taught.

INTRODUCTION

This chapter describes our improved understanding about how to teach digital literacy and why to undergraduate and graduate students. We are faculty in the Instructional Technologies (ITEC) Master's program San Francisco State University (SF State). The program is part of the Department of Equity, Leadership Studies and Instructional Technologies in the Graduate College of Education (GCOE). The ITEC program prepares pre-service and in-service teachers, corporate trainers, and a variety of other students in instructional design[1] (ID) using technologies. We were both Master's students in the ITEC program in the 1990s, graduated with our Master's degree in Education: Instructional Technologies and

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went on to doctoral programs before returning to SF State. We both held administrative positions and currently are faculty. We both have experience in teaching in various environments and have business experience serving the education sector.

We came to our current knowledge of the critical importance of personalized, culturally relevant approaches to teaching digital literacy when we tried new methods in two of our courses that flipped the learning control from us as instructors to our students. We came to see an effective digital literacy curricula must incorporate two approaches:

- **Personalized Learning:** Addresses individual learners on the basis of their learning styles and needs, and empowers a self-directed learning process.
- **Culturally Diverse Learning:** Addresses the cultural/ethnic background of experience, personal perspective, and point of view of every learner. It often infers a broad swath of diverse learners.

Digital Literacy education requires each learner to grasp unfamiliar terminology, learn skills for unfamiliar tools and interfaces, and apply complex ideas and skills to digital interactions. Digital Literacy involves sophisticated skills and knowledge (see Hinrichs & Coombs, 2014). We realized we could not begin to teach the full set of digital literacies to our students without addressing each individual's ability to learn and practice them. Our courses would need to re-shape instruction to address culturally diverse, personalized learning perspectives so that we could enhance our learners' experiences and thereby their retention of the complex digital literacies covered.

We knew from our combined experiences in teaching instructional technologies that students responded with more energy and greater interest when they interacted with newer technologies such as games, augmented reality, Wii remotes, and multiple-player or collaborative online challenges. We also knew that many of these technologies would leave some students behind for multiple reasons, such as disinterest in games, lack of technology access, or lack of accommodation for disabilities. Our students must learn the technologies taught in the program and as instructional designers must learn how to incorporate the technologies into instruction. We knew we had to shape our courses to new realities: that technologies for learning were rapidly emerging, that current student expectations about technologies had changed, and that students' skillsets were different, especially their knowledge of how to operate and apply the newer, emerging technologies. We established the following goal for our studies that would seek students' increased knowledge in digital literacies by applying methods to improve their personal learning and by giving them culturally relevant experiences in the courses.

The following pages present two case stories from the ITEC program – the case of ITEC 299, *How 2 Lrn w Ur iPod*, a digital literacy general education (GE) course for undergraduates, and ITEC 830, *Designing Learning with Emerging Technologies*, an advanced graduate course for preparing ITEC students

Table 1. Changes to courses; Table shows modifications to course methods to improve student retention and digital literacies

Methods	Changed	Goal
1. Gamification mechanics 2. Heutagogical strategies 3. UDL principles	1. Personalized Learning & 2. Culturally Diverse Learning Experiences of students.	To improve retention and application of digital literacies

in instructional competencies for using emerging technologies to best advantage in their instructional designs. The stories offer rich description of our efforts to improve the digital media literacy curricula of our two courses to become more culturally responsive, personalized, and student-centered. We report what we observed ourselves and heard from students. The first story covers the case of ITEC 299 that prepares undergraduate students in how to learn and teach themselves using today's technologies. The course is delivered entirely online asynchronously. The second story covers the case of ITEC 830 that prepares students in using emerging technologies. This course was given a heutagogical modality to encourage students directly to learn new technologies. The second story also touches on related discoveries from two additional ITEC courses: ITEC 800, *Theoretical Foundations of Instructional Technologies*, and ITEC 860, *Distance Education.*

Significance of the Research

Developing 21st-Century skills (Partnership for 21st-Century Skills, n.d.) and global competencies are recognized today as required skills for preparing students to become more fluent with the digital, global communications' world they encounter when they graduate. However, students' cultural knowledge and worldview deeply impacts how they interpret what they learn (Michie, 2004). In today's classroom, the use of information communication technologies (ICTs) dominates much of the delivery of instruction and information. As a result, students need to be prepared in the effective and appropriate use of online and 21st-Century technologies to be successful in the classroom or training room and as global digital citizens.

Cultural and personalized attention to digital literacy instruction was the focus of the Association of College and Research Libraries' (ACRL) publication of a set of Diversity Standards for information literacy (ACRL, 2012) and has garnered the attention of researchers in education (e.g., Hobbs, 2005; Michie, 2004). Recognizing these two needs in addressing digital literacy, our pedagogical methods tapped into current pedagogies that incorporate both approaches (cultural and personalized attention in the learning environment): gamification, personalized learning methods, universal design for learning (UDL), cultural strategies in the curricula, and metalearning techniques that help students with deep thinking.

Students need to know how to comprehend context, evaluate implied values, and break down assumptions before any lessons can impart meaningful learning (Lorenzo & Dziuban, 2007). When digital messages are hidden in subtext, skewed to one interpretation, or outright deceptive, the viewer/listener needs effective skills for analysis – skills that are learned. However, before a viewer/listener can analyze subtext, he/she must know how to parse through his/her own cultural and personal context, values, and assumptions. An effective digitally literate person understands the role that he/she brings to interpretation of a media or digital content. We turned to the methods mentioned above to help prepare students for the five competencies outlined by Hinrichs and Coombs, Critical Digital Literacy Explained (2014):

1. **Persona:** The identities we inhabit in the digital world.
2. **Using:** How to use the tools and techniques of digital literacy.
3. **Decoding:** How to cipher and decipher the messages in the digital world.
4. **Meaning Making:** The pro-active role of the learner and user in understanding digital messages.
5. **Analysing:** Analyzing the context of the digital world.

Our pre-study investigations showed that ITEC students were not learning the digital literacy skills sufficiently and some of the reasons seemed to be large differences in students' knowledge and expertise with the technologies and the inability of the courses to address many students' learning needs. We recognized that effective teaching of digital literacies meant teaching learning literacies first. We needed to prepare students in the metalearning and deep thinking techniques that digital literacy requires and we would have to meet students on their individual personal and cultural ground if they were going to understand what these literacies meant and how to use them. We would need to encourage self-efficacy in learning new technologies and prepare students to teach themselves to decode, analyze, evaluate and make meaning (see Hinrichs & Coombs, 2014 framework) of the digital sites and messages they encountered.

The three methods we studied – Universal Design for Learning principles, gamification mechanics, and heutagogical approaches to instruction – are methods that focus on strengthening students' capacity to learn and retain content. This was our goal – to improve students' retention of the digital literacy skills covered in the courses. It also speaks to the following significances in our research.

The ITEC program prepares instructional designers for industry and in education. Students must be well versed in how to manage their way around existing and emerging technologies, how to comprehend the digital implications in their instructional designs, and how to build digital competencies in learners. ITEC is the only program in the GCOE that focuses on preparing educators in a comprehensive program of skills' development, fluency with, and application of technologies for learning. The program was one of the first in the university to develop and apply the HyFlex^2 (Beatty, 2006) model of blended learning delivery throughout its courses. In 2014, the ITEC program required all courses to be offered in HyFlex, thereby living up to what it taught.

There are two other points of significance to our research. The first is that while ITEC has spent 20 years teaching educators how to use technologies in their instruction, it has spent less time on the concept of digital media literacy (see Definitions) and the breadth of knowledge and skills that it covers. The second is that despite the facts that social justice has been embraced by the University for decades, is a commitment of the ELSIT department and the GCOE as testified in their mission statements, that the ELSIT department offers an Equity and Social Justice M.A. program, and SF State was the first to create an Ethnic Studies program in the U.S., ITEC has never directly addressed ethnic, cultural, racial or bias issues in the design of instruction, in the applications of media and technology to learning, or as a major component of digital media literacy.

Research Objectives

Our goals for our course work have been defined above as the learning and retention of knowledge in three digital literacy areas. Our pre-assessment of learning needs showed us that many students – graduates and undergraduates – were under-prepared for either role, to learn or teach with technology. Clearly a stronger preparation in digital literacies was needed. We set three objectives for ourselves to reach our goal of improving digital media literacy education for our undergraduate and graduate students:

1. Instill in students an awareness of personalized learning and cultural literacy when using, and designing instruction with, technologies.
2. Evaluate the effectiveness of gamification, heutagogy, and UDL to improve student engagement, content understanding and knowledge retention.
3. Evaluate the application of digital media literacy in online and blended-learning environments.

BACKGROUND

The Case for Digital Media Literacy Education in ITEC

Most educators today have a clear sense that K-12 students need to be better prepared for a digitally literate world and that both students and their teachers only partially understand what that means (Lorenzo & Dziuban, 2007; Lorenzo et al., 2006; Menton, A., 2014; ICT Literacy Panel, 2002; Kubey, 2004; Partnership for 21st Century Skills, n.d.; Pew Research Internet Project, 2014). Most K-12 teachers know that digital media literacy is a critical 21st-Century skillset, but they often do not have a full understanding about how to teach these skills. Complicating this situation is teachers' lack of knowledge about the cultural literacy that undergirds and defines media and technology use, much less how to address it in digital media literacy education – a fact that Paulo Freire (1970) would point out needs swift correction.

The job of the ITEC program is to prepare classroom teachers and a variety of other instructional design professionals, including corporate trainers, global online learning specialists, and software developers working in educational product development. Digital literacy preparation in all contexts is vital. ITEC prepares students in the design of instruction using a variety of media and technologies from across a changing panorama of choice. The ITEC student's objective is to find those technologies that can support and enhance the learning they are designing. They need to know the digital competencies required by each. Students are confronted when they enter the program with the fact that they may be very fluent in social media, mobile applications, ICTs and other technologies they use on a daily basis, but have never considered how technology may help people learn. Most ITEC students are at a loss at first to consider what goes into designing an instructional experience that uses technology to improve the learning tasks. It was obvious when we analyzed our current program and its historical record that we needed to more effectively prepare students in a digital and media technology fluency.

We had gaps. ITEC students needed to learn the three digital literacy areas identified in our goals. They needed to learn how to teach those literacies to others. More importantly, they needed to learn, as did we, how to address the cultural implications of digital media use and how to raise the cultural awareness of others. Media literacy has become a required passport for digital citizenship in the global education marketplace today. We clearly needed to raise the bar on 21st-Century skills we were bringing to ITEC students and to credential and education candidates, as well as to those who were going to go into corporate training in companies anywhere in the world. The big question was how to raise ITEC students' cultural awareness in themselves and in their designs. The three methods chosen focused on individualizing and personalizing instruction in non-threatening and engaging ways, thereby opening the door to reflect on and observe cultural implications across the digital landscape.

Digital Media Literacies Addressed

Information literacy has been defined as the "basis for lifelong learning" (Association of College and Research Libraries, ACRL, 2000, p.2) by the ACRL in their report, *Information Literacy Competency Standards for Higher Education*. The global information society that has evolved today makes information technology the primary source for access and processing of information. The technology also inserts a medium between the sender or developer of information and the receiver, opening up potential gaps for miscommunication (Shannon and Weaver, 1949). The ACRL report notes that information literacy has "broader implications for the individual, the educational system, and for society" (p.3). Quoting the

National Research Council 1999 report, *Being Fluent with Information Technology*, the authors explain, "fluency with technology focuses on understanding the underlying concepts of technology and applying problem-solving and critical thinking to using technology" (NRC, 1999, p.3). The report makes a distinction between information literacy (a focus on content, communication analysis, information searching and evaluation) and information technology fluency (a focus on deep understanding of technology and graduated increasingly skilled use of it" (p.3).

George Lorenzo and Charles Dziuban (2006) in, *Ensuring the Net Generation is Net Savvy* raised the question of whether educators should be concerned with information literacy or the greater need for *Information Fluency* and *New Media Literacy* (or digital literacy with new media). However, the new media literacy, they explain, comes with a darker side that makes it more important than ever, even suggests urgency, that students become better informed:

Media products entertain us, inform us, and help us stay connected to our community and the world. But not all is positive. Public relations spin, hyper-commercialization, violence packaged as "entertainment," news bias, digital photo manipulation and other issues provide many reasons why both children and adults need media literacy education. (Lorenzo and Dziuban, 2006, p.4)

They explain that students are in greater need of information fluency as described by the 1999 National Research Council report, *Being Fluent with Information Technology*. FIT students as described below in the Definitions section, are persons who are "able to express themselves creatively, to reformulate knowledge, and to synthesize new information" (Lorenzo and Dziuban, 2006, p.4).

There is little disagreement today over what *Media Literacy* means (see Definitions below). The problem in identifying what we should be teaching is that the meaning of media literacy has evolved over the years as technology and media have changed. The Center for Media Literacy (2001) reports agreement on the original meaning of media literacy in the United States derived from a 1992 Aspen Media Literacy Leadership Institute, as, "the ability to access, analyze, evaluate and create media in a variety of forms" (Par. 2). The National Association of Media Literacy (2014) later adopted a small but significant change in the definition to be, "the ability to access, analyze, evaluate and COMMUNICATE INFORMATION in a variety of forms." This change signals a large shift in our classroom attention on what we teach students, even to the point of recognizing we may need to prepare students as much for information and communication fluency as for literacy. We determined that we needed to focus on literacies of media and technology use, cultural inclusion in media and technology use, and application of these literacies in an online environment (See *The Online Challenge* below). The skills and competencies identified in the Definitions section below were targeted in our investigations.

ITEC students are learning how to build their technology fluency so that they can use and tap into the power of technology to improve learning through instructional design. However, to be information fluent, an ITEC student needs first to be fully digitally literate in all the five dimensions that Hinrichas and Coombs (2014) identify in their framework. An ITEC student should be able to identify a learning need, determine a technology that can assist in meeting that need, and then design a learning experience that incorporates best practices and integrates the technology into meeting that learning need. An ITEC student must work to improve their own media literacy and information technology fluency, learn to pay attention to and teach media literacy to their learners (classroom or corporate), and design instruction

that uses media literacy as well as pays attention to what each learner brings to the learning context from their own background, history and experience. Digital Media Literacy is the foundation stone of skills and understandings that are needed before any learner, teacher, or instructor can expand into information culture or information literacies. The ITEC student's charge could be: First know the technologies and the skillsets they require. Then use them effectively to learn more.

The Case for Addressing Cultural Literacy in ITEC

ITEC courses have historically taught media use for designing learning, but without attention to the cultural implications in the instruction they design. The proliferation of technology has bred numerous learning systems and methods of information search and dissemination. This onrush has surpassed ITEC's ability to keep up with all the new technologies, making media literacy education increasingly critical for ITEC students. In order to bridge the knowledge gap between knowing how to use technologies and being fluent in their application, we realized we needed to address a cultural digital gap. One missing ingredient in our digital media literacy education efforts, as previously noted, has been preparing ITEC students to understand the cultural impacts on learners. Cultural response deeply affects how instruction is interpreted, students' understanding of the instruction, and their recognition of the importance of what they are learning (Michie, 2004; Smith & Betancourt, 2007; Agarwal-Rangnath, 2014; Sieck, 2013; Ross, 2005; Causey, et al., 2000).

We approached the inclusion of cultural awareness in the ITEC curricula from Michie's (2004) article "What is a Culture Broker" that views the teacher as a "culture broker." She suggests there are two conflicting views of teacher as culture broker coming through the literature: 1st) the role of teacher should be "filled by someone from the Other and that teachers are better off searching for the best person to fill the role"; or, 2nd) any teacher can, "develop a set of skills to become more proficient in their cross-cultural classroom, with the implication that upon attaining them they would have achieved the role of culture broker" (par. 5). A critical concept for us was recognizing her criticism (quoting McKinley, 2001):

[the] Assumption that western science teachers only need to learn how to deal with pedagogical aspects of cross-cultural differences, rather than dealing with the teachers' views of their students' abilities as learners or the validity of their knowledge. The second criticism is that if white teachers can learn to become culture brokers, then seemingly there may be no role for indigenous people in the educational enterprise. (Michie, 2004, par. 9, in What is a Culture Broker)

Our question became: How do we incorporate cultural brokering from a diverse faculty to a highly diverse student population across all ITEC courses?

The ITEC program has always been a diverse program, crossing ages (from 21-71 years of age), cultures, nationalities, ethnicities, and varying levels of knowledge and skills. Over the past decade, the international student population has steadily expanded, bringing in Mainland Chinese, Japanese, Southeast Asian, Middle Eastern, Arabic and Israeli students, and students from Russia, Southern Europe and the Baltic countries. The international student enters the program with different cultural understandings and values towards media use, media products, and how to teach. From our experience, we noted that they have a different knowledge of other technologies and less about American-based technologies. They

are often more skilled and aware of search and research methods than their U.S. counterparts. They also struggle the most with language comprehension in a program that is highly technical in digital tools and pedagogical theory. In addition to this range of diversity, there appears to be an increasing gap between those who enter with little to no technology skills and those who enter already using several advanced technologies. We also noted there appears to be no common digital literacy attributes across our population.

The same struggles and lack of literacy common ground is also reflected in domestic students. At SF State, the dominant cultures, in addition to the minority Caucasian students are Latino/a's, Asian American and African American. The result in our view has been that this expanding diversity has lost its common ground: students do not work as well in groups, do not engage smoothly in discussions, and have difficulty understanding what digital instruction means, much less how to create it. Informal feedback from students in recent semesters indicated students wanted to learn more new technologies (than they were currently getting) and how to apply them effectively to boost their teaching and training efforts – in the US and abroad.

The challenge for teaching cultural literacy in our courses we determined was the necessity to build common ground for communication.

The Online Challenge

SF State is being challenged to go fully online as much as possible. The California State University System (CSUS) has experimented with online learning initiatives for a few years and currently offers faculty grant incentives for proposing online courses that can be implemented across all campuses. Fueling the online drive are erratic enrollments in ITEC's F2F attendance. ITEC has been teaching online and in blended learning formats for many years, but up until the past 2-3 years, an ITEC course was most likely to have a majority of students in the classroom with a few students in the online synchronous system. For the past year or so, we have noticed that percentage has flipped.

For this study, we recognized the increase of global education issues, cross-cultural misunderstandings and an increase in online learning presented us with new challenges. Comprehension of material or solving a communication misunderstanding is difficult face-to-face but cannot be solved at all or as easily in an online environment. Separate the teaching, the learner, and the instructional mentor and the communication challenges triple. This year our ITEC efforts have included experimenting with how to raise and encourage the participation of all students in the program's blended-learning environment, and how to, given that environment, encourage students' deeper thinking about technology – its uses, drawbacks, applications, and powers to affect human behavior.

We were already familiar with methods for teaching media literacy online but needed to improve our attention to media literacy education. Teaching issues and impacts of cultural awareness in the online context proved to be a greater concern. Addressing culture would mean applying communication solutions. It would mean:

Greater attention in classes to the cultural issues;

Adapting the LMS (iLearn) interactions to accommodate cultural recognition of issues and possibly including a space for offline chatting;

Adding a new cultural dimension to the Instructional Design frameworks taught in the program.

CHAPTER FOCUS: A STUDY OF TWO CASE STORIES

Methodology

The research we began in fall 2014 investigated how effective the pedagogical applications of gamification, heutagogy and universal design for learning practices could be in engaging learners in course content and helping them to think more critically about what they were learning. We added to our course contents development of metacognition or metalearning skills and media literacy fluency. We also began at different levels in our courses to investigate development of a cultural literacy in students' work that could be translated to the increasingly online environment.

To conduct our research, we chose a participatory case study approach that would allow getting as close as possible to student thoughts and understandings on the two issues of concern: media literacy education and cultural literacy awareness. We chose the three applications of gamification, heutagogy, and UDL in the courses because we had already been working with these pedagogical techniques and found them to be effective at giving students the personal and 21st-Century skills to engage in teamwork, sensitive communications, and deep or critical thinking on content that traditional methods of instruction did not accomplish. We wanted students engaged; we wanted them to "get" metalearning techniques; we wanted them to be capable and willing to think deeper about issues raised. The pedagogical techniques were effective in helping students build self-efficacy around content learning, and a sense of autonomy and control over their individual learning. If these strategies worked, we assumed we could transform our online course environments to show a cultural inclusiveness in discussions and possibly an excitement about applying new technological achievements to the design of instruction for a deeper learning.

Our observations to-date have shown positive results in our methods and in what students have learned. The two case stories below outline our research.

ITEC 299 Case Story

Instructor: Dr. Kevin Kelly

How 2 Lrn w ur iPod - Lessons from a Course About Metacognition

About the Class and its Students

How 2 Lrn W Ur iPod is a large section, fully online course in the Instructional Technologies Department at San Francisco State University, serving 150 to 300 students per semester. The class satisfies General Education requirements related to lifelong learning and development. As a result, it attracts a diverse group of students. Over the last five years, students in the class have belonged to almost every major, including pre-service teachers in Elementary, Secondary, and Special Education. Similarly, students at every grade level—freshmen to super-seniors—and representing different age brackets—recent high school graduates to returning adult students, including retirees over 65—have enrolled and participated. Further, at San Francisco State, students speak over 100 languages other than English as their first language at home. This sometimes makes basic literacy as important as media and technology literacies. Last, but not least, students enter the class with varying levels of technological experience.

The highly interactive class uses constructivist methods to help students improve their learning, with or without technology. When the department chair asked Dr. Kelly to create the first-ever undergraduate course for the department, he conducted a needs assessment to determine what skills undergraduate students need most to succeed academically. He found that most higher education students have not learned how to learn. Further, even those students who are savvy about using different technologies for communication or entertainment have little idea about how to use those same technologies for learning purposes. Therefore, the class lessons and activities focus on multiple forms of literacy.

Developing Global Competencies through Multiple Literacies

First and foremost, students learn to evaluate digital information for reliability, validity, and bias, since they consume, use and cite resources and content created by a wide range of people. They are taught to check sources, check facts, ask questions of content providers and conduct peer evaluations. They are given different scenarios to evaluate so that they can see where information is biased or unreliable. Since the course is about learning how to learn with technology, the course content changes every semester. New technologies emerge, while some technologies disappear after they lose support or funding from their creators. Studies of the brain uncover new facts about how humans learn. With no regular textbook available, the instructor creates short mini-lectures and provides links to resources that he vets first. As the class follows Universal Design for Learning principles (described in more detail below), the instructor finds resources provided in media formats other than text. In order to encourage exploration, students are asked to support any arguments they make by finding information above and beyond the information and links that have been provided. However, before the students may begin any of this work, they must complete an activity on evaluating web-based information so they are prepared to question facts and ideas they find.

The course itself is built around developing technology literacy. Students learn how to use as many as thirty mobile, computer, and web-based technologies to facilitate learning improvement in any and all subject areas. They investigate personal learning with mobile devices, such as smart phones, tablets, and clickers; mobile apps and services; subscription services, such as microblogs (e.g., Twitter) and blogs; and individualized environments, such as intelligent tutors and electronic portfolios. They explore collaborative learning through social tools, such as discussion forums, wikis, and online phone services (e.g., Skype); and social environments, such as social networking sites (e.g., Facebook), massively multiplayer online games (MMOGs), social bookmarking sites (e.g., Diigo), and virtual worlds. They research interactive learning through tools and practices that generate different types of media, such as lecture capture, podcasts, screencasts, digital storytelling, digital comics, concept maps, virtual labs, and media sharing sites (e.g., Flickr).

Succeeding in the course is possible only if students develop media literacy. To perform preliminary research, students learn to access and analyze multiple forms of media, including text-based media (e.g., blog posts, infographics), audio-based media (e.g., podcasts), video-based media (e.g., vodcasts, screencasts) and more. After they have gotten a good understanding of a topic, they must demonstrate their knowledge by creating and using those same forms of media.

Applying Universal Design for Learning Principles

After just one, highly successful and over-enrolled semester, our department chair changed the class format from hybrid to fully online, with a primary goal of increasing enrollment. Recognizing it would be more difficult to accommodate more students' needs with fewer opportunities for direct interaction, the instructor turned to Universal Design for Learning (UDL). The UDL mantra is "teach every student." As a result, he redesigned the course based on the three core UDL principles—multiple means of representation, expression, and engagement.

To apply the principle of multiple means of representation, the instructor presented course content in different formats. In a simple example, mini-lectures were created for each course module. The instructor would make presentation slides, record the presentation as a screencast, save an audio-only version (i.e., mp3), and share his notes. Over time, he has worked on generating transcripts for each mini-lecture as well. This UDL strategy is also supported by education thought leaders like Michelle Pacansky-Brock, who found that students voluntarily opted to consume course content in different media formats. "40% chose to read the lecture, 15% listened to the lecture, 30% did both, and 15% toggled between reading and listening throughout the semester" (Pacansky-Brock, 2013, para. 12). Sharing content through different media formats supports the "teach every student" approach.

With respect to multiple means of engagement, the instructor offers several options to motivate students to persist and engage in class activities. We use a number of technologies—Twitter, social bookmarks through Delicious and Diigo, forums, wikis and more—to collaborate and build a learning community. Students apply what they learn by using media and technology strategies for academic, work-related, and personal aspects of their own lives. The instructor encourages them to help each other with issues they have as they use new technologies or familiar technologies in new ways.

When it comes to multiple means of expression, the instructor allows students to choose from different pathways to show what they know. They use multiple media formats and technologies to communicate with me, with each other, and with people outside the class. As a class, we discuss strategies for managing information about themselves and what they are learning. Students have regular opportunities for self-assessment, so they can monitor their own progress and take actions to correct mistakes. For peer review and instructor evaluation, we use rubrics that allow students to submit their work in different formats, such as essays, online presentations, screencasts, or videos.

Applying Gamification Strategies

As the class grew, the instructor sought to increase student engagement and motivation further. He turned the online class into an online learning game through several gamification strategies (Donohue, Kelly & Wilcox, 2015). Students begin by choosing their own learning paths—Learning Warrior, Learning Sage or Learning Guide—based on their personal goals—personal growth, new knowledge, or helping others.

Once they select a learning path, students complete "Quests" and Quest activities related to information, technology and media literacies for metacognition, or learning improvement. As they go through these Quests, they are asked to apply what they learn about learning with media and technology to other

classes they are taking concurrently. The Point Accrual grading system was adopted —i.e., there are twice as many possible points than they need to get an A+ grade. Everyone starts with zero points and earns points as they go as they would in a game. If students make mistakes, they can go earn more points elsewhere. Many students are thrown out of their comfort zone by this new grading scheme, since most other classes follow traditional grading schemes that subtract points from fixed totals.

The majority of Quests address using either metacognitive strategies or specific technologies to improve learning. Level 1 activities let learners show they can describe what the metacognitive strategy or technology is, what it does, and how it can be used for learning. Level 2 activities let learners show that they can use the strategy or technology for specific learning activities and evaluate or debate how effective that technology is for them. Level 3 activities let learners show that they can plan, execute, and reflect on personal growth activities that use a specific strategy or technology for learning in their lives and report what happens. Students may attempt as many activities as they want, in whatever order they like, to reach their goals and desired grade.

Other gamification strategies include levels, challenges, a leaderboard and gifting. Students earn badges to recognize achievement as they progress along their learning paths from Apprentice to Grand Master. They can also earn points by helping their peers.

Asking Students to Demonstrate Multiple Literacies

As we approach the last month of the semester, we begin the Student Perspective Quest. Through this Quest, students have an opportunity to share their thoughts about what they have learned with the rest of the world. First, the entire class compiles media and technology literacy strategies and solutions for every field of study represented collectively by all of the students. For example, a future high school math teacher shared a mathematical formula reference app for iPads and other tablets. Likewise, a future elementary school teacher shared a web-based, educational game that provides grammar and spelling practice for children in Kindergarten through eighth grade. Then the students break into small groups to answer questions about using a specific technology to learn. The teams submit these drafts for peer review, edit the drafts based on the feedback, and then submit final drafts for a class vote. Starting next semester, the projects that best represent the technologies from a student's perspective—i.e., as they pertain to supporting learning—will be posted publicly, as a way to share students' conclusions about technology literacy with teachers at all levels.

At the end of the semester, the students synthesize their individual experiences by presenting a collection of information in an electronic portfolio, or ePortfolio, to show that they have reached the seven learning outcomes for the class. For each learning outcome, students have the opportunity to submit a reflection that answers specific Synthesis Questions. Moreover, in accordance with UDL principles (Kelly, 2014), students may choose to submit each reflection response in any media format they choose—e.g., text with images, online presentations, audio, video, or multimedia—to demonstrate further mastery of the outcomes. If they choose formats that do not include a writing component, such as a screencast, then they must include a narration script.

ITEC 830 Case Story

Instructor: Dr. Patricia Donohue

First Lessons that Shaped an Understanding of the Power of Heutagogy

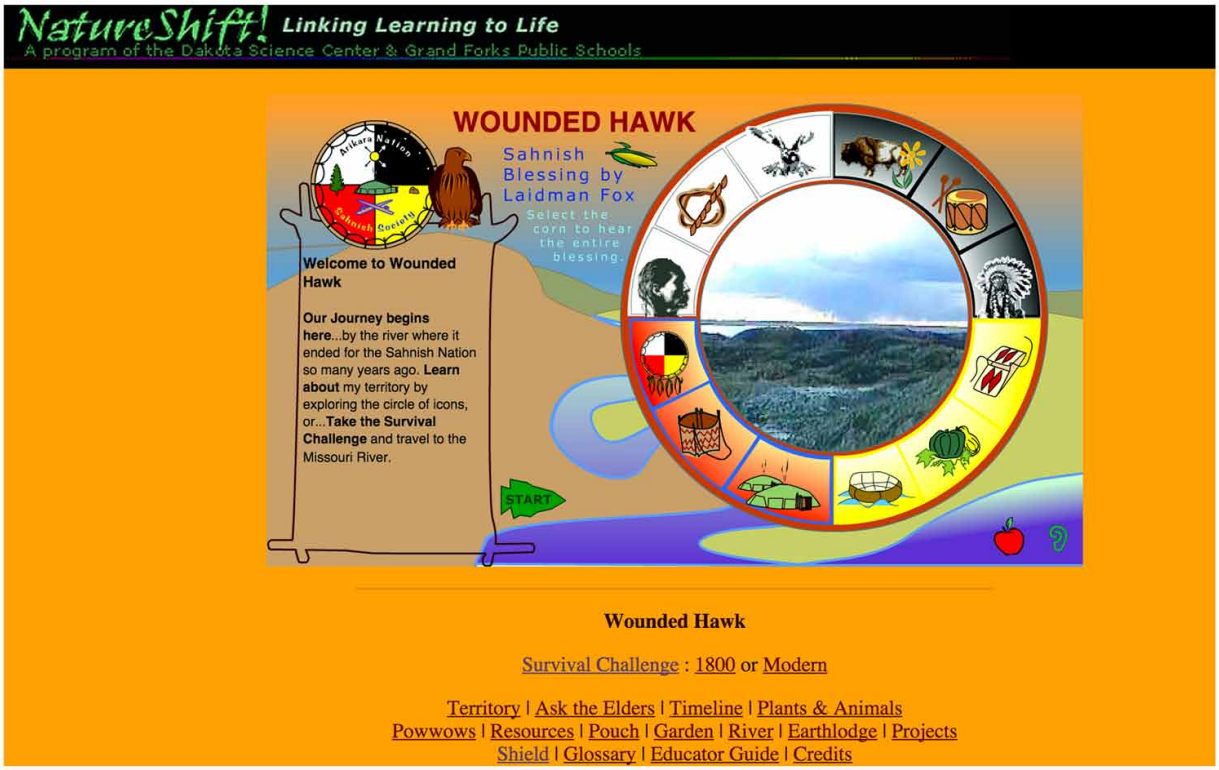
There was a missing component in the ITEC curricula that caught the attention of the instructor from the time she started teaching in the program in the fall of 2008. While ITEC curricula addressed multiple technologies and a broadly diverse student population, there was no recognition paid to the impacts of culture in teaching people how to use or how to teach others to use technology wisely in instruction. The instructor was convinced that ITEC needed to do more than talk equity and social justice. ITEC faculty needed to develop a transformational knowledge about how instructional technologies would be taught inclusively with deeper thinking about the implications for preparing students and future teachers for a globally interactive online world. Preparing ITEC students for a global digital literacy meant understanding the cultural and media literacies to be taught and to be used. The heutagogical approach relies on the principles of Personalized Learning as students must identify their own learning goals, pursue them, and deliver findings.

A Sahnish Lesson

This issue was brought to the instructor's attention from her time as Principle Investigator (PI) on a grant to prepare teachers in culturally responsive science and mathematics teaching using new technologies. The *NatureShift! Linking Learning to Life* project (www.natureshift.org) was a U.S. Department of Education TICG (Technology Innovation Challenge Grant) program with two goals; the first was taking new technologies for science and mathematics to rural schools across North Dakota and preparing teachers in their application using the *NatureShift* inquiry model. The second goal was to offer the same instruction through a website that teachers anywhere could use as a resource. The grant involved five major statewide partners in developing five science and history learning modules. One of the partners was the Sahnish Nation whose elders wanted to partner on the grant as a way to bring tribal knowledge to their young people and teach them a technology and media literacy not available at the time. They became the developers of the *Wounded Hawk* module because they would have the control to prepare and teach new learning in the right way. The image below (Figure 1) shows the website entry to *Wounded Hawk* module. Design of the entry page was one of the first of many lessons learned about culturally appropriate instruction. The designer who had prepared the home page used a Tic-tac-toe style of presentation where students and teachers could click on a square to access different activities in the module.

"Oh, No! That will never work!" said the elder who came to review the site. Sahnish children would not accept a square image as an entry point for learning. Learning was always associated with the Sun Wheel. The elders sat with the instructional designer and the web artist to create what is seen below. The entry is not only constructed as a sun wheel, but the learner who arrives seeking knowledge is blessed by an elder, and flown by Hawk into the wheel of knowledge to begin their teaching.

Figure 1. Entry screen to the Wounded Hawk module, designed for culturally relevant instruction in media literacies, new technologies, and STEM curricula; available at http://www.natureshift.org/Whawk/index.html



A Lesson of Mixed Ethnicities and Missed Communication

The second influence arose from several experiences with ITEC course teams who were assigned projects with clients. Students on a couple teams were of mixed ethnicities with clients from different cultural backgrounds. The challenge of working for a real client on a project with a time deadline always adds pressure for the students, yet in four years of doing client-based courses, the end products always were exceptional. It came as a surprise to discover these two teams had almost insurmountable problems related to issues of cultural misunderstandings that – it should be added – they had not been prepared in the course to address. One team worked successfully with their client but experienced severe communication problems on the team that required separation of team members from each other. The second team had a member who disagreed over the cultural appropriateness of instructional materials for the client and proceeded to argue, in-class and online, with the team member who had been the designer. The instructor and team members negotiated through a resolution without involving the client but it was disastrous for the members of the team and could have been worse if the client had been involved.

A Literacy Gap in ITEC Foundations

Prior to the fall of 2014, the instructor noticed that in spite of increased technical skills, students continued to demonstrate a lack of understanding about: a) Information security, intellectual property, and copyright issues, b) effective online and reference search techniques, and c) comprehension of the mediated nature of technologies, especially when it came to learning – an understanding at the heart of the ITEC program. The ITEC 800, *Theoretical Foundations of Instructional Technologies*, course covered the three classic theories of Behaviorism, Cognitivism and Constructivism. It also prepared students in new learning theories such as Connectivism, social learning and experiential learning theories and instructional concepts such as situated and distributed cognition – all with the idea of designing instruction effectively using those theories with appropriate technologies to impact learning. Out of the 18 members of the course in Fall 2014, seven were international students, four were returning Caucasian adults in professional careers, one domestic student was of Asian heritage, two were Latinos, one was a Latina undergraduate student and the remainder were of unknown ethnicity. Nevertheless, all 18 students demonstrated gaps in their knowledge of digital media literacies and the technologies they were required to use in the course. During the course, the instructor added a unit on media literacy and digital citizenship, and included instruction on the cultural implications for learning. Badrul Khan's (2001) *Web-Based Training* chapter on his *8 Dimensions of eLearning Framework* was added to the course to supplement the standard text and numerous online resources. This addition introduced new ITEC students to an integrated set of guidelines for online instruction that considered dimensions such as ethics and culture when designing online learning, not previously covered in other 800 courses. The capstone project was also changed to a personal project that was meaningful to each student. Students were given practice in blending instructional theory and technology in three smaller design projects where they were asked to focus on Behaviorist methods for one, Cognitivist methods for another, and Constructivist methods for a third. The practice designs prepared students to think critically about how to explain the integration of theory and technology into a learning activity.

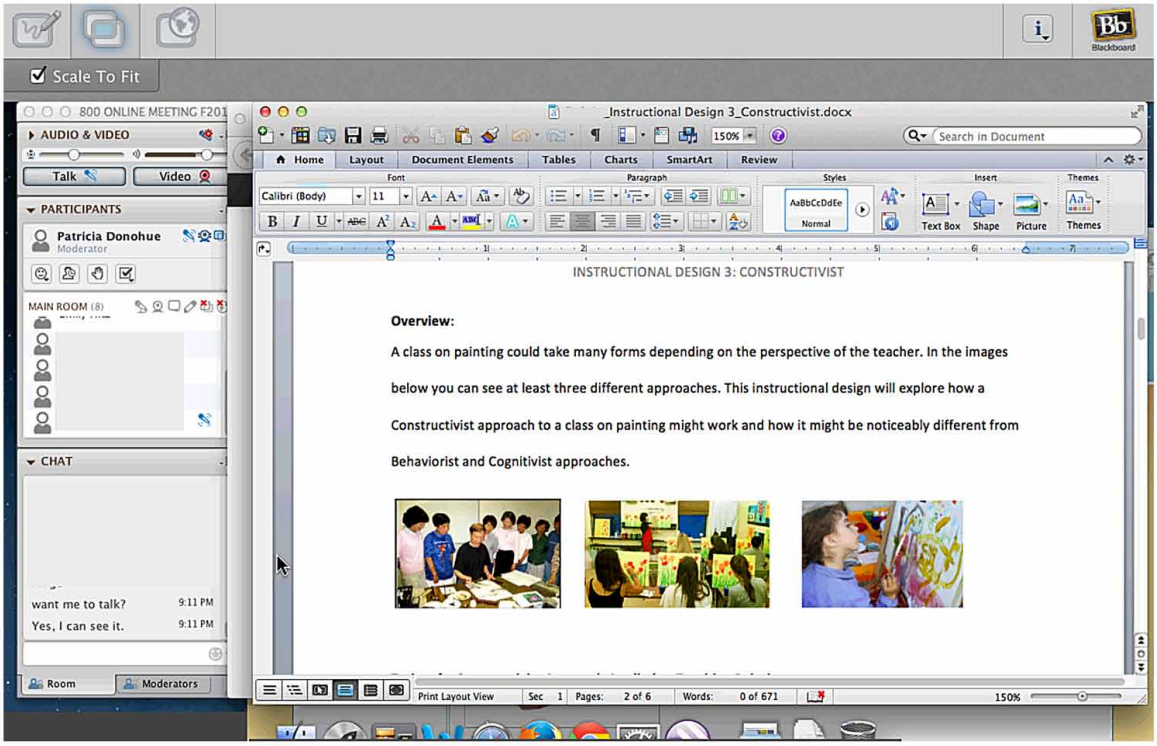
What Students Learned in ITEC 800

The instructor held a focus group towards the end of the 800 course with students before they had completed and presented their capstone projects. Students had presented their Constructivist based project designs before the focus group. The students revealed in the focus group the degree to which they had achieved an understanding of the uses of technology in learning. They also alluded to what they had "absorbed" about cultural relevance in their learning designs. Some comments are given below (names are changed for privacy).

Steve's Design: The first design was from Steve who is an elementary teacher and an online attendee. He shared his design over Blackboard Collaborate (Figure 2) with the class members in-person and online. He explained his Constructivist lesson and the principles he teaches:

S | I start from students' own suppositions about how to do painting. In the second picture, Teachers interact with students by seeking questions and respecting the students' "point of view." In the third picture, motivation is shaped by targeting students' interests and the relevance of the lesson to their personal lives.

Figure 2. Screen capture of Steve's online presentation of his Constructivist lesson



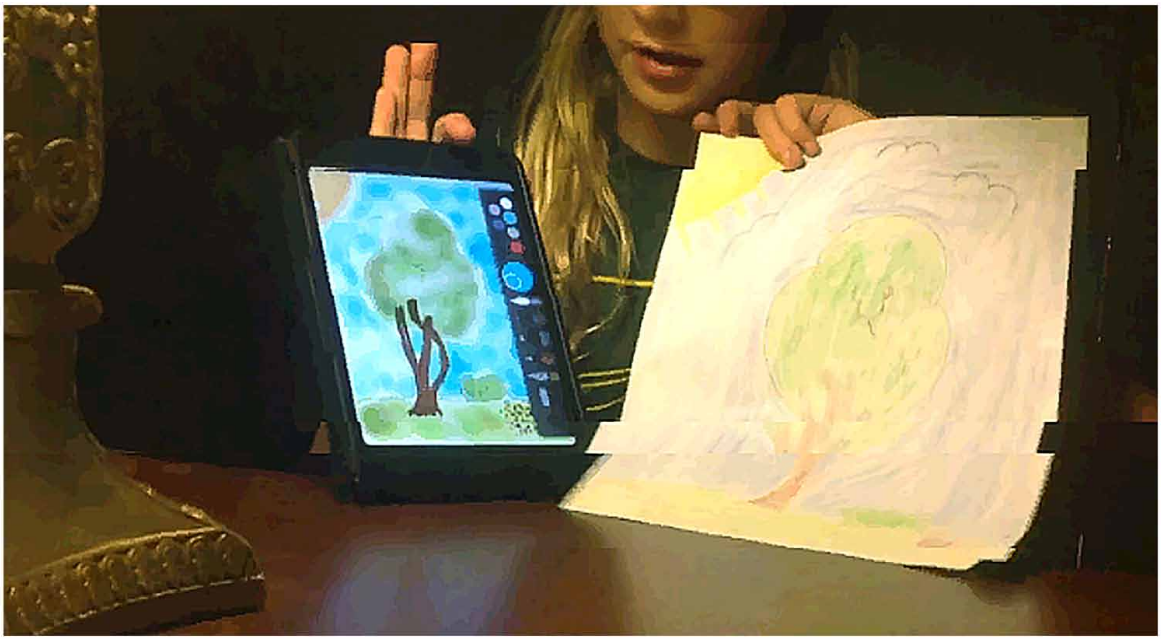
Steve's explanation shows a deep understanding of cultural and individualistic implications for his instructional design, a level of awareness not noted in prior 800 courses.

Melissa's Design: A second design was from Melissa who is a returning adult making a career change. She was neither familiar with many technologies nor with teaching when she entered the program. She had been very unsure of her Constructivist lesson but ended up doing a video of what her daughter learned through discovery learning how to transfer a skill at painting to the iPad. Melissa used two new technology tools (Figure 3), Prezi and video, to present her lesson to class members in-person and online:

M | I wanted to see if showing her the device and the application but letting her explore the application on her own would engage her and help her learn. The video shows my daughter explaining what she learned on her own: "So, you have to figure out how to change what you drew into something different using the tools. So I used crayons and changed to paintbrush and marker tools … it was hard but not difficult. I had to change the, the colors and on the application the colors are not right, so you have to figure out what to do.

Melissa demonstrated a new self-efficacy around the use of technologies and a sophisticated knowledge about how learning theories integrate with technology use to improve learning. As an adult learner, Melissa did not want to be told how to learn. She wanted to know what to do and then took the assignment to a new level of self-knowledge with just some encouragement.

Figure 3. Screenshot of Melissa's video showing her daughter's painting and its translation into the iPad application, Paint



What the ITEC 800 Foundations Class Revealed

A focus group question, "what are the things you think a young person needs to be digitally literate?" produced some interesting responses:

1. Knowledge of digital citizenship.
2. How to build a website.
3. Young children need motor skills first, like hand-eye coordination.
4. Understanding how the different technologies work together.
5. Analyzing what has gone wrong when technology breaks. Barbara explained:
   | I found in general, a lot of people know how to do things digitally, but have no idea how things happen. So, when it breaks down, they go "what do I do now?" It's broken!" And I think in addition to that, it's how do we ask the question? Digital literacy is about, "I can't figure out how to do something, but how do I ask the question to get help?" Online it is different how I would ask for help than in the traditional setting. Ask an expert; well, what if I can't find an expert; do I just email the professor immediately? What are the alternative steps to deal with my understanding?
6. Organizing your digital world. Franklin said:
   | for me it's like from when I was young, just trying to organize … how to set up files and folders … the software is hard enough, and there's navigating to what you want. I mean, I've seen adults' desktops just trying to wade through files and folders … (laughter and jokes) … I mean kids need to know that, it gives them an idea how to set up a work flow. It's a big skill later.

Barbara adds:

| so these are things that students really need to learn. They don't actually understand the structure. So, "it's on my desktop." But if you look through your desktop this way and you can't find it. It's like not understanding how it really works. I mean I've tried to do the Linux thing and it's "can you just TELL me where the folder IS?' (laughter).

ITEC 830: Design for Learning with Emerging Technologies

ITEC 830 is one of a three-course set that may be chosen to meet one of the ITEC program requirements. Because of a scheduling snafu, there were only eight students enrolled in the Fall of 2014. All eight students were well-established students in the program. It is noteworthy that of the eight students, three males were Caucasian, two females were Latina, two females were Asian (one American, one mainland Chinese) and one male was African American. The course requires students to investigate new technologies on their own, to create a sample instruction and present the technology to their peers with an explanation on how the technology impacts learning, and defending why it is an emerging technology. Given the small number of students in the course, the instructor decided to run the course along the lines of a doctoral seminar. Each week consisted of reviews or demonstrations of different types of technologies and how they could enhance the learning process, followed by deep discussions on what surfaced during the class or on topics the instructor brought in for the evening. The instructor told the class in the beginning with reminders during the weeks that followed that this course section was being run quite differently than normal. The instructor was running the course as a co-teaching experiment, that she was there to learn as well as instruct and students were there to instruct as well as learn. This nearly complete heutagogical approach was a leap of faith to see what students might learn. In addition to a personal project and several "demos," a third requirement was to produce a journal – preferably a journal using a media or technology. Throughout the course, the instructor kept a journal as did the students, and the instructor presented mini-demos as did the students.

What the ITEC 830 Class Revealed

Three quarters of the way through the course, the instructor used an evening to hold a focus group with the students on what everyone thought about how the course had worked. The instructor began by telling the students a large lesson she had learned over the course of the semester about failing to give timely feedback to students. That generated a large response including use a rubric on the demos so you can get feedback right away, and have students get feedback from peers. The discussion then led to a question about what worked in the class. Respondents agreed:

1. Bring in experts to show new technologies.
2. Have teaching moments where everyone can learn some new technology (like the Captivate class).
3. Specific comments suggested:

   Nancy | one of the things that is good about doing the mini demos as you go is that you get to learn some new things really well, and you get to learn about other people's technologies that you never knew or would not have learned yourself. Like M—'s Google Docs, I never knew lots of those tips that she showed.

Nancy | So can I go back to the feedback thing? You mentioned needing to get adults feedback sooner; but you kind of respond to us as a whole, and every class you try to say something positive [general agreement]. When you're trying to be creative and not succeeding, that is more important to us, to encourage. [laughter and agreement].

Daniel | Yeah. One of the things that really struck me was, more than emerging technologies, one of the things I'm learning is working and learning together. Kids minds are ever changing and one of the things I keep stumbling across is that the importance is always focused on the people, on learning. So you have this emerging technology and all this stuff but when you dig through the learning features and the way it works, and all, it comes down to what can we do to make people feel empowered to take this on itself and learn **on their own** trusting the facilitators. The reading comes back to this. That's one of the things I didn't realize I was going to get from this course that we are really empowering people to take responsibility to go with their own natural instincts for learning.

Ann | One of the things I'm relating to is last week's conversation …[joking and laughter because there was no class, but three people showed up and had a great discussion]. It connects with the Veletsianos' point about distance learning because this is something I've had to do a lot of reflection on. I'm taking another course and it is entirely online; I hate it.

Daniel | okay, I have to take agreement. I just hate online only learning.

Ann | …and I hate to say that because I love to learn. But, I don't love to learn in that format. I'm not motivated. I really read a lot of material, the Vygotsky stuff and Veletsianos. When he was writing about this distance learning thing it really hit me, "wow, this really doesn't work for me… that I'm not a digital native. So I go through all his reasons and wonder why is this not working for me, and there were several things But one of things I go back to our discussion last week when M— said it really does work for her.

A | So we were having this compare and contrast moment. So it was really revealing for me. And I said, "Really?" [laughter]. So it's something in my reflection journal.

The seriousness and depth of thinking in the fall 2014 830 class and the extensive discussions and sharing, were beyond what had occurred in the course in prior semesters. The result is that the approach is being used in the spring 2015 course. Many of the students' recommendations have been implemented. To date, students are responding very favorably to the course structure and individualized challenges.

Solutions and Recommendations

ITEC 299 Lessons learned

Support Students in Producing Media Formats That are New to Them

Students are well-versed in consuming different types of media—sometimes simultaneously. Anecdotes about college students portray them on both laptops and mobile devices while watching television. In her research, Pacansky-Brock (2013, para. 12) found that "30% of [her] students chose to listen and read [lectures] at the same time." On the other hand, students do not have as much experience producing dif-

ferent types of media. It is important to support students in this process, by providing links to tutorials and easy-to-use tools that you have reviewed or used yourself. The tutorials should cover all parts of the process—picking a technology, creating drafts, editing, and saving in different formats. Also, model creating your own resources in different media types if you want students to do the same.

Share the Significance of Multiple Literacies with the Students

We often hear the phrase, "Use the right tool for the job." The same holds true for media and technology. Encourage students to select the best media format for the knowledge or skills they are trying to demonstrate, even if creating something like a screencast or audio file will require a little more effort. This may include giving students guidelines for choosing what media format to produce. For example, they should consider making concept maps to depict relationships among course concepts. Provide real-world examples of how information is conveyed in different fields, such as visualization strategies for large amounts of data.

ITEC 830 Lessons Learned

The ITEC 830 course was designed to use heutagogical principles to encourage student autonomy and increased efficacy with technology tools new to the students. This proved to be positive for the quality of the student work received, as seen in the above case story, and in the quality of thoughtfulness students provided in their feedback. The same was seen to a lesser degree in the ITEC 800 interactions. Towards the end of the 830 course, a focus group discussion with class members revealed many personal stories about what they learned. Discussion in ITEC 800 revealed similar stories. Students were reminded during both discussion sessions that the courses were being recorded as all ITEC courses are. While that always makes students somewhat alert to what they are saying in the classroom, it is so commonplace after a few weeks that it does not appear to have had much impact on students' responses; other than students are reluctant to say anything overtly negative in open class to the instructor. Given that non-negative bias, student comments showed a depth of thinking and understanding about the topics raised, pulling from their own experiences and their learning in the courses to seriously contribute to the discussions. This proved to the instructor the benefits of a heutagogical approach in bringing students closer to their own learning, and the benefits of a personalized, culturally-sensitive approach in giving all students encouragement to voice their opinions about their skills with technology.

Media Literacy Lessons

Students were introduced in both the 800 and 830 courses to the Digital Citizenship tutorial from Commonsense Media and afterwards they were asked to take the Digital Citizenship test, self-correct themselves and post a reflection on what they learned and thought was important. Students in both courses noted with surprise how much they did not know about digital literacy. They also had opportunity to take a Copyright quiz from Gavilan Library that is given to pre-service teachers and surprised themselves about their confusion in this area.

Several students in the 800 course are elementary teachers in public schools. They had much to say about the vagaries of teaching media literacy in a complex information world. They recognized that what

they needed to learn was the same as what their students needed to learn. Other students were thoughtful and highly specific about the uses of technologies, recognizing after reflection that there was much they did not know and that as educators they needed to be more fluent for preparing their students or their company employees to function in the global digital world.

Autonomy Lessons

Students in the 830 course confirmed the helpful nature of their autonomy in the course. They recognized that without it, they would not have been able to explore as well the effectiveness of the technologies they researched. They made a point to recommend the positive nature of the instructor's feedback during class sessions as just the right touch to encourage them to be creative and expose their work to criticism. Students in the 800 course did not have past history in ITEC for comparison, but the quality of their practice projects, compared to prior courses, showed more courage and creativity in their technology explorations and in their reflectiveness on their own work.

Plus and Minus from ITEC 860

A third course taught during fall 2014 was ITEC 860, *Distance Education*. That course was changed from an internal class design project to a distance learning experience for clients. Students were given a great deal of autonomy in how they approached their projects with clients and that provided two lessons. The first was that the teams needed more instruction in how to function and communicate on a team and they also needed to practice the skills. A few instances of miscommunications on the teams set them back briefly in their work. The second lesson learned from the course was that students highly valued being trusted to manage their own sections of the course LMS on an equal footing with the instructor. They noted that they were able to learn from the modeling of the LMS structure and from being able to practice how to set up their own instruction.

FUTURE RESEARCH DIRECTIONS

ITEC Program Future Research

The information from the fall 2014 studies will provide a baseline to conduct empirical studies in future ITEC courses on students' understanding of media and cultural literacies and how to teach them. This will provide richer data from which to formulate guidelines and best practices for student preparation in digital media literacies in the Instructional Technologies program.

Additional research possibilities for the ITEC program lie in online education. Because the program has been a leader on campus in online delivery methods and the university is currently seeking ways to grow its online offerings, the ITEC program should conduct a full empirical study of its students' use and experiences in online course attendance. A review of best practices for incorporating media literacy and cultural literacy into online instruction in ITEC courses would supplement the study proposed above. This knowledge would be beneficial for the university as a whole and to the Graduate College of Education.

ITEC 299

Future goals include integrating a cultural literacy component, wherein the students explore how media and technology are used for learning in other parts of the world. Dr. Kelly has plans to introduce elements of culturally responsive pedagogy to accommodate students who may require additional types of support to complete and achieve success in a fully online course. As a class he says he will seek to connect with groups of students in other countries and share course findings about using media and technology for learning.

Additionally, he will provide support mechanisms for students who may be at risk academically. These strategies will include virtual office hours, and a more thorough effort to provide alternate media formats for primary course content. Dr. Kelly has taught some of the same media and technology literacy strategies as a series of workshops for middle and high school students, as well as related seminars for K-12 parents and teachers. He intends to develop more structured curriculum for K-12 students, professional development for K-12 teachers, and valuable information for K-12 parents.

ITEC 830

A research possibility that emerged from the ITEC 830 case study has been the implementation of a new course with a proposal for a Studio Learning Laboratory. The course and its physical laboratory will give students complete autonomy in designing and conducting self-directed project-based learning. Students have expressed a desire to have a 'maker space' for digital tools and technologies. The course will give students the opportunity to design their own digital learning concept and take from idea to design to testable prototype. It will also provide a place to test further findings on the heutagogical approach and to see what projects students conceive to come out of their ITEC program learning.

CONCLUSION

We introduced the focus of the chapter as improving the teaching of critical digital media literacies in the ITEC program by incorporating personalized learning and culturally diverse learning approaches. We studied this in two different ITEC courses: an undergraduate course that teaches media literacies and exposure to a volume of media tools and technologies, and a graduate course teaching instructional design using a volume of emerging technologies. The pedagogical methods of Gamification, Heutagogy, and Universal Design for Learning were evaluated across the two courses for their impact on improved student retention of content by using personalized learning and culturally sensitive approaches.

This research is significant because the ITEC program prepares pre-service teachers and corporate trainers in design of instruction using technologies, especially new emerging digital technologies. In a world that has seen a paradigm shift in technologies for education and the workplace, teachers and instructional designers must rapidly learn the digital media literacies associated with these new venues of learning. K-12 students also need to learn 21st-Century skills and global competencies to function in this evolved digital world. The research has shown that personalized learning and cultural sensitivity is critical in conjunction with new technologies to engage students in individual learning so that they gain metalearning skills to be effective digital media and technology evaluators. The researchers set three objectives for themselves; to:

1. Instill in students an awareness of personalized learning and cultural literacy when using, and designing instruction with, technologies.
2. Evaluate the effectiveness of gamification, heutagogy, and UDL to improve student engagement, content understanding and knowledge retention.
3. Evaluate the application of digital media literacy in online and blended-learning environments.

The Background introduced the 20-year history of the ITEC program and its leadership in blended learning approaches on the campus. It also identified that students were not receiving thorough preparation in digital literacy or in how to teach it. This is one of the prime functions of the ITEC program. The need to address cultural literacy and diversity issues in ITEC curricula was identified as contributing to the lack of digital literacy preparation. Thirdly, the online challenge was introduced revealing issues for ITEC courses in cross-cultural misunderstandings and communications impinging on students' ability to learn.

The chapter discussed what was done and learned in the gamification of the undergraduate ITEC 299 course. Application of gamification and Universal Design for Learning approaches were able to personalize the large class experience for students, exposing them to global competencies and multiple literacies that they need in life.

The ITEC 830 course described the power of personalization through application of a heutagogical approach. Earlier lessons about the inappropriateness of cultural content and communication difficulties from mixed ethnicities in ITEC courses were shown to be overcome through raising student awareness of cultural implications and giving them freedom to self-learn. The result as shown in the ITEC 830 course was greater sensitivity to learner perspectives and recognition of the deeper complexities of digital literacies.

We found that gamification mechanics could improve students' experiences in an online course to keep their interest and involvement. We also found that gamification does not appeal to all students and an effective method for structuring an online course for success is to offer multiple methods for completing the course. We did find from both case stories that giving students greater self-autonomy, when support structures are in place, produces higher quality work, more critical thinking and reflection and may help keep students engaged in a course, especially for retention in an online course.

ITEC 830 students made several astounding discoveries (to them) about the need to keep instruction focused on student needs, that greater learning occurs when students are free to explore their own questions, and personalized learning requires faster and more frequent feedback for students to benefit from their freedoms. Students also considered the pros and cons of online learning and concluded that it works for some but not everyone. One of the biggest gaps in online learning is the lack of spontaneity and creativity when humans are together in the same space that cannot happen in online courses. In true creative fashion, students thought there might be ways to develop that creative exchange online that have yet to be found.

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KEY TERMS AND DEFINITIONS

Cultural Literacy and Competence: A congruent set of behaviors, attitudes, and policies that enable a person or group to work effectively in cross-cultural situations; the process by which individuals and systems respond respectfully and effectively to people of all cultures, languages, classes, races, ethnic backgrounds, religions, and other diversity factors in a manner that recognizes, affirms, and values the worth of individuals, families, and communities and protects and preserves the dignity of each (ACRL, 2012, par. 6).

Heutagogy: Self-directed learning (Hase and Kenyon, 2001). The authors describe heutagogy as lying on the extreme of a continuum of learner-centered control over learning from pedagogy to andragogy to heutagogy.

Information Fluency: Persons who are Fluent in Information Technology (FIT) are "… able to express themselves creatively, to reformulate knowledge, and to synthesize new information" (Lorenzo and Dziuban, 2007, p.4).

Information Literacy: The set of skills needed to find, retrieve, analyze, and use information (ACRL, 2012).

Media Literacy: A 21st century approach to education. It provides a framework to access, analyze, evaluate, create and participate with messages in a variety of forms — from print to video to the Internet. Media literacy builds an understanding of the role of media in society as well as essential skills of inquiry and self-expression necessary for citizens of a democracy.

Personalized Learning: Bray and McClaskey (2015) define personalized learning as: *an ecosystem that supports achievement by every learner.*

Personalized Learning – Industry: Educational Technology Research & Development special journal issue on *Personalized Learning* (ETR&D, 2012) describes personalized learning as: *behaviour [sic] tracking of learners and learner analytics … [to align] learning processes with personal cognitive attributes of learners*. While it is true that digital systems in the form of intelligent tutors or intelligent learning systems can individualize the learning process, we would argue that they do not *personalize* the learning experience.

Universal Design for Learning (UDL): *A process of making course concepts accessible and skills attainable regardless of learning style, physical or sensory abilities.* The three Key Principles of UDL in course design *address multiple methods of: Representation, Engagement, and Expression*. In other words, we believe the UDL principles encourage instructors to provide multiple pathways for students to review content, stay engaged, and show what they know.

ENDNOTES

[1] Instructional Design is a broad field that masters the science (and art) of designing instruction for delivery of a learning outcome. The field includes several frameworks and models for developing instruction. Today, design nearly always includes the integration of technologies for addressing learning needs. The ITEC program focuses on learning, using, and preparing students to use what are called "instructional technologies." For ITEC, the term instructional technologies refers to any media or technology used instructionally.

[2] HyFlex is a term that describes a student-centered method of delivering instruction. It identifies a *Hybrid* method of blended learning including online and face-to-face (F2F) instruction, and offers students the *Flexibility* to choose which method they wish to use. The ITEC form of HyFlex allows students to select each week any one of three methods to attend class: (1) In person, (2) Online synchronously through webconferencing, or (3) Online asynchronously through the learning management system by completing additional work.

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Chapter 13
Cognitive Approach to Improve Media Literacy: Mind Puzzles

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ABSTRACT

This chapter starts with an exploration of the media literacy literature and its place in the developing 21st century. The literature suggests that media literacy should be considered as one of the capstones for the skills needed for the 21st century citizens. In terms of developing media literacy skills, scholars look at the concept from either cognitive or social perspective, and the review reveals that both of them are closely related to each other. Moreover, the study asserts that cognitive and metacognitive skills play a significant role in developing the media literacy and the skills for 21st century. Then, the chapter presents a city-wide activity done in Bayburt, Turkey. It is our assumption that the case presented here may be an inspiring example for whom may want to explore different approaches.

If you're not careful, the newspapers will have you hating the people who are being oppressed, and loving the people who are doing the oppressing. - Malcolm X

INTRODUCTION

By adopting the quote of Malcolm X to the internet media, particularly social media, one could easily argue that, "If you're not careful enough, the digital media will have you hating the people who are being oppressed, and loving the people who are doing the oppressing." That is; the information presented in social media might lead you in an opposite direction. Anyone spending some time in social media can easily confront with the same posting with different titles or the same picture but different captions. Hu-

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man beings are exposed to a continuous and increasing bombarding by digital media, printed media as well, in our daily life. This is a bombarding of information coming through a number of media channels, such as TV stations, radio channels, newspapers, internet websites, YouTube videos, email lists, social media channels, etc. It is rather challenging to distinguish the truth and hearsay under the bombarding of such a heavy traffic of information. Indeed, the traffic is getting worse and more aggressive with the support of the innovation in technology.

Spencer (2012) talks about 684,478 pieces of content shared on Facebook, in every minute. This information may help us to anticipate the amount of information flow over social media. People, who are surfing on the internet, always confront with lots of information and use or share all these information without actually assessing them. How many of us pause a second before sharing any information being shared by a friend? Very rarely! People usually assume that the information, seen on the internet –for example, their friend's wall on Facebook –is supposed to be true. Is it really so? What if, that friend has already made the same assumption and shared the information seen on another friend's wall? Would the content be shared on your wall be harmful to someone else? How frequently do we assess this case?

It has been speculated that the youth are raised in the digital age have been negatively affected by mass exposure of digital media and that they should be protected from harmful content. However, there are many young people playing with digital content and alter it or create new ones. Even if they do not become part of re-creating the content, they help them get spread out through their personal contacts. Therefore, how could the content be spread, if, not created, by youth be harmful to themselves? Well, the discussion in the previous paragraph could be one answer addressing this issue. Still, we need to find a way to overcome this challenge. What should we do, protect or engage? What should be the best strategy?

- To reject the challenge, protect our children from digital media, or
- To embrace it, help them learn living with digital media?

The authors of this chapter definitely prefer the latter and suggest engaging the youth to learn how to cope with emerging and evolving conditions. However, this is exactly where the problem emerges for many people because this new world is under a continuous attack of mass media, both digital and printed –although our primary concern is digital media and an evolving world with the support of technology. No one is really sure what strategy should be followed because we still try to understand the structure and the consequences of the change. This is true to any of us, including even technologically savvy people; it is rather challenging to predict what the future will look like. Moreover, this challenge is not a new challenge; it has been a challenge for the decades since the internet was introduced.

There is another concern that media shapes our lives and takes the control of our actions. Is it really so? If so, how could this happen? In order to reply this *how* question, one should also answer *wh*o creates media and *what* makes media so powerful? Then, we can put further questions on the table: In order to help 21st century citizens shape their *own lives*, what actions should we take to provide educational opportunities? One effort to achieve this goal would be to provide a better media literacy education (Flew & Smith, 2011; Kamerer, 2013; Potters, 2008). Many agree that providing better media literacy education is a primary goal.

However, it is not an easy task to provide adequate and efficient education for new generations. Many educators trying to educate today's youth had been raised in a world with comparatively limited technology. Therefore, they are still at the stage of an attempt to understand the change, which has been triggered by technology. Despite the challenge we experience, it is our responsibility to educate today's

youth for the future world, which is a mystery to many of us. Still, we should find a way to educate the youth for the future. This mission is conceived as to make people ready for the 21st century, and, as a result, some private and governmental institutes put their effort forward to explore the challenge and to develop solutions.

For example, Partnership for 21st Century Skills (P21) is a "unique public-private organization formed in 2002" (P21a, 2014, p. 2) and explores the skills needed for the 21st century by collaborating with employers, educators, parents, policymakers and community leaders to build a consensus on what these skills would be and to suggest a framework to be incorporated in educational settings. They issued a call to policy makers and educators, identifying three dimensions of citizenship as civic, global, and digital and recommended three actions:

- Developing "the knowledge and skills that empower the youth to be informed, engaged, and active citizens,"
- Reflecting "global forces, challenges, and opportunities" and,
- Full understanding of "the prevalence of the digital space." (P21b, 2014, p. 6).

Their position, as the authors of this chapter, seems to improve youth's awareness on new challenges and develop youth's cognitive skills to become better citizens.

This chapter is concerned to understand the relationship between new media practices in our daily life and evolution in young people's expectations. In a broader sense, the concern is to understand the interwoven and evolved relationship between media practices and the ways people cope with and to contribute to the formation of 21st century citizens by sharing our experience with citywide Mind Puzzles activity. In order to predict the future, we believe that, one should better understand what has been done in the past and today, uncover the relationships among practices, and make connections between results and practices. We, the authors of this chapter, position media literacy holistic in scope, following the decomposition of the dimensions of media literacy we direct our attention to a particular strand. How do we contribute to the improvement of youth cognitive abilities, which might lead them to be more responsible citizens of 21st century? Could our experience with Mind Puzzles be a contributing factor?

Despite the fact, that aforementioned topics and questions are too broad to cover in one chapter only, our attempt will stay at the level of reviewing fundamental relationships and raising more questions about the future direction. The intention is to look at the challenges and opportunities through cognitive perspective only. We are aware of the existence of unpredictable challenges and opportunities one may confront in the future, and therefore, we believe that the improvement in their cognitive abilities may help 21st century citizens find their *own way* of coping with unexpected scenarios. That's why we position ourselves, for the sake of this chapter's context, to inquiry cognitive effects of current experiences and seek opportunities to improve awareness and cognitive abilities of youth to help them find their own solutions. The opportunities to increase the awareness on what responsible citizen means and on how the popular elements of emerging technology can stand to empower the 21st century citizen may provide them a mean to develop their own perspectives.

The following sections review recent innovations and changes in ICT, the practices of communication, and the amount of data production and reproduction. In order to pause for a moment and reflect on what we have in our hands, the changes will be evaluated with the guidance of the McLuhan's tetrad, more specifically tetrad of media effects (McLuhan & McLuhan, 1988). The following questions are a version of McLuhan's Tetrad to the Media Literacy:

- What capabilities do digital media extend? What potentials do social media and mobile communication intensify and accelerate?
- What medium or habits of people do digital media obsolesce? What habits of people were faded into the ground, become less granted?
- What might be reversed when the use of digital media and its partners reach to its limit?
- What do digital media retrieve that had been obsolesced earlier?

These questions will guide our exploration of capabilities and current effects of digital media and challenges we have been confronted as well as the role of media literacy education to overcome these challenges. The exploration will continue looking at a recent experience in Bayburt, a small city located in the northeast of Turkey, with an intention to understand the possibility of remediation of challenges.

BACKGROUND

The last decades have been witness to enormous changes, particularly in technology. Technological innovations –particularly on the Internet and Communication Technologies (ICT) –have our daily lives evolved and transformed. This transformation has been appreciated by many governmental and non-governmental institutions and encouraged them to take actions. For example, the International Telecommunication Union continuously makes an effort to understand and describe this evolution: "The availability of information and communication technology (ICT) infrastructure and the uptake in its use – continue to grow. The internet, in particular, is transforming society, with a growing amount of information and a large number of tools available." (ITU, 2014, p.1)

While the society being transformed, new terminologies have been introduced: Net Generation, X Generation, and Y Generation! Many people, including the authors of this chapter, believe that daily practices, beliefs, and even cognitive abilities of this new generation have been evolved through a continuous *interaction* with the ICT. The word interaction is emphasized on purpose because both ICT and people affect each other through this transformation process. For example, on the one hand, people become more visual and read manuals less than it has been ever before because ICT tools provide visual manuals –tutorials – and menus. On the other hand, ICT tools offer more visual tools because people demand visually equipped means. Thus, a continuous interaction keeps the cycle works.

However, we are still unsure of the dimensions and the degree of this evolution. Scholars from education, psychology, sociology, economics, and computer science have been involved in many research projects to explore the evolution and understand new society in order to better serve for their future. Attempts to make websites and blogs more visual, as mentioned above, emerged from understanding of the demand of the new generation. Even in cell phones, it is very easy to see the shift from entry-typing menus to visual menus. We have iconic lists of menu items rather than pop-up menus. While talking about the ICT and its use in daily life, we should better clarify the distinction between invention and innovation.

"An invention is a new idea or new theoretical model, while innovation is the implementation of this invention in a market or social setting." (Storsul & Krumsvik, 2013, p. 14). The development of the ICT could be taken an example for invention whereas the implementation of the new ICT tools into our daily life, including digital and physical society as well as informal and formal learning settings, should be considered as innovation. We believe that people should be aware of the capacity and the volume of the ICT tools and the internet use to better understand how innovation rapidly changes the environment.

How are certain habits and information spread out so fast? How do people hear about a protest occurring at a particular place in the world, even seconds after the incident happens?

The following sections may help the readers to refresh their minds on some numerical facts. The next section will present some key numbers from the ICT industry to help us understand the trend. Similarly, the following section will talk about how people use the internet.

Key Numbers from ICT

The number of internet users throughout the world has been increasing dramatically; the number of users which was about one billion in 2005 is almost tripled, reaching 3 billion in 2014, in the last decade. Although the figures illustrate that almost two-thirds of internet users are from developing countries, the percentage of people going online to the population in developed countries is much higher. ITU (2014) report reveals that 78 percent of the population living in developed countries is online whereas the percentage is only 32 for developing countries. Fox and Rainie (2014) claim that 81 percent of Americans (US citizens) is online and that the internet usage strongly correlates with the income and level of education. Their finding seems to explain why developing countries have less internet penetration.

An OECD report (2001) identifies two types of the digital divide, such as the opportunity to access digital tools including internet, what is also called first digital divide, and the ability to use digital tools, also called as second digital divide. "While the gap between the 'haves' and the 'have nots' has continued to narrow since the 1990s, it is also evident that there is a proportion of the population that continues to lag behind." (Haight, Quan-Haase, and Corbett, 2014, p. 506). In this chapter, we concern the second type of digital divide primarily because we believe that it is mainly rooted in the lack of adequate digital, or media, literacy education.

While talking about the total number of people using the internet is increasing, a closer look at the ITU (2014) data reveals that this increase is stemmed mostly in developing countries. The number of users in the developed countries is increased about 50% (from 616 million to 981 million) whereas the number of users in the developing countries is moved from 408 million to about 2 billion (1,942 million) for the last decade (ITU, 2014). These numbers in increases help us conclude that the number of people using the internet will be more in the future because the number of the users in the developing countries is still unsaturated. Moreover, we may also expect more democratization in both internet access and internet use in the very close future.

Another critical key information drawn from (ITU, 2014) data is the tendency of preferring the mobile-broadband access comparing to the fixed-broadband access. Data reveals that the mobile-broadband penetration is exceeded 2 billion as of 2014. 55% of this access comes from developing countries, meaning that more people from developing countries become the global citizens of the new world. In other words, more people start using the internet and contribute to the increase in the amount of information created and shared online. Interesting enough, it is identified that people who have lagged the internet adoption are more likely the users of mobile devices, mobile-broadband subscriptions (Pachler, Bachmair, & Cook, 2010).

The mobile-broadband subscription is very common in the Bayburt University, a recently established university in the northeast of Turkey. It seems quite reasonable for students to prefer mobile access because they are mobile in most of their time. However, this does not appear to be the only reason. They prefer mobile access because they might prefer staying connected and communicating to each other

continuously. Unfortunately, we have less evidence that they employ this opportunity to invest in their development although they are supposed to be teachers to be role models for their students.

Internet Use

How does the increasing number of the internet users reflect on the amount of information produced, or re-produced, delivered in a particular period? Spencer (2012) posted an infographic on the visual news website, pointing out some interesting facts, happening in every minute of a day (table 1).

These numbers are the facts from 2012 and that 217 new users get mobile access in every single minute, and the online interaction –interaction on the web –among people would be much higher in 2014. The ITU report argues that more and more people are having online access as time goes. The more people get internet access; the more information gets into the circulation on the web, which is actually a good news if we are sure that all information on circulation is correct.

It is a challenge to recognize the fake information that is being circulated on social media networks. Even the same picture could be used to support a number of claims. When it is asked to those sharing that piece of fake information, they usually admit that they circulate the information without really evaluating them. How could those people be engaged in being aware of what they are doing? How do those people develop a habit to properly evaluate all information they share before doing that? Awareness and responsibility seem to be the keywords; however, being responsible is not always enough to take the right action. One needs to develop proper skills and accumulate correct information to be able to act responsibly.

Blank and Groselj (2014) published an empirical research paper based on the Oxford Internet Surveys' 2011 data. They grounded their analysis on the understanding of "(1) amount, (2) variety, and (3) type of Internet use" (p. 416). In the research, 48 different activities were identified as the activities to be done on the Internet as well as on the classical media, from emailing to online shopping or reading, and organized under certain categories: Entertainment, Commerce, InfoSeek, Socialization, Email, Blogging, Production, Classic Mass Media, School and Work, and others. Results revealed that 73 percent of participants described themselves as the Internet Users and that Emailing (93.5%) and Information Seeking (85.7%) are the leading two activities done on the internet. Interestingly, 78.3% of participants declared that they had used Classic Mass Media, which is listed on the third. The rest of the activities and their frequency of use are as follows: Socializing (61.2%), Commerce (59.8%), School and Work (48.1%), and Entertainment (46.3%) while Blogging (30.1%), Production (23.4%), and Vice (20.9%). The last three seem interesting because although these three activities are performed comparatively less than the previous ones, people doing these activities perform the other activities too on a daily basis. For

Table 1. One perspective of the online activity for a minute

WordPress users	publish 347 blog posts
Web Developers	create 571 new sites
Instagram users	share 3600 new photos
Facebook users	share 684,478 pieces of content
Email users	send 204,166,667 emails
YouTube users	upload 48 hours of new video

example, people do Production perform 6.3 other activities, which is a maximum for the measurement of the variety of activities. Similarly, people do Blogging perform 5.9 other activities while people using School-and-Work perform 5.3 activities. In contrast, people use Emailing perform 4.1 other activities. This is an interesting result drawn from the study as put forward by Blank and Groselj (2014):

Notice the inverse relationship between participation in type, and amount and variety of use. People who participate in the least popular activities – vice, production, and blogging – have both the highest variety and also the largest amount of use. This suggests that people who do niche activities are likely to be more active and do more things than people who do the popular activities. (p. 429)

A similar research done in Turkey illustrates interesting contrasts, it may be because the study was done in 2013 and only children were included in the study. However, it seems still important to review the results because our goal is to understand the current situation rather than to compare one with another. The study reveals that the children start using the internet as of age 9, as an average and that about 60% of children use the internet at home. The age group of the participants is declared as 6-15, and their way of internet use looks as follows: Homework and learning (84.8%), playing game (79.5%), and information seek (56.7%) while social media (53.5%) (Sirin, Oktay, and Altun, 2013, p. 23).

Having said that inventions in the ICT and innovations in the digital media grow increasingly and attempt to close all existing gaps, it may be a good idea to assess the current situation in the aforementioned context. In order to assess the current situation, let us apply McLuhan's tetrads. First, we need to look at *what is intensified*. It seems that communication opportunities and means to share information are intensified. As a result of easy access to these opportunities and means, people have the chance to accumulate more information than ever before. In addition, people have more chance to create and build new knowledge in various disciplines. Secondly, *what becomes obsolete* should be explored. The existence of the enormous amount of information makes people reluctant or overwhelmed to evaluate them. It is because evaluating all the information flowing down from a number of media channels demands an excessive amount of time and high level of skills. Thus, people start relying on certain information channels, such as TV channels or certain friends on social media. In case they realize that the information that they get and pass forward is not true, they start losing their trust to others. For this reason, trust may become obsolete as a result of overloaded information. Thirdly, we need to reflect on *what is retrieved that was previously obsolesced*. The world population is increased, and people have started living in almost every corner of the world, comparing to certain intellectual centers before and fewer populations living in those places. That is; more people live in an isolated manner. Recent inventions and innovations made communication easier and faster for everyone, even for the people living in extremely inaccessible places. Fourthly, we should understand *what is produced or emerged when it is pushed to its extreme*. On the one hand, we have an increasing bombarding of information flow. Many people have already started struggling on the amount of communication, such as emails, WhatsApp messages, text messages, as well as the information coming through multiple media channels, including social media networks. That is; some people have already been pushed in the extreme bombarding of information. On the other hand, the fake nature of some of the information, even if circulated by some trusty person or channel, has already led people losing their trust in the information they get. Time management and digital media literacy skills become getting more and more critical.

Individual people and societies have always had a problem with information. For millennia, the information was one of generating enough information about important aspects of life, then providing people with access to that information. But with the rise of the mass media, especially over the past half century, the problem has shifted from one of gaining access to one of protecting ourselves from too much information. (Potter, 2008, p. 5)

Prior to moving forward to theoretical considerations and a particular case we will discuss, we cover the formal and informal educational settings in the next section. Currently, many people in different countries have started questioning the formal education and admitting that schools are not the only places to get education. Demands from these people make homeschooling and online schooling more popular. However, we will take these alternative schooling options aside and look at certain settings, social media, as informal learning options.

FORMAL VS. INFORMAL EDUCATION

Many teachers may experience challenge while trying to implement current innovations in their classroom. Share (2010) talks about a project, called SMARTArt (Students using Media, Art, Reading, and Technology), which allows "students from kindergarten through fifth grade worked with teachers and artists to analyze media and create their own alternative representations of everything from violence, to advertising, to their community." (p. 53) Student artifacts included paintings, writings, photographs, and animations, and the project was funded for three years. In order to learn how they were using what they learned from the project, the participant teachers were interviewed two years after the grant was ended. Although all teachers admitted the importance of media literacy and implementation in school curricula, they also spoke about a decrease in implementation because of school policy. For example, a drop in school standardized test score occurred in one of the schools, and the district put the school on a Watch List. Most importantly, computer lab was closed upon a change in school administration.

It is quite common to hear similar stories in various countries, in various districts, and in various schools. In a similar story from Turkey was spoken by one of our former students. The story took place at a school in a small city located in the east part of Turkey. The school was announced as the sister school of a bigger school in Istanbul and provided technological support to establish a brand new computer lab. However, the school administration returned computers back by claiming that they do not NEED them at all.

Despite the unpleasant reaction to the implementation of the ICT and the Media Literacy in school curricula and contrary perspectives against the ICT tools in some places, there has been encouraging stories going on. Asthana (2010) talks about a project, called Cybermohalla, took place in India. "Cybermohalla is an experimental project designed to enable democratic access to information and communication technologies among poor young women and men in Delhi, India." (Asthana, 2010, p. 14) The project provided an environment for the participants to explore and express their creativity as well as talk about the social and moral issues they experienced. They were encouraged to become media makers through exploration of the issues they faced and communication of their perspectives with others not only to better understand the context, but to act responsibly.

The main difference in these stories is not only, of course, the acceptance or success of the experiences, but the context that the experiences took place. The first stories took place in school whereas the

last one is a story from outside of school setting. Despite the similar stories resisting in implementing the ICT into school curricula in formal education settings, it seems that informal settings are more flexible for innovations. There are two main clarifications we need to make: First, not all formal education settings demonstrate resistance to the ICT implementation. For example, many schools in Turkey attend to the national coding competition. Second, the contemporary informal settings are mostly online. Taking the advantage of cost effectiveness into consideration, people prefer online settings such as Pbworks, Facebook, Twitter to set up interest groups to work on a specific content.

How would it be possible to support formal education with the informal education opportunities taken place on social networking sites? To what extent do people accept informal settings as learning places? The blended education involving formal and informal settings has been suggested one of the themes while describing short term solvable challenges in the NMC Horizon Report (The New Media Consortium, 2015). The report points out the existence of a variety of informal learning environments, such as "museums, science centers, and personal learning networks." (New Media Consortium, 2015, p. 22) Similarly, Cartelli (2012) puts forward that a considerable amount of learning takes place in informal settings including internet resources such as Facebook. In order to better understand the opportunities provided by social media, we need to understand the structure and affordances of these places. We should take one step back and look at how these landscapes could be acceptable by the community.

In fact, the community and social networking sites are evolving together. Many environments and habits have already been changed, evolved, or transformed. Mihailidis (2014) argues that our physical surrounded communities are not the only communities we communicate and that the communities and the ways we communicate each other are continuously affected by how we think about community and communication. "In mediated spaces, a new landscape continues to emerge. Supported by the growth of mobile and social media technologies, new digital platforms now encompass large, diverse, collaborative, and interactive networked communities. They are not limited by demographic or physical boundaries." (Mihailidis, 2014, p. 1) Many people, including the authors of this chapter, involve in the overseas projects and establish new collaborations through internet.

Social Media and Evolving Communication Habits

This section talks about the ways youth use social media and about how their methods of communication have been evolving. New opportunities associated with mobile phones, such as affordable Facebook plans, help them stay connected almost all the time. "We live in an environment that is far different from any environment humans have ever experienced before. And the environment changes at an ever increasing pace." (Potter, 2008, p. 6) The change has been accelerated by the innovation and broad acceptance of Web 2.0 tools. For this reason, one should understand the concept of Web 2.0 and then start exploring digital media because this new generation of web content dominates internet usage (Flew and Smith, 2011).

"As we have seen, new media is a rapidly evolving and complex assemblage of technology, social uses, and business models. While much remains up in the air and the future is far from certain" (Flew & Smith, 2011, p. 23), it seems hard to anticipate what skills we need to develop for 21st century citizens. Indeed, we live in an environment, which is an amalgam of physical and digital spaces. Although some may consider the online space is completely out of physical space, many accept the online –digital –space "the online aspects of regular life." (Flew & Smith, 2011, p. 55) Our personal experience, limited to communication with our students at the Bayburt University, demonstrates that most students keep offline and online communications simultaneously. For example, they keep talking about the same topic,

which was started in the classroom, when they are on Facebook or in a group chatting on WhatsApp. Similarly, they may keep a conversation active when they come to the classroom even if the conversation was started online, either on Facebook or WhatsApp.

What makes the Web 2.0 widely acceptable has also been explored by researchers. Flew and Smith (2011) describe their advantages as being user-friendly, decentralized controlling, connecting many-to-many, being cost-effective, and the last but not the least, the chance to evolve and change in time and the possibility of modification with respect to one's own needs or preferences. The one own preferences include political, educational, entertainment and gender-based, and intellectual preferences. They can play with background themes and colors and use avatars and their own pictures as the profile pictures.

The chance to make modifications and implementations engaged people to create their own interest groups and be the part of content developers of those spaces. This is how a new concept emerged: *participatory media culture*. "One of the great promises of new media has always been that it could create a more participatory media culture." (Flew & Smith, 2011, p. 107) Social network analysts put forward that, (1) actors and their actions are interwoven and dependent to each other's, (2) relationships among actors controls the source of information flow, (3) the descriptive structure of the space defines the dependency level of each individual, and (4) preferences identifying the space limit the relations among actors (Wasserman & Faust, 1994).

In terms of popularity, wide acceptance and the integration of our daily life, social networking sites or social media has become one of the major actors in our life. Some scholars studying digital divide claim that this media is going to be the source of third digital divide. **"**The education divide continues to persist in terms of internet access, level of online activity, and SNS usage." (Haight, Quan-Haase, and Corbett, 2014, p. 514) Social media is not only and simply a platform for transmission of information, but an interactive environment allowing people to produce knowledge through discussions and to develop the identity shaped through discussions. Their continuous connection seems to have a number of effects located on a spectrum. Getting informed and ready to accumulate more knowledge is found on the one end while distracted from current tasks and disconnected from her physical surroundings is placed on the other end.

However, some concerns arise around this emerged media and evolved habits. "In these spaces [mediated digital spaces], the lines between news and entertainment, facts and fiction, truth and hearsay are less distinguishable." (Mihailidis, 2014, p. 1) The concern becomes particularly significant when the medium is anonymous, and no control exists in the space. This matter brings the challenge addressed in the introduction section on the table: How should we educate our children so that they could be aware of fake information being circulated in social media networks? How should we educate them to avoid misguiding their peers by sharing this false information?

Looking from McLuhan's perspective, social media definitely *intensifies* the communication among the participants sharing the same interest environment. The easy access to mobile tools allowing one to take pictures and share them with others makes regular library use or note-taking and writing, which demands a significant cognitive skill, *obsolete*. People using the library had privilege of living and studying at an uninterrupted and undistracted place. The notifications coming to mobile phones may *retrieve* interruption and distraction even if people are in the library like places. When social media use and control of our life are *pushed to their extremes*, it may result in chaos and suffer from the existence of technology. People may start not using –or at least limit using –technology and its social media component.

Games and Digital Games

Games have been a specific industry in computer technology and been developed with the support of both hardware inventions and software innovations. "Over the past 30 years, the games industry has evolved a multi-layered structure in which games development, distribution, platforms, and users have found themselves in shifting and interconnected arrangements." (Flew & Smith, 2011, p. 127) Despite the resistance against games, particularly video games, by number of educators, psychologists, and parents, the industry has reached tens of billions of dollars of revenue, meaning that millions of users.

Digital games take resistance by those people who usually believe that gamers are asocial people, mostly young boys, living in dark rooms and playing games for hours and hours. However, research and evidence in current data demonstrate that gamers have various online and offline communities, meeting and playing in a number of social and public settings. Some games ask users to get connected through local area networks and play in groups and against other groups (Flew & Smith, 2011; ESA 2014). The data claim that 42 percent of gamers play with their friends while 50 percent play with their family members (18 percent with parents while 32 percent with other family members). We have similar experiences in the Bayburt University. We do not see much gender gap in involving games, including online games.

ESA 2014 data reveals that 59 percent of Americans play video games, and the average age of game players is 31, being 39 percent of players are more than 36 years old. In contrast to the stereotype for the gender of players, data suggests that 48 percent of players are women. The types of games played online are mainly the Casual/Social games (30%), Puzzles, Board Games, and Card Games (28%), and Action, Sports, and Strategy Games (24%). The order for the mobile games remains the same with slightly different numbers: Casual/Social games (46%), Puzzle, Board Games, and Card Games (31%), and Action, Sports, and Strategy Games (11%).

Games or Puzzles, particularly mind puzzles, could be an excellent tool to help children improve their competencies in various skills. We would like to take the attention of the readers, for the sake of this chapter, to a more specific portion of games industry: Mind Games and Mind Puzzles. The names, as well as the content, vary a lot depending on the country and culture. Therefore, it is good to define the term briefly. We use the term for the puzzles demanding cognitive skills, thinking mathematically, developing strategies, evaluating possibilities, and demanding problem-solving skills. Sudoku, Clouds, Easy as ABC, Four Winds, Skyscrapers are some of the puzzles mentioned on the World Puzzle Federation Website (WPF, 2014).

The World Puzzle Federation organizes world puzzle championships in a different country each year. The federation calls issue for the championships and asks country representatives do selections in their own country and bring competitors to the worldwide competition. The championship for the year 2015 will be in Sofia, Bulgaria. Besides the paper-and-pencil materials to play these games, a number of websites offer online platforms to play them all. Moreover, many game developers create free applications to allow gamers to download in their cell phones and play accordingly.

Escape Games are another genre of Mind Puzzles, usually played in teams although there are online and mobile versions to play individually. The game is played at a particular place, typically in a locked room or the like, asking gamers to find their ways to escape from the place. "Being locked in a room and battling for a way out might make some feel like they've been jailed — or worse — but for a growing number of Torontonians it's becoming part of their Friday night fun." (Deschamps, 2014)

What opportunities may these Mind Games and Escape Games provide to improve their skills to get better 21st citizens? Would Mind Games, including Escape Games, serve a context to improve people's cognitive abilities? What are the possibilities to integrate these mind puzzles and media literacy?

THEORETICAL CONSIDERATIONS

In the previous sections, we set the stage better to understand the dimensions of technological inventions and digital media innovations in our daily life as of the end of 2014. We looked at the number people having internet access as well as number of people performing online activities and types of leading online activities. In addition, we also looked at the social media and digital games. It is not because they seem to be the major components of digital activities, but related to the themes that we will ask the reader's attention for the rest of the chapter.

What does media literacy or digital literacy mean? Based on our daily experience, there are three types of social media followers: (i) those who are reading everything on the social media but do not contribute at all, let us call them *read-only people*; (ii) those who are reading and sharing but commenting, call them *semi-active people*; and (iii) those who are continuously sharing and commenting, on social media, particularly Facebook, call *fully-active people*. Which of these groups of people look more digitally literate? Would there be any consensus on digital literacy? More importantly, why is being digitally literate so necessary for the 21st century?

Media Literacy

What is Media Literacy? In order to set the stage for further discussion, it might be better to look at its definition first. Tyner (2010) states, "*Media literacy* is the term most commonly used in North America, especially in relationship to media education for youth." (p.3) Media has been located at the heart of daily life and has been affecting a number of the abilities of the human being. These abilities include cognitive abilities such as analysis, evaluation, synthesis; emotional abilities such as love, hate, anger; and moral abilities such as judgment on good or bad. Potter (2008) describes media literacy *multidimensional* while explaining these abilities and how these abilities affect our perspective.

"Taking control is what media literacy is all about." (Potter, 2008, p. 9) There is an enormous flow of information coming from a number of media channels. It is the person's responsibility to evaluate them all and to take the control of his or her own life rather than to leave the control of political and personal perspectives, professional or general knowledge, and even beliefs to the media. For example, mass media usually states that digital games are for boys only. However, data declared by ESA (2014) puts forward that the ratio of women to men playing digital games is almost the same. This is true even for the small city where we live in Turkey. We have been observing that the number of girls playing Facebook games, particularly Mind Games such as Sudoku, is similar to the number of boys if not more than that. "You are able to build the life *you* want rather than letting the media build the life *they* want for you." (Potter, 2008, p. 9)

One of the concerns raised by researchers is the existence of fake and faulty messages exposed by mass media. No matter what the reason or the source is, media literacy should be a state of prevention against this exposure. By prevention, we do not mean that banning some or all mass as a method, rather we suggest first creating awareness and then supporting with an adequate media literacy education.

We, probably many others, do believe that banning media also hinders our and also youth's intellectual improvement. For example, the authors of this chapter enjoy the information exchange occurring in some specific Facebook pages. The *GeoGebra 1xjBRET* is such a page bringing GeoGebra fans from different parts of the world and helps them exchange ideas and provide support for those needed. It is like an online fan club or sometimes even an online learning environment.

Similarly, a friend of us, Levent Kocoglu – a high school friend of the first author –has decided to take a worldwide trip on his motorcycle and created a fan page on Facebook, Kocoglu (2014). He aimed to be the first Turkish person taking a worldwide tour by motorcycle. He has many followers from various countries, getting more and more because new friends have been added to his list. He regularly updates his current position including a live link to follow his position online and shares pictures, videos, and comments to his *Facebook friends*. Rather than having friends from his close neighborhood, he has many friends from all over the world. This example could be counted as a counter example for those who claim that social media makes people asocial.

Why should we miss such an excellent opportunity to follow a high school friend's world tour or an opportunity to review mathematical artifacts created and posted by someone from Indonesia while listening to the Sufi Music on the YouTube? However, the criticism against mass media exposure is also a reality. Facebook conversations and dealing with fake messages and information could waste one's time even if they are not harmful to those who are not literate enough to cope with these issues.

Potter (2008) claims, "[m]edia literacy is a process, not a product" (p. 13) and puts his claim on a three-leg chair. He suggests that the process has three components, what he calls as *building blocks*. Personal Locus is the first component, responsible for "determining what gets filtered in and what gets ignored." (p. 12) For example, we, as the university professors who are responsible to improve our academic knowledge and to be the role model for our students, should be aware of the content of the information that we share and the comments that we make on any posting. Moreover, we should follow pages related to our academic interest to demonstrate that it is possible to use social media responsibly and effectively. Moreover, since the authors of this chapter are the professors at the Faculty of Education, whose students are the prospective teachers; we assume that they may, actually they do, take our actions as the role models and adopt in their professional life. This makes our responsibility rather elevated, and this responsibility will be discussed later in this chapter.

The second component is the knowledge structures, which are organized information pieces in one's mind. "Information is the essential ingredient in knowledge structures." (Potter, 2008, p. 13) Information may be described as the pieces of data attracting our attention. Before attracting our attention, they are in their primitive forms, called data. Cognitive psychologists describe the information as some kind of data that we start processing in the working memory of our mind and locating it in our long-term memory as knowledge (Baddeley, 2007; Masssaro & Cowan, 1993; Matlin, 2005). The ability to process the information is the third component, called skills, of the media literacy. The knowledge structures, relying on Potter's explanations, have two roles: (1) intellectual artifacts accumulated by the person and (2) a set of guide to filter the new information and let it go through the process and become knowledge.

Information is composed of facts. Facts by themselves are not knowledge any more than a pile of lumber in a house. Knowledge requires structure to provide context and thereby exhibit meaning. Think of messages as the raw materials and skills as the tools you use to do something with the raw materials. That "something" is in the service of attaining the goal of pulling the information out of the messages and

turning that information into knowledge, that is, to reconstruct the information so that it will contribute to our knowledge structures. (Potter, 2008, p. 14)

We prefer adopting Potter's description of media literacy by putting more emphasize on skills. Although we appreciate the importance and the role of personal locus and knowledge structures in developing and improving media literacy, we put more emphasis on media literacy, acronyms with skills, by following on his vision of media literacy as a process. Potter (2008) argues that, "[s]kills are tools that people develop through practice" (p. 15) and describes the skills as verbs such as analyzing, evaluating, grouping, inducing, deducing, synthesizing, and abstracting. This description of skills as verbs supports our argument if he does not take the media literacy in a broader sense.

Exploring Media Literacy Framework

It seems that media literacy framework is a working framework because many scholars, including some institutions, approach the framework from a different perspective and take the term in a different context. It is quite understandable and appreciable that each of these approaches has a specific value and contributes to the building an overarching framework. In this section of the chapter, we will revisit these approaches and reflect on each from our own perspective and our experience. It is important to note that our context reflects the social media experiences at the undergraduate level or up.

Potter (2008) suggests seven skills relevant to media literacy, analyzing, evaluating, grouping, inducing, deducing, synthesizing, and abstracting by stating that the skills are also usable and developable out of media literacy context. Therefore, his main approach to these skills is not to develop them but to be able to implement them in media literacy context.

"*Analysis* is the breaking down a message into meaningful elements." (Potter, 2008, p. 16) This skill is used to delve into the message itself to better understand the components and relationships among the components. For example, we expect our undergraduates to ask several questions when they confront an online message. *What*, *who*, and *why* questions are the main questions they could ask. Here are some possible forms of questions to ask: *What does the message contain? Who created this message or who shared this information? Why is this message posted?* However, our experience does not provide us any evidence that students really attempt understanding of rather than relying on what is posted.

"*Evaluation* is making judgment about the value of an element." (Potter, 2008, p. 16) Following delving into the message and asking questions –analyzing them, -one becomes ready to evaluate them through a comparison of the message elements to some standard, meaning knowledge structures s/he developed earlier. Depending on meeting of their knowledge structure standards, people could accept or reject the message, meaning that commenting or sharing with others versus ignoring or deleting.

"*Grouping* is determining which elements are alike in some way –determining how a group of elements is different from other groups of elements." (Potter, 2008, p. 17) For example, students should be encouraged to share their messages in the right groups if the message is not commonly interested. That is; a message regarding political issues should not be posted on the Mind Games page. The admins of some pages make these rules clear and accessible by posting on the top of the page while some expect the members have a common sense.

"*Induction* is inferring a pattern across a small set of elements, [and] then generalizing the pattern to all elements in the larger set." (Potter, 2008, p. 17) People sharing a common goal, in a group, for example, should develop an understanding of commonalities of the postings and goals; and then start

contributing to the group page by finding new elements or commenting on current postings. These efforts may support the developing of the participatory culture, which is one of the main features provided by Web 2.0 tools.

"*Deduction* is using general principles to explain particulars. When we have faulty general principles, we will explain particular occurrences in a faulty manner." (Potter, 2008, p. 18) Once people develop an understanding of responsible use of certain social space, they should be able to distinguish the actions that do not fit into the general principles.

"*Synthesis* is assembling elements into a new structure." (Potter, 2008, p. 19) This skill is particularly useful when people construct their own values or knowledge structures. In order to synthesize a new knowledge structure, one should go through several of the aforementioned stages such as analyzing, evaluating, and grouping.

"*Abstracting* is creating a brief, clear, and accurate description capturing the essence of message in a smaller number of words than the message itself." (Potter, 2008, p. 19) This skill is relevant to see the main idea of the message and assess if it is worthy to analyze or take care of it. Most of the time, people may only scan messages and ignore them if they find them unnecessary to analyze.

Kamerer (2013) talks about five communications, which were taken from a Hobbs (2011) work: Access, Analyze, Create, Reflect, and Act. This list seems to be more hierarchical, meaning that one comes after the other. *Access* should be understood as the opportunity to go online and become part of online community, which is more related to infrastructural issues. Once students access to the platform, they are supposed to *analyze* the messages through critical thinking point of view. People who are able to access to the online platform should also *create* their own messages if they feel confident in doing that. In order to create effective messages, one should be aware of the capabilities of the medium as well as responsibilities of creating and sharing, which could be considered as *reflect*. In order to *act* at various levels, in-groups, inter-groups, or even national and international levels, people should develop a strong understanding of context and content.

Both Potter's (2008) and Hobb's (2011) frameworks demonstrate different perspectives in terms of audiences. The Potter's framework seems reflecting more cognitive skills and provides an individualistic perspective while Hobbs' framework looks like more collaborative and relevant for social context. Although they both emphasize the importance of analysis and synthesis (creating) Hobb's framework seems to be more aware of about the group needs and possibly the sensitivity for some cultural issues, and therefore, suggests reflection.

Mihailidis (2014) presented three different frameworks in his book. The first one, what he calls arguments, consists of critical thinkers, creators and communicators, and agents of social change. "Common to the skills of engaged citizens is the ability to act as critical thinkers –able to access and analyze information on which democratic participation." (Mihailidis, 2014, p. 42) This seems a particularly important skill for new generation living in social media era because they do not consume the information that they gather from a static media, such as their parents had done for newspapers, rather they are supposed to take information, process, and contribute to it. Is it always the case? Well, not really. At least, our own personal observation, many scan rather reading and pass the information with little contribution or no contribution at all. What we mean by *little contribution* is to tag the posting with some supporting words, such as *aynen* in Turkish, literally meaning *I completely agree.*

Mihailidis (2014) also claims that, "[p]roposed definitions of 'good citizenship' also rely on individuals' ability to act as effective *creators* and *communicators*" (p. 43). He examines this perspective in the political context, which we believe that, *not limited to*. The features of social media allow users

to reinterpret the messages and their content and use them while reflecting on them or communicating with them. This also could be a way to learn new content for those young people. However, they usually put less emphasis on reinterpreting as mentioned above.

The third argument proposed by Mihailidis (2014) is being the "agents of social change" (p. 44). Today's youth, who are expected to be engaged citizen of 21st century, is also supposed to advocate their opinions after analyzing and reframing the content of the messages rather than being the passive consumers of message flow. They are expected to be aware of their role in reconstructing their future. It seems that Mihailidis' arguments for the media literacy framework is much closer to what was suggested by Hobb in terms of audiences because both demonstrate a social constructive perspective. However, the latter puts more emphasis on critical thinking and change –contribution to change.

Mihailidis (2014) then elaborates on the arguments and suggests a 5C model for media literacy. "I have identified five competencies that I think are central to media literate collaborative efforts in networked culture." (p. 61) His 5C model involves curate, critique, contribute, collaborate, and create. These competencies seem demanding more collaborative work suggested for online communities only. Again, critical thinking and collectively creating seem to be particularly emphasized.

Later in his book, Mihailidis (2014) suggests a framework, taking media literacy to improve new generations' abilities who are supposed to live in a networked society. "This framework builds on the work of media literacy pioneers who have been exploring and developing models to advance media literacy in classrooms and society in general." (Mihailidis, 2014, p. 128) The 5A's of the model represent access, awareness, assessment, appreciation, and action in a continuum. He details the content of continuum as, "access to media, awareness of media's power, assessment of how media cover international and supranational events and issues, appreciation for media's role in creating civic societies, and action to encourage better communication across cultural, social, and political divides." (p. 130) His perspective in suggesting this framework illustrates more individualistic approach and aims to strengthen the skills of individual.

National Association for Media Literacy Education (2007) declares six core principles for media literacy, illustrating a couple of themes with special emphasis. For example, critical thinking, process nature of the media literacy, contribution to and integration of individual skills and competencies to collective knowledge, and engagement and collaboration seem to be ones with particular attention.

- Media Literacy Education requires active inquiry and critical thinking about the messages we receive and create.
- Media Literacy Education expands the concept of literacy to include all forms of media (i.e., reading and writing).
- Media Literacy Education builds and reinforces skills for learners of all ages. Like print literacy, those skills necessitate integrated, interactive, and repeated practice.
- Media Literacy Education develops informed, reflective and engaged participants essential for a democratic society.
- Media Literacy Education recognizes that media are a part of culture and function as agents of socialization.
- Media Literacy Education affirms that people use their individual skills, beliefs and experiences to construct their own meanings from media messages. (p. 3)

Buckingham (2009) discusses similar issues in his plenary paper at the European congress on media literacy. "Media literacy, it seems, is a skill or a form of competency; but it is also about critical thinking, and about cultural dispositions or tastes." (p. 15) His description consists of all media forms, all age groups as well as creativity and collaboration. Moreover, he takes media literacy –education for Europeans – as a collaborative, creative, and progressive effort and suggests all people and institutions being part of this action.

It seems that almost all agree on the critical thinking, social communication skills, and collaboration as important parts of media literacy. Therefore, the question concerns to develop and improve these skills, whatever their names would be. In fact, formal education taking place in schools also states the importance of these skills and seeks strategies to improve the competencies of children in these skills.

Critical Thinking

The review of the literature reveals that media literacy is a process of constructing a number of skills. The innovations Web 2.0 tools, particularly social media platforms have caused a major shift in media literacy. As a result of this shift, educators need to take collaborative and cooperative works into account. This is rather challenging for many teachers and educators because they also need to move their strategies from the psychological perspective to the sociological perspective, integrating with critical thinking theories (Share, 2010).

Dwyer, Hogan, and Stewart (2014) argue that critical thinking is "a metacognitive process, consisting of a number of sub-skills (e.g. analysis, evaluation and inference) that, when used appropriately, increases the chances of producing a logical conclusion to an argument or solution to a problem" (p. 43). Their definition emphasizes two main points, one being the high-order thinking skills having dimensions while the other is the possible effects. The dimensions stated by Dwyer, Hogan, and Stewart are parts of media literacy skills mentioned in the previous sections. The only difference lies in the social interaction perspective, which is reasonable because critical thinking theory is a study area of philosophers'.

Having said that critical thinking is a metacognitive process, it should have some self-monitoring and self-regulation dimensions. This necessity brings the importance of learners' awareness of their personal skills and needs as well as learning objectives. This perspective is stated by Dwyer, Hogan, and Stewart (2014): "in order to improve CT [critical thinking] ability, students must be aware of what it is they are supposed to be learning; and likewise; their teachers must also be aware what it is they are supposed to be teaching" (p. 44).

We may be far from a comprehensive understanding of critical thinking before reviewing the consensus statement declared by a group of experts after working on various perspectives of the theory. A group of academics explored the theory in a series of meetings supported by American Philosophical Association in 1990 and organized by Facione. Then, they came to a consensus on the following statement:

We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. (Facione, 1990, p. 2)

The statement consists of six core skills, with some sub-skills for each: Interpretation, analysis, evaluation, inference, explanation, and self-regulation. *Interpretation* refers to comprehensive understanding of cases, meanings that are carried by messages, contexts, and the overt and covert meanings of concepts and processes. *Analysis* covers examining ideas and arguments as well as detecting arguments while *evaluation* is suggested to point out assessing arguments and claims. All of these concepts are almost the same concepts mentioned in media literacy frameworks above and may be familiar to many of us in regular daily contexts. The other three skills sound elaborative skills. *Inference* demands more cognitive abilities to query evidences, to conjecture alternatives, and to draw conclusions. In media literacy context, inference may mean asking questions such as what if I pass this information to my friends or what if I comment or not comment on this posting, etc. *Explanation* sounds like the advocating the acts, stating results, presenting arguments, and justifying procedures. In this sense, explanation demands more metacognitive skills because the sub-skills mentioned here could be performed through self-monitoring. Similarly, *self-regulation* is another metacognitive skill allowing one to regulate his or her actions after self-monitoring (Dwyer, Hogan, & Stewart, 2014).

ELABORATING ON ALTERNATIVES

Literature states that media literacy is a set of perspectives to interpret the media messages and that media literate describes the person who is able to judge media messages as accurately as possible to get inform herself and to spread out the reliable information through her own social environment (Kamerer, 2013; Mihailidis, 2014; Potter, 2008). In order to better help new generations act like the responsible citizen, it has been recognized by various governmental institutes in various countries that children should be educated properly and that they should be provided enough chance to develop skills they need for 21st century.

Upon briefly reviewing the skills youth may need for the 21st century, we will talk about our experience on Mind Games in a small city located at the north east of Turkey. One may find the relation between media literacy and 21st century skills unclear. However, improving critical skills from the cognitive approach may help us identify the close relationship.

21st Century Citizenship

"The world is getting smaller." This Turkish proverb does not take "getting smaller" in physical sense, rather it points out that the opportunities to get connected with people living abroad and to access information easily, and even to be able to travel for shorter periods of time. Technology people invent new tools and develop opportunities for us to make the life easier and to create more options. However, it is rather challenging to anticipate what the next will be. How will be the life and possible job opportunities for our children 25 years later? How do people communicate 25 years later by considering that we did not have cell phones and WhatsApp 25 years ago? How do technological inventions change the daily life and what skills will be needed for the people, who are five years old now and when they come to their 30s? What kind of education do we provide for our 5-year-olds to train them for 25 years ahead of today?

WhatsApp, a 5-year old technology, has about 500.000 users all around the world and changes our communication habits a lot (http://blog.whatsapp.com). It is incredible to know that doctors living in Mumbai, India help patients with heart attacks by sharing their ECG through WhatsApp and help save

the lives (Shelar, 2013). The ways we live, communicate, and interactive with others evolving and changing. It is quite difficult to anticipate the future! So, the questions still remain unanswered: How do we educate our 5-year-old so that she could easily adapt herself to the 21st century?

In terms of curricular content, our 5-year-old may not need what the formal education offers at the school when s/he becomes 30. However, they will probably need the skills to help them adapt themselves to that environment. "An increasingly international, interdependent and diverse world rewards people with global competencies and understanding, such as the ability to make local-to-global connections, recognize divergent perspectives, think critically and creatively about global challenges, and collaborate respectfully in heterogeneous forums." (Partnership for 21st Century Skills, 2014b, p. 9)

That is; our 5-year-old may need critical thinking skills, thinking creatively and respectfully. We are not even sure what language they are going to speak. However, we should educate them to have enough skills to learn a new language in very short period and to adopt their lives into their rapidly changing environments. In other words, we need to educate them for a world, which is completely unpredictable for us. The following experience emerged during a brainstorming by the authors of this chapter, and the next section will talk about our experience and what we have learned from that experience.

Mind Games in Bayburt

In this section of the chapter, we break with the perspective that puts technology at the center and present an alternative perspective not necessarily associated with technology but applicable to the technology supported contexts, as well. It takes a more explorative approach to 21st century skill development and provides strategies for developing critical thinking in teacher education context.

Undergraduate students attending to the Faculty of Education in Turkey have to complete some volunteer work as part of their course work. In 2013 Spring semester, we, the authors of this chapter, encouraged two other university professors to join us to organize a citywide event. First, we had to take care of funding, which was solved with the support of Bayburt University. Bayburt University funded the project completely, except prizes. We got support for the prizes from local people.

We believe that it is worthwhile to provide some contextual information about Bayburt and Bayburt University to help readers better understand the challenge we had to overcome. Bayburt is a small city located in the northeast of Turkey, with a population of 33,000 people, including university students, slightly more than 5,000. Most of the residents are under-educated and live in low socio-economic conditions. Students coming to Bayburt University are usually under-achievement group of the students based on Turkish university entrance exam. Their mathematics and science background is significantly low comparing to the other undergraduate students studying at the other Turkish universities. The answer given by one of the university students to a questionnaire may give an idea to the reader about the level of students: "I have seen Sudoku in some newspapers. However, I never looked at it in detail when I saw the numbers because I have always been very bad with numbers and mathematics."

The case was not encouraging among university students, at all. 175 undergraduate students worked on the project. Only a few of them had little information about basic Sudoku, so-called classic Sudoku. None of them knew anything about variants of Sudoku, Kendoku, Tangram, Quarto, or Mangala. This was the another challenge for us because we had to train them in very short period and even we were not experts of these games, except the first author, who had been involved in some activities as solver but not trainer. Therefore, we decided to get professional help from the Turkish Mind Team (TMT). The TMT

consists of a group of talented people, solving the mind puzzles, create new puzzles, organize educational activities to promote mind puzzles, and present Turkey in the International Puzzle Championships.

However, we had limited amount of money for the training; it was impossible to provide first-hand training for all university participants, a total of 175 students. Therefore, we develop a strategy and asked volunteers for a weekend training program offered by the Leader of Turkish Mind Team, Ferhat Calapkulu. 50 students attended the program on the last weekend of March, 2013, learned solving a number of Mind Puzzles. We called this first group of students as the *education leaders*. Following the training weekend, these education leaders were grouped in pairs and assigned to a group of 5 peers to help them solve Mind Puzzles. This was a great opportunity for them to learn collaboration as well as to take responsibility for each other. We called this period as the *internal training period*.

The reason, why we assigned each pair of students to 5 students, was to provide education leaders opportunities to collaborate and support each other during their internal training period. They were asked to complete this training session in their spare times in two weeks. Upon completing this internal training period, we had two groups of students with varying levels of expertise and experience: The 50 students –the first group,-who got training from Ferhat Calapkulu, were better solvers because they got training from an expert, and they trained their peers. The second group of 125 students, who got their training from their peers, had no teaching experience; therefore we called them as *assistant educators*.

After completing internal training, we encouraged students to go to the schools for external training. Since this external training was planned as after school program, some school administrators preferred weekdays while others on weekends. The external training program was planned in two stages:

- Explaining how to solve Mind Puzzles,
- Mind Puzzle solving sessions.

The role of the education leaders was to explain each Puzzle to Grade 5-7 students at the beginning each session. Then, those Grade 5-7 students were encouraged to solve their own Puzzles in the Mind Puzzle solving sessions. These sessions were the sessions that assistant teachers were involved in training. During these sessions, they, education leaders and assistant educators, helped students work on the one-on-one basis or in small groups because there were at least two assistant educators and one education leader in each classroom. This external training was completed in three weeks. On the last day of external training, school-wide competitions were organized to select students for the city-wide competition.

A two-day festival was organized in Bayburt University at the end of May, 2013. During the festival, there were mainly two types of activities: (1) Activities open to everyone and (2) the competition. For the festival, we set up 10 stations of Mind Puzzles controlled by our assistant educators. Since these activities were open to all students at any grade and attending to the festival, many were unfamiliar with activities. In these activities, we used concrete materials, so-called manipulatives to engage them in learning and trying the Mind Puzzles.

For the competition, 300 students were selected at the end of the external training in the schools and invited to the University for the Citywide Competition. 100 students from each Grade competed with each other on the first day of competition under the control of Ferhat Calapkulu, the leader of TMT, with the support of 50 education leaders. On the first day, the best 10 out 100 students from each grade won the competition and were invited to the final stage on the second day. The second day the first 3 students of each Grade level were selected as the champions of the Bayburt city. The festival was completed by the Prize Ceremony.

Reflection on the Experience

What have we learned from this experience? It seems that it is a good idea to organize our reflections based around two major themes: (1) University students' perspective and (2) Elementary students' perspective.

To our knowledge, it was the first collaborative effort that the undergraduates of our university had ever experienced. First, the education leaders had experienced in taking responsibility to train their peers. Since the success of the project strongly depended on their internal training, they were all aware of the challenge. Based on personal observation, they took their responsibility seriously and put a great effort to make it success. Second, they all experienced how a learning model could be developed to survive with a limited financial support. Third, they all experienced learning and teaching of Mind Puzzles. This last experience led some of our graduates to work on this specific area of education.

In terms of elementary students' perspective, they all got a chance to learn the Mind Puzzles. This could be a significant chance for some because there is a good reason to believe that these games may help them improve their creativity. Our personal conversation with some school teachers and principals support our claim. More importantly, some elementary students stated that it was the first time for them to visit a university and be part of an activity.

FUTURE RESEARCH DIRECTIONS

As the researchers, we had not been aware of the potential of Mind Games in supporting creativity. We knew that these games may have some contribution to improving students' problem-solving skills. The project helped us reflect and explore further on the relationship between creativity and Mind Games, and the contribution to developing 21st century skills in this regard.

One suggestion for the future research direction could be to explore the relationship between cognitive ability and communication in social media. How do the people who are good problem solver or Mind Puzzle solver communicate in social settings? Are they mostly read-only people, semi-active people or fully-active people?

In terms of the potential of material perspective, we would like to see the Mind Puzzle or Digital Game preference of the people whose activity in social media is at various levels.

CONCLUSION

Currently, we have a generation growing up in the technology era, although there is still some degree of the digital divide in some parts of the world. We have been educating this emerging generation with the guidance of the last century educational theories and models. In contrast, we ask them to live in 21st century. Despite the fact that this is an obstacle of our formal education system in many countries, it seems that we do not have much chance to alter the system. It is because no one really is sure about what the best education system would be. What education system is the best one that can develop our next generation's 21st century skills? Even worse, we are unsure what skills will be most important for the 21st century.

Still, we –educators –need to find and suggest some directions and provide some guidance for the future. As the authors of this chapter, we discussed the possibilities to help next generations improve

their cognitive skills. We intend to propose a self-regularity method supported with enough cognitive abilities may help them find their own solutions whenever and wherever they confront with them. With this intention in mind, we shared our experience with readers by assuming that the experience might inspire the readers.

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KEY TERMS AND DEFINITIONS

21st Century Skills: 21st Century skills are the skills that citizens of the 21st century may employ in their daily lives.

Formal Education: Formal education is an educational model to deliver a pre-defined curriculum and offered by institutions.

Informal Education: Information education is an educational model emerges spontaneously and does not necessarily have a pre-defined curriculum, rather the content emerges during the process.

Innovation: Innovation is the implementation of an idea in our life by a unique procedure.

Invention: Invention is to introduce a new idea, process, or model on a specific topic.

Media Literacy: Media literacy is the ability to assess and deconstruct the meaning of the messages conveyed in media.

Mind Puzzles: Mind Puzzles are the puzzles demanding cognitive skills such as mathematical thinking, analyzing, and problem-solving.

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Chapter 14
Developing Digital Empathy: A Holistic Approach to Media Literacy Research Methods

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ABSTRACT

In the Digital Age, when technology offers many solutions and distractions at the same time, we should use media literacy research to address these advantages and challenges through a holistic approach. This chapter introduces digital empathy as a holistic framework combining empathic design and empathic listening to bridge the traditional protectionist and empowerment approaches in media literacy research. Digital Empathy is a mixed methods approach that has been developed through a longitudinal study. It is an inclusive model that addresses the participants and the researcher's cognitive, emotional, and social skills through empathic design and empathic listening. Using a longitudinal case study of a month-long media literacy summer class with underprivileged high school students, the chapter describes digital empathy, not only as a pedagogical approach, but also as a holistic research method that will advance media literacy scholarship.

INTRODUCTION

Digital and Media literacy research explores human ability to access information, analyze media messages, create media, reflect upon her/his use and act responsibly (Hobbs, 2010). There are two main approaches to media literacy research: protectionism and empowerment (Buckingham, 1998). This chapter calls for using an empathic methodology to advance media literacy research making it more valid and to address ethical issues. The described longitudinal case study of a summer program helped me develop the framework of digital empathy as a research methodology. Digital empathy is the result of my efforts to design a research framework to address cognitive, emotional, and social skills while using digital media.

Digital empathy explores the ability to: analyze and evaluate another's internal state (empathy accuracy); have a sense of identity and agency (self-empathy); recognize, understand, and predict other's thoughts and emotions (cognitive empathy); feel what others feel (affective empathy); role play (imagi-

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native empathy); and be companionate to others (empathic concern), via digital media (see Table 1, Friesem, 2015). My goal in this chapter is to: a) introduce the traditional protectionist and empowerment approaches to media literacy research; b) offer a new framework for media literacy research methods using digital empathy; c) showcase the use of digital empathy as a media literacy research method using one longitudinal case study.

The app generation (Gardner & Davis, 2013), which is increasingly engaged with mobile technology, experiences problems with her/his sense of identity, intimacy, and imagination. It seems that instead of promoting a deep connection and reciprocal interaction, our digital engagement is commercial and superficial making us emotionally detached from each other (Turkle, 2011). In other words, we are connected to our devices and not to the people around us, which put us in a state of "present shock" (Rushkoff, 2013).

One of the solutions for this problem is empathy. Empathy can help people develop: richer analysis and evaluation skills (empathic accuracy), stronger sense of identity (self-empathy), deeper intimacy (cognitive empathy, affective empathy), greater imagination (imaginative empathy), and better collaboration skills (empathic concern). Going back to McLuhan's (1994[1964]) theory of technology as an extension of man, reiterate the question for the digital age: how do we interact with each other via technology? While media literacy research explores human interactions and understanding of others by using media tools, we should consider combining it with empathy scholarship. Combining recent studies on empathy with media literacy practice and research can help us bridge the gap between the humanistic potential of digital devices and the actual media consumption.

The field of media literacy is influenced by both communication scholarship (Livingstone, 2004) and education scholarship (Alvermann & Hagood, 2000). As a young field, media literacy has many tensions that led different scholars and practitioners to define it using different lenses (Hobbs, 1998). The common US definition for media literacy was formulated at the 1992 Aspen Institute where it was described as "the ability of a citizen to access, analyze, and produce information in a wide variety of forms" (Aufderheide & Fireston, 1993, p. 6). However, the digital revolution in the last twenty years calls for an updated definition. This is why Hobbs (2010) modified the definition of digital and media literacy as "the ability to make responsible choices, access information… analyze messages… create content… reflect… and take social action" (p. viii). Her addition of social and emotional factors to the traditional cognitive definition opened the door for a holistic approach to media literacy research. Still, a range of different approaches according to a discipline (communication or education, Kubey, 1997) and purpose (protectionism vs. empowerment, Buckingham, 1998) proliferates.

The Media Literacy Tent

In order to study media literacy using digital empathy as practice and research method, we need to understand the different approaches in media literacy research that developed from both Communication and Education disciplines. Communication and Education scholars are part of the Social Sciences, which means that they explore social phenomena to understand and explain the world around us (Singleton, & Straits, 2010). Communication includes: quantitative research such as media effects (represented by Gerbner & Gross, 1976; Potter, 2012), investigating outcomes of media consumption; qualitative research, such as audience research (Jenkins, Clinton, Purushotma, Robison & Weigel, 2006) and media practi-

tioners who study how their participants produce media messages (Tyner, 2003); and mixed methods exploring case studies of media literacy practices (Soep, 2006). In Education, we find descriptions and evaluations of media literacy programs (Burn and Durran, 2007), historical research (Moody, 1993), and transformative research (Vasudevan, 2008).

Media literacy has been compared to a big tent where different research methods and practices fall under either protectionist or empowerment approaches (RobbGreico & Hobbs, 2013). Media effects research as part of the Communication discipline, represents the protectionist approach and is more likely to use quantitative methods to examine the impact of media messages through a survey or an experiment (Scharrer, 2005; Primack, Gold, Land & Fine, 2006). Research on production represents the empowerment approach that usually applies such methods as ethnography to examine experiences of media production using observations and interviews (Ito, et al. 2013; Niesyto, Buckingham & Fisherkeller, 2003). In the Education discipline, critical media pedagogy represents the protectionist approach that typically uses mixed methods to evaluate critical thinking of students by analyzing their skills, coding their work, and conducting interviews (Goodman & Cocca, 2014; Kellner, 1995). Participatory and civic engagement research represents the empowerment approach, which commonly uses phenomenology or action research to describe the relationship between composing messages, interacting with media, and the social outcomes (Halverson, 2010; Kahne, Middaugh, & Allen, 2014).

Protectionist and empowerment approaches to media literacy use different methods to explore how mediated social experiences affect the individual and society. In both disciplines, when applying protectionist approach, media literacy research looks at the way media literacy skills can help to gain control over media messages by analyzing and evaluating these messages; when applying the empowerment approach, media literacy research looks at the way media literacy skills can promote self-expression, agency, and communication by producing media. While media literacy research as an interdisciplinary field bridges Communication and Education disciplines, it has yet to bridge the gap between the protectionist and empowerment approaches. Now more than ever, it is time to bridge between the protectionist and empowerment approaches to promote a better understanding and explanation of human interactions and interpretation of their digital use.

In this chapter, I suggest using two empathic practices that can bridge between protectionist and empowerment approaches and advance media literacy research in the Digital Age. "The possibility of empathy between observer and respondent is one of the advantage that the social sciences have over the physical sciences" (Guba & Lincoln, 1981, p.140). In addition, Guba and Lincoln explained how empathy and objectivity are complementing each other. Patton (2002) described how the researcher can be at the same time empathic and neutral. While neutral means being nonjudgmental, being empathic means communicating understanding, interests, and caring. This is why, researching media literacy empathically prevents the researcher from looking at the participants as those who need to be protected from media or those who are empowered by it. Using empathy-based research design applies nonjudgmental inquiry of participants' digital engagement. In order to find the method for empathic neutrality, Merriam (2001) suggested using case study to establish rapport between the researcher and the participants using interviews, observations, surveys, and analysis of documents and artifacts. More specifically, I will introduce the practice of empathic design combined with empathic listening as a holistic method to research media literacy that I call digital empathy.

Digital Empathy

Digital empathy is a set of cognitive, emotional, and social skills as well as a process, through which a person can analyze, evaluate, reflect, project, predict, feel, sympathize, engage, and role-play through mediated communication with digital technology. This complex concept encompasses various psychological and sociological definitions of empathy. Holistically, empathy combines cognitive, emotional, and social skills and processes that help one better interpret and interact with the other (see table 1, Friesem, 2015). It is important to point out that empathy is not a unified framework. There are multiple approaches that define empathy differently. Historically, empathy as a psychological and sociological term was coined more than 100 years ago as a translation to Theodor Lipps' German word "Einfühlungsvermögen" ("feeling into"). For Lipps "empathy not only plays a role in our aesthetic appreciation of objects. It has also to be understood as being the primary basis for recognizing each other as minded creatures" (Stueber, 2014). Since then, empathy has broken into fragmented silos. Digital empathy is my attempt to recover Lipps' holistic definition adapted to the Digital Age. In this section, I will explain the six psychological, social, moral, and educational aspects of empathy as it evolved from Lipps' definition and how it relates to media literacy research.

Empathic Accuracy: Analyzing and Evaluating

Empathic accuracy is a successful attempt of empathic inference. It is a fundamental dimension of social intelligence that can be measured. It applies perspective taking as data gathering, analysis, and evaluation. In the last twenty years, Ickes (2009) developed a method to measure video-cues interpretation. During each video recording at several points, the filmed individual reported her/his thoughts and feeling. Later on, the same individual explained her/his thoughts and feeling at the same accuracy points while watching the video she/he featured. The correlation created the database from which the actual

Table 1. Digital empathy

Empathy	Definition	Digital Media Literacy
Digital Empathy	"The cognitive and emotional ability to be reflective and socially responsible while strategically using digital media" (Friesem, 2015)	Access, analyze, create, reflect, act (Hobbs, 2010)
Empathic Accuracy	"'Reading' other people's thoughts and feeling" (Ickes, 1997, p. 2)	Analyze
Self-Empathy	"A process in which the individual adopts an attitudinal stance of nonjudgment and openness toward the self" (Neff, 2003, p. 90)	Reflect
Cognitive & Emotional Empathy	"Knowing another person's internal state, including his or her thoughts" and "feelings and coming to feel as another person feels" (Batson, 2009, p. 4-5)	Access, analyze, act
Imaginative Empathy	"The tendency to imaginatively transpose oneself into fictional situations" (Davis, 1996, P.57).	Analyze, create
Empathic Concern	"The underpinnings of compassion and connection in social relations" (Zahn-Waxler, Robinson & Emde, 1992, p. 1083)	Create, act

Note: Table is adapted from Friesem, Y. (2015). Digital Empathy. Retrieved from www.digitalempathy.net

research participants were to infer at these accuracy points what were the thoughts and feelings of the filmed individual. Similar to media literacy scholars who research media effects, empathic accuracy research method can help increase the validity of the research. This branch of media literacy measures the participants' ability to take the authors' perspective and interpret the meaning of the media message.

Self-Empathy: Reflecting

Self-empathy combines self-consciousness and mindfulness as the ability to reflect on oneself. While some scholars use a self-reported survey (Greco, Baer, & Smith, 2011), others use observations and dialogue to foster and measure self-empathy (Jordan, 1997). Individuals who can be self-aware and mindful are more likely to be thoughtful consumers and creators of media messages. In addition, not only do these individuals have a strong sense of identity due to their high level of self-empathy, but also they can voice their opinions and build a strong sense of agency as media literate people. Media literacy scholars who are interested in individual outcomes of consuming or composing media messages should use reflective practices of mindfulness to validate their results.

Cognitive and Emotional Empathy: Projecting, Predicting, and Feeling

While cognitive empathy is the ability to understand others' perspective, emotional empathy is the ability to feel others' feeling (Shamay-Tsoory, Aharon-Peretz, & Perry, 2009). In their neuroscience study, Shamay-Tsoory et al. found two independent but overlapping systems. From a neurological perspective, the ability to identify, analyze, project, evaluate, predict, and respond is separated when it comes to thoughts and emotions. However, from a psychological and sociological perspective, it is harder to separate these overlapping systems of cognitive and emotional empathy. Zahn-Waxler, Robinson, and Emde (1992) examined both cognitive and emotional empathy of twins combining interviews, observations, and survey to triangulate the data. Cognitive and emotional empathy can help validate how digital interactions are made, perceived, and affect others. Composing media messages and communicating them to others effectively demands a high level of cognitive and emotional empathy. Media literacy scholars who are examining participatory culture should emphasize the mediated social interactions through the lens of cognitive and emotional empathy to increase their validity.

Imaginative Empathy: Role Playing

When interpreting or composing fictional situation, one must have the ability of imaginative empathy. It is highly relevant to the work of media literacy that explores digital texts and online games to show how identity can be formed using imaginative empathy toward fictional characters (Tronstad, 2008). Research of imaginative empathy can vary from clinical interviewing and observations (Kaine, 1999) to content analysis (Scott, 2014). In fact, at U.C.L.A. Brain Mapping Center, students are investigating how using imaginative empathy promotes the understanding of digital networking (Iacoboni, DeLiema, & Hoyer, 2014). Media literacy researchers should use measurements to evaluate the ability to role play and imagine fictional situation. Using interview, observations, and/or content analysis, media literacy researchers can estimate the level of the imaginative empathy of the consumers and/or producers to increase their research validity.

Empathic Concern: Sympathizing

In many cases empathy is mistaken as sympathy (empathic concern). However, "sympathy refers to the heightened awareness of another's plight as something to be alleviated. Empathy refers to the attempt of one self-aware self to understand the subjective experiences of another self" (Wispé, 1986, p. 314). In their experiment, Batson, Eklund, Chermok, Hoyt, and Ortiz (2007) examined responses of individuals to hypothetical situations in their psychology lab. Regarding media literacy research, empathic concern is a key component to phenomena such as cyberbullying. Depending on the nature of the digital engagement, it can promote either emotional detachment or on the other hand, empathic concern. Furthermore, media literacy researchers should be empathically concern about their subject as they evaluate their digital consumption and production. Being empathically concerned does not mean to project the researcher' subjectivity and skew the data. On the contrary, it means to be more attentive to and caring about their research subjects as human individuals with emotions. This is an ethical issue that can be practiced while keeping neutrality, as I will explain later.

Empathy and Media Literacy

Since empathy is a "universal human necessity for functioning in an interpersonal world" (Bohart, & Greenberg, 1997, p. 437) now, more than ever, it is crucial to combine research methods of both empathy and media literacy. I would like to suggest that each empathy construct as seen in Table 1. (Friesem, 2015) can be applied to media literacy research. With case studies, media literacy researchers can empathize with the participants through surveys, interviews, observations, reflections, and content analysis of participant' artifacts. Evaluating media literacy is an assessment of five media literacy skills: access, analyze, create, reflect, and act (Hobbs, 2010). For that purpose, the five empathic constructs (empathy accuracy, self-empathy, cognitive and emotional empathy, imaginative empathy, and empathic concern) all together can offer cognitive, emotional, and social methods to measure and evaluate the five media literacy skills using empathic design and empathic listening.

Reframing Media Literacy Research

With the intention to bridge the two disciplines (Communication and Education) as well as the two approaches (protectionist and empowerment), we need to reframe media literacy research as a holistic method combining cognitive, emotional, and social concepts. Applying digital empathy would increase the validity of media literacy studies along with ethical values and better practices. Applying a holistic method would go back to McLuhan's (1994[1964]) media theory. Since its inception in the 1960's, media literacy research, influenced by McLuhan, had connected to social responsibility and civic engagement (Culkin, 1964). Nowadays, our use of digital devices as a mediated communication process require us to use our empathic abilities to thoughtfully access, analyze, create, reflect, and act. The empathic abilities can be assimilated into media literacy research using the following holistic approach, merging two empathic practices into media literacy research methods.

The first, *Human-Centered Design* (IDEO, 2014) is a five steps process developed by a design firm that reframed empathic design (Leonard & Rayport, 1997) for educators (discovery, interpretations, ideation, experimentation, evolution). Redefining for educational context, the toolkit connects empathic design as it enhances learning. These steps can be applied to a research process as well. The process

starts with discovering a challenge or a research problem. By empathically reviewing previous research, the researcher can define the issues and how it was addressed so far. Then, ideate or in other words articulate the research question and the research path and its methodology. The researcher can frame the research question imagining her/his audience. Imaginative empathy can help frame the experiment or the data collection. Last, the results can evolve into action and solution to the problem in other settings as we acknowledge the differences by emphasizing with various recipients. While human-centered design offers many activities to emphatically re-frame design process, it does not address research methods, especially how to validate the findings.

Bohat and Greenberg (1997) described the three Rogerian steps to validate thoughts, feelings, and interactions "one must have unconditional positive regard for the clients, one must be able to empathically grasp the meanings in their communications and actions, and one must be able to respond genuinely" (p. 435). To put it simply, in order to have empathic interactions, one must listen without judgment, ask for clarifications, restate the others' statements, and validate that what they understood is what the other meant. McKee (2014) used Goffman and Goffman's (2007) longitudinal research that showed the effectiveness of empathic listening as four linear steps: listen, ask, restate, and validate.

Both the five human-centered design steps and the four empathic listening steps are not just about being more cognitively, emotionally, socially, and morally aware; this is purely good research practice. In the following section, I will showcase the use of these two empathic practices as part of a longitudinal case study. During four years, our research team used surveys, observations, interviews, autoethnographic reflections, and content analysis of students' media production. Applying case study in education (Merriam, 2001), our research team explored and tested different methods to collect data and analyze it as the project developed. Over time, we came to the conclusion that the empathic practices of our media literacy study were the most effective ones to help us understand the benefits and challenges of the media literacy program to students' outcomes, teachers' instruction, and the learning process.

CASE STUDY IN MEDIA LITERACY

In the last four years, the Media Education Lab at the University of Rhode Island provided media literacy classes for twenty underprivileged high school students as part of a month-long summer academy that familiarized students with the University campus. We studied the effects of the program in a longitudinal study using human-centered design and empathic listening practices. As we developed our

Table 2. Digital empathy as media literacy research method and media literacy

Empathic Design	Empathic Listening	Media Literacy Research
Discovery	Listen, Ask, Restate	Literature Review and Exploration
Interpretations	Listen, Ask, Restate	Planning
Ideation	Listen, Ask, Restate, Validate	Teaching
Experimentation	Listen, Ask, Restate	Data Collection
	Validate	Analysis
Evolution	Restate, Validate	Findings

Note: Table is adapted from Friesem, Y. (2015). Digital Empathy. Retrieved from www.digitalempathy.net

research design we explored different components that became a structured research method I called digital empathy. Using surveys, observations, interviews, authoethnographic reflections, and students' artifacts, we were able to (1) evaluate the program effectiveness; (2) find changes in students' attitude and behaviors in regard to their media literacy skills; (3) portray best practices of media literacy instruction. Upon receiving the University approval for the research, the legal guardians of the students, the students themselves, as well as all the instructors and staff were introduced to the research and signed on consent forms. While all legal guardian signed on the forms, four students chose not to sign since they felt uncomfortable participating.

Discovery: Literature Review and Exploration

Our team varied in their educational experience and media literacy training. Furthermore, the unique context, offering a university level class to underprivileged adolescents challenged us as both instructors and researchers. At first, we looked at the existing literature to create the program. We did not know what variables interested us besides evaluating the program effectiveness. Our priority was to teach. First, we tried to learn about our future students by interviewing the national and local program organizers. Second, we studied the literature. Third, using empathic practices such as gathering information and understanding what are the needs of each stakeholder, we created a coherent curriculum to teach a 36 hours class in digital media using analysis and production to introduce media literacy practices (Friesem, Greene, Provorova, Tierney, & Hobbs, 2012). While brainstorming, we looked at the topics that we were asked to teach, wanted to teach, along with what works according to the literature.

Interpretations: Planning

Our instructional team agreed that the most relevant and useful frame was *Digital and media literacy: Connecting culture and the classroom* (Hobbs, 2011). As the lead instructor, being the experienced teacher, I provided a lesson plan template. Each instructor was in charge of specific topics. Our team prepared for the program during two months and met regularly to review the lesson plans. In addition, we reviewed each other's instruction as we modeled our lesson while the other team members gave each other feedback. This was not part of our research, rather our preparations for the program. Nevertheless, retrospectively, I saw it as the first two steps according to human-centered design to empathically discover and interpret what are our needs. In the next two years, being familiar with the students, with the program, and having confidence in our own instruction, we were looking for new areas to discover and interpret. Using the same lesson plan frame, we explored the interjection of informational and computing literacy in the second year, social justice, activism, and marketing in the third year, and reflective production in the fourth year.

Ideation: Teaching

Arrogantly, in the first year, we considered ourselves highly prepared to teach the first class. Though we conducted interviews and reviewed the literature, we neglected to ask the students themselves, ahead of time, what they wanted. Our twenty underprivileged students came to this program to learn college readiness since they had difficulties in high school that none of the instructors were familiar with. Each

teenager student in the program had been gone through many challenges in their short lives that made most of them question authority and mistrust strangers. While our discovery and interpretation phases, using empathic practices, were good on paper, we needed to find strategies to offer the students trust and meaningful relationships in order to proceed with our lessons plans. We decided to have two strategies that would become the core of our work in the program. We found that trust issues were divided into the interactions between the students themselves and with us as the instructional team.

Peer empathic feedback was developed to address the students' trust with each other (Friesem, & Greene, 2013). In order to have a meaningful discussion using positive reinforcement reflection, each student's work was given a sandwich feedback (praising, criticizing, and praising). However, some students were not always receptive. We decided to make two major changes. First, students were given a beginning and ending statement to fill out: what I love about your video is… Second, instead of criticism in between, they offered an empathic suggestion using first person to state that this is their own opinion putting themselves in the other students' shoes: if I were you I would… Over the four years, we observed positive change and anticipation practice the peer empathic feedback by the students. For some students with emotional disorders it was very difficult to hear the suggestion though they were not criticized. Still, the peer empathic feedback was successful as an instructional tool as well as a research one. It was helpful as a validation tool, as I will discuss later.

Empathic listening was the other strategy used to address the tension between the students and the new instructors. Like the peer empathic feedback it developed during the four years and was used according to the instructors' personality and familiarity with the students. During the first year, the program introduced the students to cinematic techniques by collaboratively producing thirty-second commercials. Then, the students, in the same groups, created music videos in which they could express their creativity. The third video assignment was a manifest of their social responsibility. Offering the scaffolding to video production enabled them to gradually express their voice and interests. Using media literacy pedagogy, we listened, asked, restated, and validated their thoughts and emotions. The second year they designed personal websites. The third year they created digital campaigns. The fourth year, they produced reflective videos. The students used their own ideas that they articulated in the first year during their storytelling class. Our empathic listening was merged with media literacy pedagogy to teach how to use the tool and at the same time made sure we were attentive as well as trustworthy for our students. Like the peer empathic feedback, it was a highly useful instructional process that was effective to collect data and validate the analysis.

Experimentation: Data Collection

We used surveys for program evaluation. We used Baron-Cohen and Wheelwright's (2004) *Empathy Quotient* as pre and post-test. However, this survey was design in the UK to evaluate the psychiatric state of an individual on the autism spectrum focusing on cognitive empathy. The results showed no changes in the cognitive empathy of the students. The emphasis solely on measuring cognitive dimension using surveys changed in the second year. While looking at the students' grade, attitudes, and media literacy competencies using surveys, we also triangulated with qualitative methods such as observations and interviews.

To capture students' interactions we used ethnographic observations. Each research assistant documented in her/his own way at least one dimension of empathy. Our observations were focusing on em-

pathic practices such as: collaboration (Friesem, E., 2014), critical thinking, civic engagement, agency (Greene, 2014), and roleplaying (Friesem, J., 2014). As we sat in the classroom, writing observation notes or video recording, we made sure that the students gave permission and knew what we were documenting. Using empathic listening, we were participant observers, documenting our engagement with the students as they learned about media literacy. To make sure that we were accurately documenting our observations, we would constituently listen to the students and ask them about their work, restate what they answered, and validate that we understood them correctly.

We conducted group interviews and had each student, who agreed to take part in the research, be interviewed each year. The semi-structured in-depth interviews were either video taped or audio taped according to students' approval. As we shifted during the four years from program evaluation toward examining media literacy skills and empathic practices, our questions changed as well. Being in the classes and knowing the students for a year or two helped us build relationships of trust while receiving deeper answers. These relationships might be perceived as a validity threat. However, the empathic listening helped us stay neutral and empathic (Patton, 2002). We made sure we were not letting our own personal bias dominate the data collection but rather making sure students were fully heard and understood. Ginsburg's (1997) clinical interview combines Piagetian and Vygotskian practices of engaging and assessing students' knowledge with ethical practices to make sure the interviewer is mindful of the young interviewee. Following Ginsburg's checklist for the interviewer, we made sure to listen, ask, restate, and validate the answers.

During the data collection, we continued to reflect. We met after every class and reviewed the challenges and successes of our instruction alongside with the data collection processes. We found that our own voices and perspectives as both researchers and instructors were extremely valuable, just as Holt (2008) stated: "autoethnography can encourage empathy and connection beyond the self of the author and contribute to sociological understandings" (p. 26). We could choose to either videotape ourselves or write a short reflection. Each week, we posted in our online closed blog our reflections. It helped us better understand what each one of us was going through, but also to triangulate observed situations from different angles. For example, one student started to argue in class and then left. We were able to better understand why after hearing a staff member mentioned that the student received troubling news from home. Hearing and reading the reflections helped us acknowledge our subjectivity as teachers and researchers. By being open about our own subjectivity and practicing self-empathy, we were able to be neutral and empathic, differentiate our thoughts, feelings, attitudes, and behavior from the students.

Last, we examined students' artifacts including videos, songs, video games, storyboards, written assignments, websites, blogs, and posts in social networks. Looking at their peer empathic feedback practice, sharing thoughts, and working together, helped us to look at their cognitive and emotional empathy as well as their empathic concern. Their ability to picture their target audience showcased their imaginative empathy. As we collected or reviewed their work, we listen to their explanation applying Iackes' (1997) empathic accuracy practices with videos. With class discussion, other students and instructors could ask questions. Using the peer empathic feedback, the students, instructors, and researchers restated and validated the purpose of the media message.

The data collection in each year combined analysis as suggested by Merriam (2001). This is a case study since it was one media literacy program that was evaluated holistically. It was related to the context of the University and it addressed current trends in education and media literacy. Using these mixed methods we were able to look at students media literacy skills, empathic practices, and develop digital

empathy research methods. While the process was framed as human-centered design process (discovery, interpretations, ideation, experimentation, evolution), the data collection implemented empathic listening process (listen, ask, restate, validate).

Validation: Analysis

As stated before, I believe that only holistic data collection and analysis with mindful introspection can represent valid results. Empathy is a useful practice to make sure participants agree with the researcher's interpretations and reception of their actions, thoughts, and feelings. Empathic practices are the key to making sure that you truly listen, observe, and interpret the person in front of you. Empathy helped us understand our students as we got to know them and work with them during the media literacy program. As researchers, triangulating our data and verifying our interpretations, made sure we not only analyzing accurately our students' work, but also ethically representing them while helping them advancing their media literacy skills.

Evolution: Findings

We found that students demonstrated an increase in each one of the digital and media literacy competencies (access, analyze, create, reflect, and act) after each year. The students became more proficient in locating credible information using different search engines, posting and sharing thoughtfully on social networks, editing on various software, and operating skillfully different cameras. As they practiced analyzing media messages from professional videos, websites, and their peers' work, students were able to increase their critical thinking as demonstrated by their detailed answers to the five media literacy critical questions (Hobbs, 2011). First year, they were able to produce three group videos. Second year, they were able to design websites. Third year, they created digital campaigns using videos, websites, and social networks to create awareness for civic action on social issues that concerned them. This was their collaborative effort to share a solution to a social problem. They reached out to caregivers who could offer support and used the digital platforms to connect with teenagers who needed help. Fourth year they created videos to reflect on their development in the program.

During the four years, we gradually developed effective empathic practices with media literacy such as peer empathic feedback and empathic listening. In addition, students' analysis skills using empathic accuracy and imaginative empathy demonstrated their understanding of their own audience and the target audience of professional videos. While working collaboratively on their civic engagement project, they demonstrated cognitive and emotional empathy as well as empathic concern for each other. This is not to say that all went smoothly without group dynamics that developed into conflicts.

Like all research, especially case studies, the context of the research is particular. While our results cannot be generalized, some of them can be transferred (Creswell, 2014). Practicing empathy as instructors and researchers cannot be practiced all the time by everybody. Many find it exhausting, being attentive all the time and practicing active listening (Stebnicki, 2008). Others find the applications and definitions confusing (Bloom, 2013). Nevertheless, the results showed that for our students as well as for us, as both instructors and researchers, applying digital empathy as holistic research method promoted critical views (protectionist approach) and creative expression (empowerment approach).

CONCLUSION

By applying digital empathy as a media literacy research design, we were able to explore the students' media literacy skills and empathic interactions from both protectionist and empowerment approaches. The complexity of the different cognitive, emotional, and social components with a mixed methods approach contributed to the richness of the findings as it can be seen in different publications (Friesem, E., 2014, Friesem, Y., 2014, Friesem & Greene, 2013, Friesem et. al., 2012, Greene, 2014). At the same time, further research is needed to test the method in different settings with different populations. Our media-saturated environments allow more people to consume and create media. While some see it as a social challenge, we can see how more and more populations can benefit from digital empathy.

It is time for media literacy research to return to its roots using a holistic method that combines protectionist and empowerment approaches to increase the validity of its research in the Digital Age. Now more than ever, it is important to find the human experience while the researchers remember to have a rapport with their participants. Empathic design and empathic listening provide a framework for research design that allows the media literacy researcher to apply ethics of care while keeping neutrality. The analysis of media messages, their production, and their effects on our students and us should be studied holistically as we are emphasizing and keeping neutral.

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KEY TERMS AND DEFINITIONS

Digital Empathy: Holistic approach to teach and research media literacy in the Digital Age. It combines cognitive, emotional, social, and moral aspects of digital and media literacy.

Empathic Design: Five-stage process that looks at the participants and community experience to explore better ways to designing produces and processes. The key components are perspective taking and role-playing to better understand other's point of views that leads toward an inclusive approach.

Empathic Listening: Active process of hearing and providing feedback in order to validate the other's perspective. In education as well as research this four-stage practice is important to have better communication and establish trust.

Empathy: Ability and process of an individual communicating with others to understand and acknowledge their thoughts, feelings and behaviors. Holistically it combines the cognitive, emotional, and social parts of the mind as we interactive with others.

Empowerment Approach to Media Literacy: Approach that looks at media as a tool to empower individual and/or communities through expressive composition of texts.

Protectionist Approach to Media Literacy: Approach that looks at the need to be critical media consumers in order to take control of the media messages that we are surrounded by.

Tent of Media Literacy: Overview of the media literacy field according to the US definition, two approaches, and practices.

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Chapter 15
The Social Media "Information Explosion" Spectacle:
Perspectives for Documentary Producers

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ABSTRACT

The semantic web, social media and the amount of user-generated content continues to grow at a staggering rate. Social Media significantly contributed to the information flow during the Arab Spring, the Occupy and Wall Street movement continue to maintain a global online presence using social media technology. But is the social media information explosion really a unique event in media history? How did story telling evolve into social media? In order to place social media in its historical context and anticipate digital native expectations, we explore the origins of narrative and storytelling from the perspective of a documentary producer. How did past media technologies prepare the way for social media? How do digital natives perceive the world via social media and what do they expect from today's documentary producer? What are the viewing habits of digital natives? What do previous 'information explosions' have in common with social and digital media? These are essential questions for media and documentary producers navigating their way through the vast maze of social media technology and the semantic web, in addition to traditional media.

1. THEORETICAL FRAMEWORK

Social media is defined by Kaplan & Haenlein (Kaplan, Andreas M. & Haenlein, Michael 2010). Readers should be familiar with the work of Marshall Mcluhan's (1994) media theory and Briggs and Burke's (2009) history of media.

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2. BACKGROUND

A physicalist approach was taken to investigate the origins and evolution of media technology and the impact of social media on documentary filmmaking. However, a reductionist explanation as to how social media moves us, remains elusive. A dualist position offers a better explanation into phenomena such as catharsis, but still leaves many questions unanswered. As a result, the author of this paper has come to view social media as an extension of our senses (Mcluhan 1994) and consciousness. What exactly is it that touches our inner world when watching a flash mob play 'Here comes the Sun' in a Spanish unemployment office? (Carne Cruda, 2012), Neuroscientists can measure the activity of our brain during catharsis, yet they cannot determine what *it* is that moves us to tears during those moments. Here we conclude that the 'hard problem' of consciousness (Chalmers, 1995) equally applies to social media *content* as an extension of our consciousness, and as such its deeper purpose remains hidden. Yet throughout history and across all media technologies, storytelling has been the key driving factor. Without compelling content there is no social media.

3. INTRODUCTION

The Internet and social media are frequently referred to as the 'information explosion'. Social Media is ubiquitous and significantly contributed to information dissemination during the Arab spring. It continues to be a major platform used by grass root movements such as Occupy and Wall Street. It is swiftly becoming a tool documentary filmmakers rely on during all production phases, i.e. 'Mon Petit', (Mon Petit, 2012) which tells the story of wheelchair-bound Albert Casal, hitchhiking from his native Barcelona to New Zealand. The producers of 'Mon-Petit' have learned how to apply social and digital media to develop, produce and distribute content. Without social media the production of 'Mon-Petit' would not have been possible in this form. Governments too are learning to use social media, but for different reason: propaganda and surveillance. Authorities find it increasingly difficult to censor the amount of user-generated content online when compared to traditional forms of documentary production. Facebook now exceeds 1 billion members (Shaughnessy, 2012).

But is social media really a unique 'information explosion'? Investigating media history from a physicalist perspective, we draw comparisons to today and put social media into its historical context in order to explore current perspectives for documentary producers. Are we witnessing a paradigm shift or another evolutionary step in the development of media history? Can a reductionist theory fully explain the impact of social media? The documentary "God, Church, Pills & Condoms" offers insight into the methods used to develop, produce and distribute content online and examine online behavior of stakeholders and audiences. A survey conducted among 2nd year undergraduate students at NHTV (NHTV, 2013), University of Applied Sciences, Breda, Netherlands sheds further light onto changing viewing habits of digital natives. Results of this paper provide media and documentary producers with an overview of social media in its historical context, a better understanding of audience behavior and insight into emerging trends.

4. RESEARCH METHODS

We investigate the evolution of social media into its current form using a variety of multi-disciplinary literary sources. We applied and tested our findings using our documentary "God, Church, Pills & Condoms" (Kohle. F, Cuevas. A, 2013), examine online behavior in today's video-verse and compare results with research papers in the field for further discussion, including a survey conducted among 2nd year undergraduate students at NHTV, University of Applied Sciences, Breda Netherlands which investigates changing viewing habits among digital natives.

5. RESULTS

Social Media and the information explosion: Terms such as *the* "information explosion" are often used to describe the impact social and digital media has on society and culture. *This* term is *by no means* a new *term:* it was first coined during the print revolution (Briggs/Burke 2009). *Instead the term 'information explosion' is better defined as a* recurring pattern throughout history. However, social media significantly distinguishes *itself from* previous information revolutions in a number of ways:

1. *The social media revolution is moving forward faster in time than any other previous 'information explosion'.* The rate of growth of social media its and corresponding public spheres (Habermas 1974) is expanding at an exponential rate globally.
2. *Social media no longer requires editorial approval by an elite, nor can censorship effectively be applied by a single state (Kohle 2012), (Bondebjoerg 2009).* Digital natives are used to not only consume content; they are capable of generating an increasing amount of online content without effective censorship.
3. *Social Media is part of a paradigm shift of similar magnitude as the invention of language (Dunbar 2003), (Corbalis 2009).* The invention of writing, printing and broadcast technologies, can be interpreted as an evolutionary process rather than a paradigm shift, whereas social media encompasses all previous forms of media.
4. Viewing habits are changing (Kohle/Cuevas 2010, 2012): *digital natives are quickly adapting to the opportunities the participatory web and social media offers.*
5. *Content development, business models, production and distribution strategies are transforming at an ever-increasing speed (Puttnam 2013).* Producers and directors are challenged to constantly evaluate and develop content and new ways of reaching their audiences.
6. *Digital natives expect instant dialogue with the makers of a programme.* Projects need to feature a number of narratives across various platforms to really meet the growing expectations of their audiences. The narrative among digital natives is rapidly developing and needs to be better understood by producers.
7. *Programme-maker need to carefully consider their target audiences, small or big, and design the programmes relevant transmedia strategy accordingly.* A linear narrative in the form of a film still features prominently in the media vocabulary of a digital native; but digital natives also expect to engage with gamified and transmedia content as well as opportunities for feedback and contribution.

6. DISCUSSION

Origins of Social Media

By nature stories require language, writing and images. Without these elements we lack the means to tell stories and engage with social media. We examine evolution of these elements from prehistory to present day from a physicalist position to provide a contextual background. Is there a repeating pattern in the evolution of the above elements? How does technology influence story telling? What can we learn from media history?

Language

Children have an "Instinct of Inventiveness" (Locke/Bogin 2006) enabling them to invent language even if linguistically deprived. As speech evolved our brains adapted to this new tool. Memory improved as we developed the capacity to speak and refer to events in the past. This ability for 'Mental Time Travel' requires two types of memory: semantic and episodic memory. Episodic memory (Tulving 2002) is more interesting to us as by nature, it lends itself to a narrative structure. The concept of time provides the basic elements needed for story telling: past, present and future. The most basic definition of a story requires a beginning, middle and end with the narrative unfolding over a period of time. Without the invention of language these basic elements needed for a narrative would not exist.

Narrative is needed for all consequent forms of media – and for that reason we submit that language was a paradigm shift, a real game changer in the history of storytelling. *Oral* story telling remained the key instrument of communicating information over distances and time for mankind until writing was invented. Stories passed on verbally over generations maintained their basic plot structure accurately but adapted to the cultural and social circumstances of the time (Cvorovic 2006). The invention of language can be considered the first prehistoric 'information revolution'. The ability to use tools while explaining their use, led to the development of pedagogy (Corbalis 2009) – a key tool regarding the dissemination of information.

Rock Art, Cave Paintings and Early Writing

As speech and language continued to evolve, man began to explore new and more abstract forms of expression and communication, such as rock art and cave paintings. In February 2012 cave paintings were discovered in Spain, which are estimated to be 42000 years old (Pike/Hoffmann 2012). Archaeologists and Anthropologists are debating if these cave paintings were created by the first anatomical modern humans or Neanderthals. The paintings depict hunting scenes, animals, the night sky and silhouettes of hands. Unlike speech, which once spoken leaves no permanent record other than in our own memory, rock art and cave paintings remain visible, forming a permanent external record.

Whichever species left behind some of the earliest records of human creativity, the question remains as to what motived early cave dwellers to decorate their environment in this way. 26 cave symbols (Ravilious 2012) are shared across caves in southern France by early man, implying that this 'creative explosion' took place earlier, perhaps even before the arrival of modern man in Europe. From rock art and cave paintings it is but a small step towards proto-writing (Merola 2007), (Lauinger 2011): a picture system dating back 30-35000 years. (See table 1)

Table 1.

	Approximate Dates Years ago	Event
Lower Paleolithic	2.5 million – 400.000	Invention of Language: 1st 'Information Explosion"
Middle Paleolithic	200.000 – 45.000	Arrival Homo Sapiens: "Creative Explosion"
Upper Paleolithic	45.000 – 10.000	Rock art, Cave paintings: 2nd "Information Explosion"
Neolithic	10.000 – 7.000	Invention of Proto-writing: 3rd "Information Explosion"
Chalcolithic	7.000 – 3.500	Cuneiform writing
Antiquity	3.500 - 600	Invention of the Alphabet: 4th "Information Explosion"
Medieval	600 - 1500	
Early Modern	1500 - 1800	Invention of the Printing Press: 5th "Information Explosion"
Industrialization	1800 - 1900	Invention of Broadcast Technologies: 6th "Information Explosion"
20th Century	1900 - 2000	Invention of the Internet & Social Media
21st Century	2000 - now	Social Media: 7th and current "Information Explosion"

Dunbar provides evidence suggesting that the human brain, when compared to other hominids, is capable of a social network encompassing some 200 contacts: a size inadequate for prehistoric permanent settlements exceeding that number. It became necessary for early man to overcome this biological limitation for cognitive evolution by cultural means (Watkins 2010), i.e. monumentalism and *storytelling*. This enabled early men to evolve from a hunter-gatherer group and develop the agricultural skills needed to form permanent settlements.

The formation of tribal settlements undergoing a cultural and spiritual process can be found in early cave paintings: some of the cave paintings in Southern France and Spain are located deep inside cave systems with no natural light available. To venture that deep into the caves, the creators of those paintings deliberately sought out a location isolating them from the outside world. It is reasonable to argue that this is intended because the creators of those paintings wanted to invoke a spiritual experience, an experience not unsimilar to the one a contemporary cinema induces on today's cinema visitor.

With external influences reduced to a minimum the viewers' attention is drawn entirely to the big screen – or cave wall enabling catharsis. A physicalist position reaches the limits of what can be explained at this point. Why is catharsis necessary? How can physicalists explain what it is like to experience catharsis? Media, as an extension of our consciousness, cannot be explained by reductionism alone. Werner Herzog's "The Cave of forgotten Dreams" (Herzog, 2012) investigates the Chauvet cave paintings in Southern France, highlighting just how deep the paintings are located inside the cave. In consequent interviews Herzog also refers to Chauvet as a form of 'proto-cinema'.

The role of the storyteller and painter changed significantly: he or she is no longer master of a narrative forming part of an invisible oral domain. The creators of cave paintings are very much in control of a physical and artful process projected onto a cave wall: a process that repositions the painters and their role as storytellers within the tribe. Karl Marx and Friedrich Engel's Communist Manifesto (Marx

& Engels, 1969,p. 98-137) offers an interesting perspective on the evolution of early communes and elites and the consequent class struggle, which persists until today. Critics are quick to point out that Marxism neglects the spiritual dimension in man (Brentlinger 2000) already on display in those early cave paintings.

The Alphabet

Documenting history, accounting for resources, trade agreements and accounts of battles lost and won, eventually led to the invention of the Alphabet. (Andis, 2012) This in turn gave rise to an 'information revolution' in antiquity. Who exactly invented the alphabet is still subject to discussion (Goldwasser 2010), but we know that Phoenicians played a major part in spreading the alphabet across the Mediterranean Sea as part of their trade activities.

The alphabet gave rise to a new form of writing: Greek writers repositioned the storyteller with a strong philosophical perspective. Antiquity gave the storyteller a voice, which did not exist before; a form of storytelling that is still found today, i.e. auteur cinema finds its early roots in Greek narrative history. Conflict and war are important *factors in* the evolution of media. As tragic as it seems: without war and conflict, media would not have developed into its current form. Conflict in the Middle-East has been described by many sources (biblical, Egyptian, Phoenician, Greek) for thousands of years. Between 700 and 588 BC nineteen Mediterranean conflicts are accounted for (Conflict History, 2012), with the amount of conflicts steadily increasing in recorded history.

Table 1 provides an overview of the various past media-'revolutions'. There is much debate about the exact timing of the *given dates.* Evidence suggests that Neanderthals were capable of speech including the creation of rock art and cave paintings. Even hominids such as Bonobo apes (Benson, J, Greaves, W., O'Donnell, M, Tagliatlatela, J. 2002) have demonstrated the potential for language, though this remains a hotly debated topic among linguists. Creativity is not a trade exclusively reserved to Homo Sapiens, though some members of the species Homo Sapiens would like to claim otherwise (Pagel 2011).

The Printing Press

It would take a few more millennia before the arrival of the next major 'information explosion': Gutenberg's printing press. Even though printing technology had been developed a millennium before Gutenberg in China, *t*he alphabet combined with Gutenberg's press, suited the literate European elite and middle classes in the 14*th* and 15*th* century Europe best, at a the time when Europe was ravaged once again by conflict.

Culturally and socially Europe was starving for new ideas, which eventually led to European Reformation and Enlightenment. The printing press also gave rise to a new problem: copyright infringement. Briggs and Burke (2009) provide an interesting account of the cultural and political background during enlightenment. To avoid prosecution Amsterdam printers named a non-existent Cologne printer as the publisher of one of the most printed books of all times: the bible. The bible would not remain the most popular book, soon romantic stories and poetry would generate revenues in the form of James Thomson's "The Seasons" published by Alexander Donaldson. Thomson's poetry soon became a copyright landmark case: on February 22, 1774, the House of Lords in the United Kingdom decided in the case of Donaldson v. Becket (Rose 1988) that copyright is not perpetual, but limited in duration, thus leading to the development of today's copyright law.

It can be argued that the media tools of creativity, used by the best writers and artists *of the time* to create prose and art, such as the alphabet and the printing press, are byproducts of thousands of years of Middle-Eastern and European conflict. Unlike language though, print technology was controlled by the elite. As power struggles continued to take their toll across Europe, the next information revolution would take place this time not thousands, but merely a few hundred years later. With each 'information revolution' the arrival of the next revolution occurred sooner, such as the invention of broadcast technologies.

Europe was beginning to lose grip on her colonial domains and once again she was ravaged by major world wars, as broadcast technologies evolved from Marconi's radio transmitter into *Film and* Television.

The scientific process, which made broadcast technologies possible, spanned some 200 years; a very short time when compared to the time needed to invent speech, writing, the alphabet and printing. During that time the world experienced nearly 900 documented conflicts, double the amount accounted for during Gutenberg's period. History tells us that past information revolutions are not associated with less but more war and conflict. The Internet too is a military invention, with its origins in the cold war: Arpanet (Mowery 2001). Since 1990 the world has experienced 322 documented conflicts, rising in speed and occurrence along with the 'new' information revolution: the Internet and social media. Conflict and media are intrinsically linked, and during times of war new forms of media technologies emerge as a matter of life or death.

As was the case with the invention of language itself, writing and the Alphabet, printing and broadcast technologies, social media requires the audience to develop a new form of media literacy, giving rise to different forms of social, political and cultural awareness. Unlike previous media revolutions, social media encompasses all of the above, providing a platform almost entirely reserved for user-generated content. Content is available instantly, globally and on a variety of screens and devices. 'Mon Petit' and 'God, Church, Pills & Condoms' are excellent examples of how social media provides a platform to guide and shape user generated content during development, production and post-production stage. Social Media was the exclusive tool used to distribute 'God, Church, Pills & Condoms'; consequently it was accepted into Cinemalaya and the Hanoi Film Festival in 2012.

How Are Digital Natives Experiencing Social Media?

A total of 26,000 hits were registered on the YouTube site since July 2011 for our documentary "God, Church, Pills & Condoms". Throughout production, post-production and distribution on the festival circuit, we made various short clips available online for stakeholders and the public, steadily building up an audience. Statistical data shows that a great deal of traffic was generated by YouTube Philippines, as the political stage surrounding the documentaries topic, controversial health care legislation, is set there. Filipinos around the world have been watching and commenting on the film on the projects *F*acebook and *Y*ouTube page, at times engaging in passionate online debates. Data collected from both sites show that audiences, especially digital natives, are increasingly accessing content in a "video-verse": 14.6% of viewers access content via smart phones.

42.4% of digital natives enrolled as 2*nd* year undergraduate students at NHTV, International University of Applied Sciences, Breda, watch mainstream news and factual programming most of the time. 53% obtain their news from the Internet. Print ranks bottom of the list at 12%. Social media and Internet have become the main source of information for digital natives. 81.1% of participants surveyed claim that mainstream news has more impact on their opinion forming process, with only 18% stating that internet and social media have most impact on their opinion. For 54% of participants the internet and social media

has significant impact and combined 72% of all digital natives surveyed consider the internet and social media as a source that has the most if not significant impact: a figure not far away from the 81% still holding on to mainstream news as the main source of information for opinion forming.

Mainstream broadcasters are competing with Social Media, broadcasting user-generated content during unfolding events such as the Arab Spring; they will need to do more to engage and retain digital natives. Experts in a studio interpreting and explaining events to the audience are not enough to satisfy the critical mind of a digital native, which increasingly develops the cognitive tools and ability to generate and react to user-generated content on a regional and global scale. News are no longer solely obtained top-down from a mainstream broadcaster such as CNN, the BBC and others worldwide, who begin to incorporate social media into the existing paradigm, slowly adapting to a new a new form of media literacy.

Digital natives engage and expect to be engaged with programme makers and their content at home, at school and while travelling. Using our documentary "God, Church, Pills & Condoms" we applied social media strategies during development, pre-production, production, post-production and distribution. We examined viewing habits via YouTube, Facebook and the impact of social media combined with real-world events such as the Cinemalaya Festival setting. *"God, Church, Pills & Condoms" is* now in distribution and social media still plays a major part. During development, pre-production, production and production of *"God, Church, Pills & Condoms",* social media was and still is crucial to engage with stakeholders and audiences on a global scale.

This significantly contributed to its success. Stakeholders for all of the above are able to interact, comment and suggest content at any time. Data from all of these sites confirms that digital natives and many digital immigrants are quickly accustomed to the new video-verse. A real-world setting is nevertheless required. Events in the virtual social media world need to be firmly rooted in events taking place in the real world. The premiere at the Cinemalaya Film Festival of *"God, Church, Pills & Condoms"* was not only sold out, it drove traffic to the projects social media sites. YouTube's and Facebook's statistics section provides an excellent overview of demographic and location data. Data is easily accessed online and suggests that the programme continues to contribute to an ongoing debate in the real as well as virtual world in the Philippines. To underline that point, 'Mon Petit' features two digital natives and accompanies them on their journey to New Zealand. 'Mon Petit' would not have been possible in this way, without social media communication between the production team and the protagonists: content and narrative structure could not have evolved accordingly. Social Media is changing the way content is developed, produced and distributed.

Digital Natives and Revolutionaries in the News: Are the Elite Concerned?

A 16-year-old girl in the Netherlands published her birthday on Facebook and did not mark the event as private. (BBC, Facebook party invite sparks riot in Haren, 2012) As a result some 3000 party visitors descended upon the small village of Haren causing havoc. A 15-year-old Dutch boy was sentenced to a year of juvenile detention for the murder of a 14-year-old girl. (BBC, Teenager convicted of Facebook murder, 2012), The boy was recruited by another teenager as a contract killer over a row on Facebook. These two cases are well documented but are by no means isolated. Cyber bullying and consequent teenage suicides are increasingly making headline news. (BBC, Teenager's death sparks cyber-blackmailing probe, 2013) (Gadkari, 2013), (Arkin, 2013) (Ensor, J., 2013) (Warren, L., Quigley, R., 2013) Schurgin, Clarke-Pearson (2011) make specific recommendations to pediatricians dealing with the negative effects of social media in children.

These examples serve to demonstrate the level of understanding digital natives have of social media and their ability to utilize social media for their purposes. They demonstrate how digital natives have adapted regarding the use of social and digital media to obtain their goals based on some of the strongest motivators in existence: aggression and murder. The above examples highlight how social media transformed life in a quiet small Dutch village into an evening of terror and violence. For a 14-year-old girl, application of social media ended in her death. A 17 year old teenager committed suicide because of cyber-bullying. Digital natives are well aware on the how to use and abuse social and digital media. Parents, teachers, media professionals and the government –all digital immigrants- are lagging behind current developments.

There is no real guidance available to digital natives on the use of social media. Bullying is not new, but cyber-bullying is a practice which has yet to be dealt with by lawmakers, who are struggling to keep up with this new development. Tragic as these events are, they confirm Mcluhan (1994, p.7): the message has not changed: the media is the message. On a global scale, grass root movements such as Occupy, Wall Street and 15M in Spain as well as Wikileaks must present an even scarier scenario to the elite. Over the last few years various Northern African governments were toppled and social media played a crucial role in news reporting as well as providing intelligence to governments, rebels and terrorists alike. Governments and their secret services are taking social media very serious. Recent events surrounding Syria once again demonstrate this reality all too well. While the public was stunned by user generated content coming out of Libya, digital natives and immigrants alike have learned to view the same more critically: the Occupy and Wall Street movements have become permanent platforms providing alternative information to users and mainstream broadcasters.

Will Social Media Replace Traditional, Linear Forms of Documentary Production?

The invention of the broadcast and cinema industry did not eliminate or reduce the popularity of the book. Book sales have increased since the arrival of the Internet. An even greater availability of TV channels, programmes and movies than ever before is available to the consumer. History shows us that broadcast technologies did not make books obsolete, nor did the arrival of the Internet. PWC predicts a healthy 3% growth for the UK Entertainment and broadcast industries and for the global economy a 4.9% growth rate is forecast (PWC, 2012). *Linear documentary narratives will still have a market.*

But there is concern about the future size of that market. More vocal critics of social media and digital technology, such as Prof. Dr. Spitzer (2012) argue that the development of cognitive functions is impaired by inappropriate use of social and digital media. They argue that social and digital media need to be regulated and better understood before it is introduced to children and teenagers as they are still developing their cognitive skills.

*The term 'digital dementia' (*Ryall, J., 2012) (Daily Mail, Digital Dementia on the rise as young people increasingly rely on technology instead of their brain, *2013) has made it into mainstream press, describing a correlation of the loss of cognitive functions among digital natives and digital immigrants alike and their use of social media. This is a development documentary producers should be concerned about as they depend on their audiences cognitive abilities to critically view and review programmes presented. Society as a whole needs to be concerned about claims made by Prof. Dr. Spitzer (2013) and his South Korean colleagues Lee, Choi, Lee, Jung and Kwon (2012).*

Internet addiction is comparable to gaming addiction – except unlike gaming, the internet is accessible without any noticeable restrictions. Average consumption of media of a digital native stood at 7 hours and 38 minutes per day in 2010, tendency up. (Rideout, J., Foehr, U., Roberts, F., 2010) Similar results were published by Strasburger, Jordan and Donnerstein (2010) who also made concrete recommendations to schools, the entertainment and advertising industry, as well as researchers and government bodies, on how to deal with the consequences of social media abuse. The scope and extent on how the social media narrative will unfold online is yet to be determined and documentary producers need to understand the evolving digital native language and culture better to maintain their audience ties.

How Does Social Media Differ from Previous 'Information Explosions'?

An elite cannot control the invention of speech, like social media, effectively. The introduction of the alphabet led to a repositioning of the storyteller in antiquity, the print revolution provided the means to develop 'public spheres', followed by the broadcast and cinema industry. But an elite was able to control distribution all of the above effectively, except speech. User generated content on social media networks is free of that limitation; web2 and social media technologies are instant, provide interaction and are nearly impossible to censor and control.

This new freedom requires a change in behavior by content creators and their audiences. During the print revolution the Catholic Church was not enthusiastic about a literate church body. Instead the church preferred the bible to be in Latin to ensure believers receive church dogma administered and interpreted by a priest. Literacy, a result of the print revolution, changed all that and took the class struggle to another level. The print revolution enabled the rise of the middle classes. Today no financial risk is involved in starting up a blog, YouTube channel or Facebook page. There is no editorial office, no government censor who can effectively stem the flood of information published on social media every minute of the day. Social media is taking the class struggle to the next level: without censorship, global and immediate, featuring an increasingly social media literate digital native audience. Julian Assange, Wikileaks and the Dutch village of Haren are the more obvious examples. Digital natives are not merely adapting to social media, they are developing into a generation of social media literate users and content creators capable of challenging the status quo of the existing system.

7. CONCLUSION

What Does All This Mean for Media Producers?

The tools at the disposal of the media producer have developed over thousands of years. Story telling did not just begin with the invention of the printing press or film camera. And it is still the key element all media technologies have in common: all require a form of narrative, the audience is craving for stories. The perspective of today's filmmaker builds on an epistemology established over centuries; from simple pre-historical records to a new perspective in antiquity, mankind always maintained, documented and told stories about their trading ventures and wars. From history we learn that the tools used by storytellers have changed, the stories have not. Mankind is engaged in an ever-increasing number of violent conflicts. And without war and conflict, the media technology we use to criticize violent conflict would not exist. The most talented and most creative writers, film & TV directors are using social media to touch people

in new and unexpected ways, for example the flash mob performance in a Spanish unemployment office broadcast on Youtube.

Understanding the Past:

Documentary film-makers need to better understand the historical origins of the tools they use in order to submit stronger and better arguments, and to better describe the human condition. A physicalist and reductionist position can explain how social media evolved. Today's information explosion is not a new phenomenon and confirms Mcluhan's (1994) assertion that the "medium is the message": whatever it was that drove early cave dwellers deep into their caves to paint and wonder about the resulting painting is equally touching people when they view the flash mob in a Spanish unemployment office. Story telling is a unique phenomenon which can be explained by the needs of a community to pass on traditions, historical events, form part of our collective memory, entertain and more importantly provide catharsis. A unique story telling perspective and a gripping story will do most of the work when combined with the most suitable media production and distribution tools.

Understanding the evolutionary pattern of previous 'information explosions' helps to understand the current situation. With the arrival of each new media technology, users of that technology needed time to acquire the skills needed to develop the necessary media literacy. Only then did it become possible to use the new technology to its full potential. Social media is still in that stage of development. Its full potential has not yet been realized, users and content creators are equally challenged to acquire the social media literacy skills and understand the evolving social media narrative. The task ahead entails to explore the unfolding social media narrative and to actively participate in it.

Copyright infringement too is not new to social media. The *Donaldson vs. Becket* (Rose) landmark ruling in the United Kingdom serves as a reminder of the ongoing legal argument about authorship. Briggs and Burke (2009) provide an excellent account of the history of media. Social and digital media however are not merely another evolutionary step in the history of media. Social media is part of a global paradigm shift, it is changing business models regarding existing and new media production and distribution. Viewing habits of digital natives are changing, abuse of social and digital media has an impact on the way the adolescent brain is developing, digital immigrants are challenged to keep up with developments. Social media is used and abused to spy on entire populations, has a significant political role, i.e. in the Arab Spring and Occupy movement and is transforming how information is disseminated in media and education.

Current events in Syria only demonstrate this point to clearly: social media had a significant role during the Arab Spring. But since the Arab Spring has begun, social media has developed into a permanent platform for users who in a very short time have learned to become 'social media literate': users are increasingly able to distinguish whether or not a government has evidence to invade another country or not. Movements such as Occupy and Wall Street provide a lively platform on which topics such as this are discussed every day. Users of social media platforms no longer just 'follow' government propaganda, but come to their own conclusions based on the evidence they find online. Social media is making the world more transparent – and at the same time provides the elite with the tools needed for mass surveillance. Documentary producers need to remember that and develop a greater awareness of the history of social media, which ironically would not have evolved into what it is today without war and conflict.

Facing this uncomfortable truth is necessary if social media is to develop its full potential as the one and ultimate information revolution empowering the 99% of humanity. Producers now have the oppor-

tunity to deliver content to a global audience – directly, and touch people in a profound way. Since the conception of speech mankind has been busy inventing and creating new media forms such as writing, print, broadcast and now social media. History teaches us that the arrival of a new media form does not extinguish previous media technologies; and a reductionist explanation of social media does not explain how social media touches our inner lives. Understanding the past, the technology, changing viewing habits are key aspects of this paradigm shift. Business and funding models too are changing. Crowd-funding sites such as Kickstarter (2013) and IndieGoGo (2013) feature an increasing portfolio of successfully funded documentary projects. Documentary forms are changing too, introducing more interactivity. (Doclab, 2013)

However, the one element that all media technologies have in common though remains in place, whether it be the spoken or written word, radio, TV or film, drama or documentary, Facebook or Youtube: content. Audiences want a good story. Narrative construction and plots may offer more options and interactivity, but technology alone will not make a bad story a huge success. It may help make a mediocre story break even. But a great story will be a success, if the tools needed to tell the story are well understood and applied.

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Chapter 16
Exploring the Liminal Between the Virtual and the Real

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ABSTRACT

The creative application of digital technologies is accelerating as artists, designers and technologists continue to experiment and explore ways to create new aesthetic fields, semantically enhanced communication and innovative relations between people and machines. Our virtual worlds meet the real material world through the interdisciplinary research of computer scientists, digital media technologists, artists, designers and culture theorists. This chapter explores ways of bringing the virtual to the real through a range of differing conceptual positions and research approaches while demonstrating the creative interplay of variable media and online platforms for producing liminal works which cross the boundary between the analogue and the digital. The intent is to provide insights and examples of creative practice employing new technologies in innovative and unusual ways to generate exciting new work and offer new pathways for digital media research and development. The chapter presents relevant theoretical frameworks and examples of current practice in the area of digitally enabled transitional spaces for artists, theorists and curators, as well as researchers working both in the field and beyond to those working with new technologies, social media platforms, and digital/ material culture.

INTRODUCTION

In considering the dialogue between the virtual (digital) realm and the real world as a semantic space for creative exploration, there are many different approaches from researchers in adjacent fields concerned with new technologies and virtual platforms. I have been investigating this interstice between two worlds as a liminal space of transition and transformation for over 5 years now, and have convened 4 panels of specialists to present at ISEA – Inter-Society of the Electronic Arts (2 panels in Belfast UK and Istanbul, Turkey), CAA – US College Art Association, New York and in October 2014 at the UAAC – Universities Art Associations of Canada, Toronto. Papers from those panels were then published in edited volumes

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with IGI Global (Harrison, 2013), the most recent of these being 'The Handbook of Research in Digital Media and Creative Technology' published in February 2015.

The seven artist perspectives are given here as a series of synopses, they have been selected from those panelists and authors from the events mentioned above in that their work examples the broad range of activities currently underway in exploring the liminal. Beginning with Barbara Rauch and her e:Motion lab where she morphs animal and human facial expressions to explore recognition and our sense of self. Lorna Moore then follows with her work facilitating the deep engagement with ourselves by momentarily experiencing our 'other' now afforded by new technologies. Another artist, Alistair Payne, approaches an understanding of the Virtual through Deleuze which has expanded his practice as a painter into a multi-medial and interdisciplinary position. Where Payne's work has extended to include aspects of virtuality through incorporating digital video with his paintings in material installations. Ian Gwilt is exploring the transformation of digital code into material objects through 3D printing and rapid prototyping. Suzette Worden is interested in the microscopic unseen material world of 'meaningless matter' made visible by artists through nanotechnology and digital virtuality when engaging with the earth sciences. Maggie Parker works with the imaginary landscapes and virtual worlds of game scenarios, her work proposes that such environments should enhance their unreality by keeping an abstract aesthetic that does not simulate familiar earth landscapes and cities. The paper ends with a solely theoretical investigation of virtual and real spaces by digital artist Garfield Benjamin, who bravely navigates between Deleuze and Zizek (Lacan) to situate the subject/self.

7 SYNOPSES

Dr Barbara Rauch

Dr Rauch - runs the e_Motion research project which integrates 3D visualization, haptic technology and rapid prototyping as a window into the Autism Spectrum Disorders (ASD) mind. Through the ground-breaking researchers such as Simon Baron-Cohen (Baron-Cohen, 1985) we have learned that ASD falls along a broad spectrum, and high-functioning autistics like Temple Grandin have taught us that they are handicapped not by their ASD, but by the fact that they learn in different ways from 'neurotypicals'. It is now well known that many ASD people are visual thinkers and learners, and this project utilizes state-of-the-art but 'approachable' digital technologies that will allow the autistic person to speak with distinct and enhanced visual voices. This differs from art therapy in that it will lead to a better understanding of how ASD individuals think and feel, through visualization.

Dr. Rauch joins collaborators Dr. Stuart Shanker and Prof. Jason Nolan, to work on studies in ASD, emotion, education and communication. The project is still in its early stages of production, however it has initiated the outlines and hypothesis of a promising cross-disciplinary study that also introduces a PLAY method for emotion rehearsals. On using the interface a productive buffer zone will be created to test out approaches, responses, anxieties and reflections in the difficult task of reading emotions in another person's face. Using Paul Ekman's understanding of universal emotions, (Ekman, 2013) expressions of the face can be read across cultures. His classification of basic emotions into a list of six distinct expressions (anger, disgust, fear, happiness, sadness, and surprise) was later extended to include guilt, contempt, shame and others. Rauch added contempt to the original six basic expressions and to select distinct facial images of the human face that demonstrated happy, sad, disgusted, afraid etc. Furthermore

being interested in the evolutionary aspect of emotions, not unlike Darwin's interrogation of expressions of emotions in animal and man, a fox's neural expression was included in the image database for morphing. This model will now be used in a study to test facial expressions and mimicry in the autistic person but has also led to Rauch's creative works that include 'emotional degrees' (animation), 'interFaced' (sculptures), and 'friends' (hybrid digital representations of merged faces).

Dr Lorna Moore

Dr Moore is a video performance artist placing her practice at the interstice between the real and the virtual. She is interested in what happens to our perception of self when we move across the boundary between the corporeal self and the live digital image as other, and argues that her work draws the performer/participant through the video frame were both participants are immersed in each other. Both performers are suspended in the belief that the live digital image of the other performer is a part of their own corporeality. The work involves two participants wearing a Head Mounted Display System linked to a live video feed. Each performers live video feed is swapped over via a real-time video programme so each participant sees through the eyes of the other performer. The aim of the work was to perceptually swap the bodies of two performers to bridge the gap between the performer and the performed, subject and object.

Moore presents personal accounts of users' experiences engaging with her headsets which she declares is an inter-corporeal experience. She then explains this phenomenon through the lens of psychoanalyst, Jacques Lacan and his work on the 'Mirror Stage' (Lacan, 1973), phenomenologist Maurice Merleau-Ponty and his writings on the Chiasm (Merleau-Ponty, 1968), and anthropologist Rane Willerslev's research on mimesis (Willerslev, 2007). These positions provide new insights into the relationship between the corporeal Self and the digital Other providing platforms to account for the blurred boundaries between these modalities. She is intrigued by the way the material body is stretched across these divisions

Figure 1. Barbara Rauch Goethe dreaming of Schiller. Paper. 2013.

highlighting the way digital media acts as catalyst in this in[bodied] experience of be[ing] in the world. Moore states that the purpose of her work is to provide alternative ways of thinking about the body and its relationship to video performance to understand the way digital media is having an impact on our perception of a single bounded self and how various selves can be shared through innovative ways of using technology. Her piece In[bodi]mental presents an alternative viewpoint of the self/other divisions and positions these modalities as a shared experience.

The findings from her work has seen the emergence of an augmented self which phenomenologically stretches the materiality of the lived body beyond the parameters of a single self were we share an inter-corporeal experience. Moreover we see the way the digital body and the actual feed into each other via the real-time video technology. Her work focuses on be[ing] rather than becoming and looks to find new ways to immerse the viewer/participant within the artwork. An exploration into real-time video technology is demonstrating that we can experience an overlap between subjects were the binary oppositions between self and other are no longer clear cut divisions but are now emerging as blurred modalities of be[ing] in the world. Moore's findings have revealed that when we interact with our real-time video image we do experience a merger between the body and the real-time video image (see figure 2). This is most powerful when there is a disruption in the proprioception of the body through the immersive experience, accompanied by a feeling of the uncanny. She argues that when we experience the uncanny we are somewhat closer to an unfamiliar part of self we have rekindled during the performance – a hyperreal experience of self-discovered through the other via the technology. For a moment, an uncanny nanosecond of time, we now how it feels to be someone else, we can reach out, cross the divide, and touch our virtual 'other'.

Figure 2. Lorna Moore In[bodi]mental, The Public, West Bromwich, UK. 2011.

Dr Alistair Payne

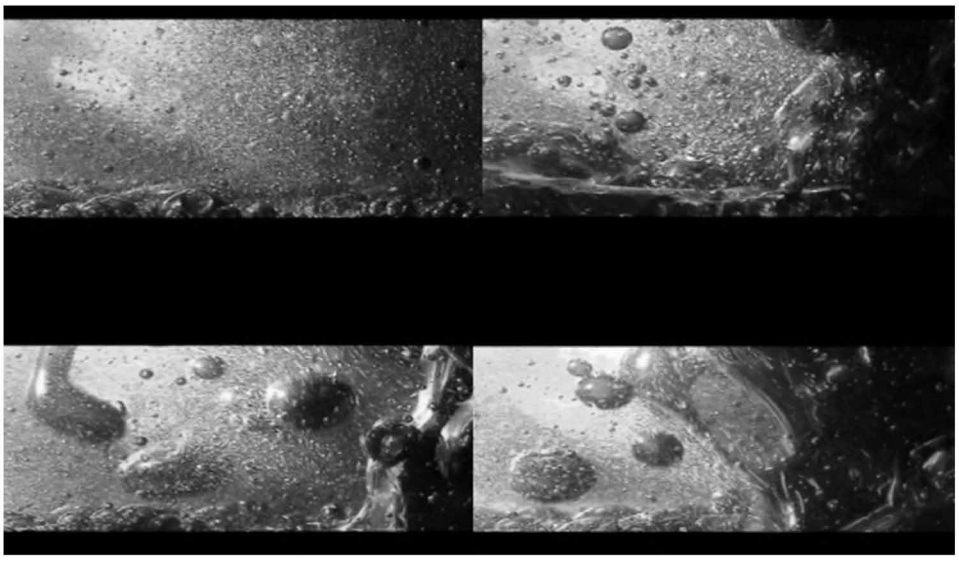
Dr Payne explores understandings of the virtual within his practice as a painter which has enabled him to move his work into new areas of expansion. In effect his investigation into Gilles Deleuze's notion of 'the virtual' instigates an interdisciplinary approach towards painting where *external* connections and relationships are introduced and developed. This equates to the opposite position of the internal critique of medium particularity or specificity and will radically alter the way in which painting can be created and consequently thought. Research into the 'virtual' and interdisciplinary practice driven from concerns within painting, effectively constitutes a new methodological model for thinking through the space of painting. In contrast to prior methodological models used, primarily within the critique (or theorisation) of painting, an investigation into Deleuze's methodological processes creates a more open position within which to redefine the limits or constraints of painting. The virtual therefore acts as an instigator for change, which effectively destabilises the pre-formity attached to medium specific practices. It is for this reason that The virtual forces external relationships and connections to come to the fore in order to radically alter and transform the physical and conceptual constructs of different disciplines, and provides a model for thinking through interdisciplinarity within, and from, other media. Alongside this understanding of the virtual and its direct affects upon artistic practices, is how it encounters the hybrid and metamorphosis as key elements of change.

This method for actualising change is based upon an examination of the notion of the virtual / actual according to Henri Bergson and Deleuze (1991). The virtual is bound into the process of becoming, but not a becoming through a systematic (or concrete) dialectical method, this is an open-ended becoming, where the virtual can be seen as series of potential. Deleuzian philosophy (Deleuze, 2001) is based within the virtual; it is the virtual that constructs the actual and the actual that is defined by its virtual intensities. These virtual intensities are the becoming actual of the virtual and this is not used as a way of defining the actual in the sense that it will subsequently have its own identity but rather it is a method for opening the actual to continual and further virtualities. Deleuze's notion of the virtual allows for a 'spacing', a slippage or the 'bringing forth' of potential within painting as a formless condition. The development of this methodology situates painting as a virtual element, an element which itself contains the potential for change within the work through integration and transformation. The virtual can be used as a way of re-thinking or re-negotiating the space of theory within which the practice can be actualised. It necessarily incorporates interdisciplinarity by forcing connections and proposing ways of re-structuring new, transformative and different dynamic forms of practice. Including the digital and cyberspace.

Prof Ian Gwilt

Dr Gwilt, in his investigation into Digital data and material objects, explores how the creation of physical artifacts based on data extracted from computer generated virtual spaces can change the way we read, interpret and respond to digital information. In an era where the visualization of complex digital information is increasingly being used to shape our social, political and economic environments, Gwilt examines what happens when you use big data to drive the parameters and form of a physical object. By asking the question why should we consider translating digital data into a physical form, and what happens to how we understand, respond and relate to digital information when it is presented in this way, he considers whether or not data driven objects are simply a novel visualization technique or a useful tool that can be used to add insight and accessibly to the complex language of digital big data

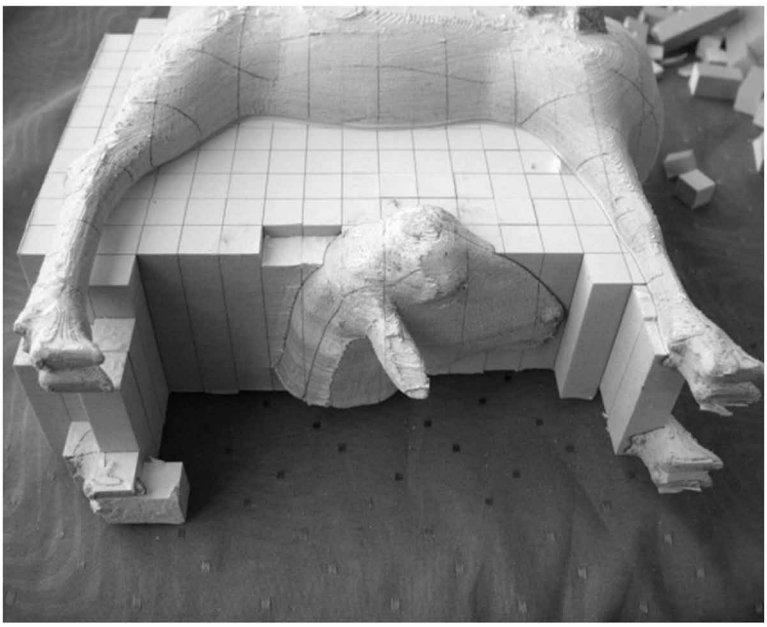
Figure 3. Alistair Payne Lost Angels (Film still), looped DVD, 9 mins 28 sec. 2010.



sets. He understands the new constructs of digital data as concretized into physical form, remediated from information sources such as, mobile phone coverage records, crime statistics and temperature patterns. These tangible translations change our relationship to screen-based content, and seek to reveal how by encoding digital information into a physical object we can establish a different way of reading data through spatial, temporal and material variations that sit outside of the computer-monitor and the digital environment. The making strategies for these digitally informed objects such as rapid prototyping techniques help us to gain insight into a set of new 'data objects' that draw from the visual language of the computer and are 'made real' in physical space.

As computing technologies become more located and related to place and social contexts the potential for the digital to augment and interact with material culture become more opportune. In terms of information visualisation this closer relationship drives the desire for data visualisations that speak to both our real-world and digital connections. The materialisation of digital data is facilitated by the development of a number of new manufacturing technologies such as computer controlled laser cutting, 3D printing and rapid prototyping techniques which allow for the translation of digital data back into physical forms. Gwilt has examined a number of various materialised objects created by artists/sculptors and designers, and also creates pieces himself. His findings indicate that the data driven object needs to be considered in light of the existing issues and conversations which are already taking place in the discipline of information visualisation. These dialogic objects have the ability to capitalize on the inherit traits found in both digital and material culture to communicate their message. By combining these attributes into a hybridised form a new way of looking at the digital/material relationship and how we can communicate through it will hopefully emerge. Gwilt looks at the different ways in which we interact with objects using touch and our other senses, and consider what these types of embodied interaction might mean in terms of how we comprehend any underlying data and information. He is particularly adept at articulating digital material hybridity, distributed technologies, communities of use, and the implications for how we receive, understand and consume big data.

Figure 4. Ian Gwilt – Trophy (showing LOM fabrication process detail) Artist: Brit Bunkley. 2006.



Prof Suzette Worden

Dr Worden's work concerns the often invisible materiality of rocks and minerals, and virtual space, where artists engage with the earth sciences as a source of inspiration and as a provider of data about the natural environment (see figure 5). This rich source of data may arise from: the conditions of the atmosphere, to physical formations; from small scale to gigantic formations; extremes of heat and cold; and the interaction of all these in time and space. Additionally, the models, visualisations and explanations of these phenomena by scientists can include aesthetic characteristics that are appreciated by a wider audience than immediate scientific peers. When we are concerned with digital environments, the discussion is most often centred on visualisation, which includes reference to objects with a material or physical existence and also to mental constructs. These constructs and models can be directly observable or become visible through an instrument or device. Visual characteristics can also be translated from a non-visual state into constructed data, as a 'conceptual' translation. With digital environments becoming so central to everyday life there is often slippage between the values attributed to analogue and virtual spaces. This can happen where there is slippage between the virtual and the real, or symbol and matter; where there is a reversal of values. As Bruno Latour (2008) has noted: "How did we succeed in having the whole of philosophy reduced to a choice between two meaninglessnesses: the real but meaningless matter and the meaningful but unreal symbol?"

In many cases of creative work, this slippage or reversal is intentional and becomes, for the viewer, an intriguing and rewarding aesthetic and emotional experience. Using examples related to the earth sciences, Worden investigates the ways in which creative works demonstrate the movement of ideas and concepts to and from the physical to the digital. She asserts that artists who engage with the earth sciences have been able to explore all kinds of information about the natural environment, including information about the atmosphere, extremes of physical formations across immense dimensions of time and space,

Figure 5. Suzette Worden – zero@wavefunction, Singapore. Artist: Victoria Vesna in collaboration with nanoscientist James Gimzewski. 2002.

and increasingly 'invisible' realms of materials at the nanoscale. This is a rich area for identifying the relationship between digital and material cultures as many artists working with this subject are crossing boundaries and testing out the liminal spaces between the virtual and the real. Not only is this a rich area for current experimentation but often these artists offer a critique of historical formations or provide a critique of theoretical concepts. Many of the works chosen for examining their interest in the field of earth sciences also demonstrate a strong sense of awareness of the importance of a 'sense of place' that refers to the values associated with cultural memory and the construction of heritage. This makes the resulting slippage culturally rich and suggests that interpretation must also include consideration of the construction of 'texts' and whether authorship is intentional or the result of audience participation. She is interested in distinctions between what is presented in an artefact, and what might be constructed by the audience, and examples creative works that take us from the digital to the physical where they make specific reference to geology, studies of rock formations and technologies supporting mining activities and resource industries. Worden has a particular investment in the paradox of invisibility within 'real' physical worlds as against the revealing and transformational potential of narrative within digital spaces will be highlighted for its creative potential.

Dr Maggie Parker

Dr Parker is a fine artist undertaking an investigation into the virtual worlds of computer game design, and classifies 'haute games' as aesthetically driven in that they are formulated to identify virtual environments creating unique, alternative 'blendings' with participant-players and assemble a framework for developers to pursue, when producing original computer game genres (see Figure 6). She sees a real need to inform both the practice and theory of Game Studies with an artistic aesthetic and an understanding of the impact of gaming on the psychological and emotional states of players or participants. Parker

Figure 6. Maggie Parker Star World. 2005.

understands creative practice as a non-verbal experience that involves a different kind of thinking and considers that, by engaging in play, access to emotional and cognitive experience is enabled. She argues that virtual space, as a medium, is both powerful and engaging; a 'meaningful space'. Haute games set up situations to evoke emotional responses from viewers, relating philosophy and theories, utilising and facilitating personal intuition and rigorous perception to create pieces of work.

In querying why we have to complete tasks in every game, Parker suggests that there is room for alternative game interaction that generates cognitive possibilities, to provide alternative and beneficial outcomes for players. Her more recent work is focused on an application for mobile phone and tablet technology, her *Digital Book of the Dead* being a contemporary version of the Egyptian Book of the Dead. Parker's version brings interactivity enabled by game technology plus integrated augmented reality technology into a museum setting, to enable knowledge of other cultural concepts to be disseminated within Museum, classroom and community areas. However an earlier piece 'Star World' better demonstrates the potential of using software as both an artistic interpretation and an alternative method of game-design. The Star World's environment contains wholly imaginary, aesthetic elements to experiment with alternative texturing. It became a virtual-environmental empirical test-bed, as well as an art piece, based on personal interaction and engagement. Parker considers that this double functionality is a function that game studies scholars and computer-game designers should take into consideration, in the future. She sees that computer games provide a unique opportunity to experience intangible fantasies and create engagement with emotions which are able to be played out in real-life. Participants in her Star World identified in various ways the hexagon objects placed in the environment, naming them as hexagons, birds, geese, space ships, fifty-pence pieces and others. In total the hexagons have so far had 29 differing descriptions.

Dr Garfield Benjamin

Dr Benjamin is a researcher who considers the subject as the 'gap' between virtual and real states. Digital media has called into question the appearance of 'reality', forcing all theories of contemporary culture to take into account the possibility of other spaces with which the (physical) human subject can engage. Within the many varied, and often incongruous, theories of digital technology and its culture there are two strands of the discussion that have emerged in which the very terms of the field are challenged. These are centred on the problematic notion of 'virtual reality' that has dominated cultural depictions of the digital world, usually taking either 'virtual' or 'real' in an expanded definition to draw out a deeper understanding of the fundamental differences, connections and interdependency between physical and digital spaces. Digital media has called into question the appearance of 'reality', forcing all theories of contemporary culture to take into account the possibility of other spaces with which the (physical) human subject can engage. There is a need to expand and intersect current discussions of the relation between virtual and real by exploring the antagonisms that arise through developing both sides of the term. Benjamin readdresses the term 'virtual reality' in the context of ongoing debates in philosophy, technology and creative practice in a discussion of subjectivity in contemporary digital society, to insist on a constant re-evaluation of the terms used in such a discussion and their ramifications for its application in digital media and creative technologies. He redefines the term 'real' along Lacanian lines (Lacan, 1977), particularly as applied to cultural phenomena by Žižek (Zizek, 2009), he then includes writers such as Gunkel (Gunkel 2010) who have furthered this notion, drawing out the real across physical and digital worlds as the hidden causality (for example, quantum wave functions, DNA or bits of computer code) that underpins the appearance of objective reality. This real is inaccessible and terrifying, embedded within the psychoanalytical construct of contemporary subjectivity. Counter to this development is the more common expansion of the term 'virtual', often taking into account the definition developed by Gilles Deleuze (Deleuze, 1969) as a surface that is not actual but with which the subject can engage. This has been applied to digital media as an alternative to the conflation of 'virtual' as 'digital', as is implied in the labels 'virtual reality' or 'virtual worlds', to instead connect the fluidity of digital surfaces to consciousness in a relation consistent with other generative effects within the structures that form the idealist element in Deleuzian philosophy.

To form a critical overview of past and current discussions of virtual reality in the field of digital media, suggesting innovative modes of interrogating the creative potentialities of digital media, he references cultural artefacts that embrace an expanded view of the digital or confront the transition between physical and digital modes of 'virtual reality', including digital art works, computer games and avatar-mediated spaces. This research will then offer a new definition of virtual reality, a challenge to established modes of thinking digital media, and a call for a constant re-thinking of the terms with which we construct our engagement with digital technologies within our subjective position between ever more permeated virtual realities.

CONCLUSION

The ways of exploring the liminal space existing between virtual and real states are numerous, diverse and highly creative. For this chapter seven approaches from the art world have been collated from four panels convened by the author with papers then published in edited volumes with the intent of interrogat-

ing the transition from the real to the virtual where the interface is understood as a transformative space of creative transcendence. Social media and digital technology is reconfiguring our relationship with the world and is also affecting how artists make their work and relate with their public. Now technologies can help to position art into the everyday of people's lives and activities, outside the gallery space. Digitally enabled new spaces have opened up where artists can engage with audiences in a participatory experience. Digital media provides virtual platforms where accessing them means stepping from one world to the other, a conceptual moving from one state of being to another. Contra to human-to-avatar experience, virtual objects are transformed into a solid materiality by crossing this threshold. The threshold is then a magic alchemical space, an interstice between the real and the virtual, a moment of change, of becoming other. The examples given in this chapter go some way to articulating an overview of the creative approaches to this ongoing exploration of the interstice between worlds.

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Chapter 17
"The More I Write…The More My Mind Evolves Into Something Outstanding": Composing Identities with Social Media Tools

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ABSTRACT

This chapter draws from a one-year qualitative investigation of a ninth-grade English classroom in a new technology-rich high school. The study explores the question, What identities did students compose as they alternately resisted and embraced the use of digital media in the writing classroom? Presenting a case study of one student, Shane, the chapter traces the ways in which he responded to the teacher's invitations to use digital media, thereby discursively crafting particular identity performances in on-site and online communities. Analysis identifies a number of tensions specific to the use of authentic audiences and purposes in the 21st century digital writing classroom and reveals three identity performance categories: Shane the comedian, Shane the subversive, and Shane the artist. In analyzing the ways in which social networking tools, literacy practices, and identity performances converge in the classroom, the chapter challenges dominant pedagogical assumptions about using new technologies in the schools to engage learners.

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INTRODUCTION

Since you're here, why don't we take an adventure into my mind? But I hope you're ready, because it's one crazy, crazy place in there. - Shane, Literacy in Our Lives Video Project

With this introduction, Shane, a ninth-grade student in a new technology-rich high school, summoned his classmates to view a video he made to fulfill the first major project in his English class, the *Literacy in Our Lives* project. Becky, Shane's teacher, asked students to develop videos, both as a way to introduce themselves to one another and to document the literacy practices they used in their everyday lives both in and out of school. In so doing, Becky hoped not only to sensitize students to the ways in which they already were proficient readers and writers of text, but also to signal that reading and writing in this classroom community, and across the school, meant using digital media and developing the 21st century literacy practices needed for postsecondary education and the workplace of the future (National Council of Teachers of English, 2008). In asking students to share their videos with each other in an online forum, she hoped to form a classroom community that functioned equally effectively in online and on-site contexts.

But just as Becky had specific goals and a particular audience in mind for the project, so too did Shane. He crafted his introduction to the video to prepare the audience for "an adventure," thereby heralding his own arrival in this classroom community and school, staking his claim for attention. In preparing his peers to watch the video and to foray into his mind, "a crazy, crazy, place," he braced viewers to expect the unexpected, creating anticipation that Shane's video would be both different from the others and entertaining. He was right on both counts. While his classmates typically pursued a literal approach to this literacy project, documenting their favorite books, movies, and songs, Shane took the assignment to a new level by writing an original script complete with a montage of goofy images accompanied by old, corny songs. He created a spoof of the creative—yet tortured—artist stereotype, with the voice-over of a stern taskmaster insisting upon obedience to school rules while the camera documented Shane breaking them. He declared himself a serious gamer and pretended to throw a laptop on the floor, overcome by feigned anger when his online opponent insulted him. He included a clip in which he was standing on a street corner with white loose-leaf paper in his hands, yelling at passing cars, "Buy my writing! Buy my writing! Doesn't anyone want to buy my writing?"

We do not know if Shane made any money pitching his words that day, but we do know he garnered the class's attention, his teacher's, and ours. This chapter features a case study of Shane, drawn from a one-year qualitative case study of a ninth-grade English classroom in a new technology-rich high school, exploring the research question: What identities did students compose as they alternately resisted and embraced the use of digital media in the writing classroom? This chapter traces the ways in which Shane responded to Becky's invitations to use digital media while discursively crafting particular identity performances in on-site and online communities. The next section explains why we selected Shane and his teacher, Becky, for this study.

CASE STUDY PARTICIPANT SELECTION

We relied upon purposive sampling techniques to select our focal student and teacher because we wanted to understand how teachers and students used digital media to compose texts and identities. We wanted to work with an exemplary teacher who valued writing and new technologies in the classroom, and we

wanted to focus on students who were highly invested in writing and technology and at least somewhat social so that we could trace the relationships among writing, technology, and student identities. Becky was widely recognized as an excellent teacher, for she was a National Board Certified English Teacher, one of the first in the state. Becky was widely known in her district as a teacher-leader in developing innovative uses of digital media, and prior to our study, she had been an invited member of a multi-year funded project exploring the uses of new technologies in English classes. Because she taught at a new, technology-rich school in her district, we knew that she would infuse digital media into class activities routinely, providing us with abundant opportunities to explore issues, processes, and products related to using new technologies in the English classroom. She was also among a select group of National Writing Project (NWP) teachers invited to participate in the NWP task force commissioned to develop frameworks for assessing multimodal products, i.e., texts that used visual, graphic and audio elements as well as linguistic signs. In short, she was a widely respected English teacher known both locally and nationally for her progressive uses of technology and for her expertise as an English teacher.

After several weeks in Becky's ninth-grade class, we selected Shane as one of our case study students. Because we thought that a very social person who was also a committed writer and technology user would teach us the most about how student identities were mediated by the discursive and digital, we focused on Shane. His *Literacy in Our Lives* video convinced us that he was definitely social, and a serious writer and technology user to boot. Despite his obvious investments in writing and technology, Shane had contradictory reactions to Becky's invitations to write, and we wanted to understand why. Moreover, his work across various social networking media demonstrated inconsistency in quality and quantity, and his engagement in class waxed and waned as well. At times he enthusiastically immersed himself in writing projects, and at other times he grumbled. We wanted to understand Shane's behaviors of engagement and resistance. We believed that Shane could provide us a window into understanding why a strong writer who relished the limelight would subvert his teacher's efforts to share work on social networking sites, especially when those efforts occurred within the context of a school with a technology mission. Moreover, we wanted to understand the identities Shane constructed through his multimodal and linguistic texts, and how those identities were mediated by discourse and varied across social contexts. In the next section, we situate our study against the backdrop of current literacy research and theory.

NEW LITERACY STUDIES AND COMPOSITION PEDAGOGIES

Digital technology practices pervade virtually every aspect of contemporary daily life—how individuals outside of school learn, communicate, reflect on, produce, consume, create identities, and share knowledge in routine matters (J. P. Gee, 2012). Researchers use the term *New Literacy Studies* (Coiro, Knobel, Lankshear, & Leu, 2008; Hull & Schultz, 2002; Lankshear & Knobel, 2006; New Media Consortium, 2005) to refer to the expanded and multiple practices and ways of knowing associated with digital media (Gee, 2009; Mills, 2010). From this perspective scholars emphasize a shift from static, decontextualized notions of literacy to broader views that understand communication as an array of dynamic social practices situated in a variety of contexts, and those contexts shape and limit possible meanings. Scholars use the term *multiliteracies* to emphasize that what counts as literacy varies and is always situated (Kress, 2003).

Just as the conception of literacy has expanded with New Literacy Studies, so too has the notion of text. Text from this perspective is constituted not only by linguistic signs, but also by audio, graphic and multi-media elements. In order to produce and to decipher multimodal texts, individuals must recruit semiotic resources and the cultural meaning-making possibilities available to them (Kress & van

Leeuwen, 2001). Producing and interpreting such texts involves global as well as local texts, resources, audiences, and purposes (Gee, 2007; Lankshear & Knobel, 2006; Lewis & Fabos, 2005; Street, 2003), reinforcing the notion of multiliteracies.

Within a New Literacy framework, the teaching and learning of writing requires not only broader conceptions of text and literacy, but also more complex renderings of composing processes in the stages of writing (i.e., brainstorming, drafting, revising, editing, and publication). Hicks argues that the digital writing classroom is built upon the same five principles as the writing workshop: student choice, revision, author's craft, publication and assessment, but "through a digital lens" (Hicks, 2009, p. vii). However, incorporating visual and audio elements, a writer is no longer limited to producing print texts. From a new literacies perspective, he argues, writers can, for instance, use technological resources in all stages of the composing process, whether gathering data through RSS feeds, Google, Facebook, or brainstorming ideas and drafting collaboratively using Google Docs.

Besides offering new resources for writing, new media makes available social networking options that enable writers to have actual audiences, instant audiences, and multiple audiences, providing authentic contexts for sharing drafts and finished texts. Digital media researchers (Jenkins, 2004; Thomas, 2006) have supported the argument that students posting in authentic, online venues gain valuable literacy skills.

Writers in the digital workshop can assess the demands of the rhetorical situation with virtual and face-to-face audiences, strategizing voice, content, and style in relation to the multiple audiences of their work. Those audiences enable teachers to sidestep the age-old problem of writing for an audience of one, the teacher. Composition teachers and researchers argue (Kahn, 2009) that writing for authentic audiences motivates students to care about the final product. In sum, by using information and communication technologies, teachers can enrich a writer's standard repertoire for all stages of the writing process, and writers can work in an authentic, nonlinear and recursive fashion, utilizing the stages of writing processes as they see fit, rather than in a lockstep, mandated sequence. New technologies serve to reinforce key principles in writing instruction: writing for *authentic* audiences and *actual* purposes, writing for an *array* of audiences and purposes, writing with the demands of the rhetorical situation—the purpose, audience, and context—intentionally governing content and style, and writing with nonlinear and recursive stages determined by the writer, not the teacher.

The emphasis on technology in literacy classrooms can also be found in the National Council of Teachers of English (NCTE) definition of 21st century literacies (National Council of Teachers of English, 2008). At the heart of the 21st Century Literacies statement is recognition that information and communication technologies are vital to English classrooms. The February 2013 version declares that:

Active, successful participants in this 21st century global society must be able to…develop proficiency and fluency with the tools of technology; build intentional cross-cultural connections and relationships with others so to pose and solve problems collaboratively and strengthen independent thought; design and share information for global communities to meet a variety of purposes; manage, analyze, and synthesize multiple streams of simultaneous information; create, critique, analyze, and evaluate multimedia texts; attend to the ethical responsibilities required by these complex environments. (National Council of Teachers of English, 2008, 2013)

As the policy encourages use of technology and emphasizes multiple literacies and multimodal texts, it resonates with New Literacy Studies principles and declares priorities for the profession. The NCTE policy statement invites and challenges us to rethink our goals in literacy education (National Council of

Teachers of English, 2008). No longer limited by the geo-physical confines of institutional spaces, with increased access to information, knowledge, and networking, students in 21st century learning contexts work within learning ecologies to connect the local with the global (Brofenbrenner & Evans, 2000; Nardi & O'Day, 1999; Walters & Kop, 2009). The 21st Century Literacies Position Statement challenges teachers to utilize the practices and processes that students will need in postsecondary education and the workplace.

Researchers also argue that bringing the out-of-school digital media practices into schools reaps benefits for learners. For instance, the argument goes, teachers can use new media to engage learners resistant to traditional literacy class work (Ito et al., 2009). Also, when students use social networking practices to communicate with various audiences and purposes, they strengthen their reading and writing skills. Cultivating digital media and 21st century literacy skills in classrooms can cultivate new modes of participation that can change the teacher-centered patterns of classroom discourse cited in the research (Applebee, 1993; Cazden, 1988). Proficiency in information and communication technology may not only enhance student engagement with school-based literacy practices, but also prepare students for successful participation in postsecondary education, gaining the 21st century literacies they need for school, citizenship, and the workplace.

Situating our study within a New Literacy Studies framework informed by 21st century literacies and contemporary composition pedagogy, we can explore the ways in which texts, literacies, and identities are constructed and interpreted with social networking technologies. While this section has suggested how literacies, texts, and digital composition processes resonate within New Literacy Studies, the next section explores perspectives on identity that are salient to the study.

IDENTITIES

Because this chapter focuses upon how a student performs identities as he produces and interprets text, it is important not only to define *text* and *literacies*, but also to define *identity performances*. Poststructuralists, feminists, postmodernists, and other scholars in cultural studies have rejected the idea of a singular, monolithic subject with a stable identity (Alcoff, Hames-Garcia, Mohanty, & Moya, 2006; Blommaert, 2005; Moya, 2002), instead arguing that individuals assume various identities that change as social contexts change, and therefore are "performatively constituted" (Butler, 1990, p. 25). That is, we perform different identities within different socially defined spaces that are imbued with cultural norms, power relations, and ideological forces, and lead to varying expectations for different players in different roles (Holland, Lachiotte, Skinner, & Cain, 1998). This allows for a "performance approach to identities, which focuses on identity as a form of socially meaningful practice" (Blommaert, 2005, p. 208).

Gee argues that identity is socially constructed. "Being recognized as a certain 'kind of person,' in a given context," is the key to identity, but individuals have "multiple identities" constructed by "their performances in society" (Gee, 2000b, p. 99). Particular identities are constituted in specific social situations, according to Gee, and each identity issues from one or more of the following four categories:

1. **The Nature Perspective:** The individual's biological traits determine "the kind of person" one is (Gee, 2000b, p. 102), for example, the identity of being a twin.
2. **The Institutional Perspective:** An identity that is sanctioned or authorized by a role or position in an institution that one holds, for example, the identity of a university professor.

3. **The Discursive Perspective:** A quality of the individual constructed through and contingent upon communication with others, for example, possessing charisma.
4. **The Affinity Perspective:** Traits revealed in one's discursive practices that show an individual's allegiance to, access to, and participation in a group with shared interests, for example, engaging in online discussions about one's passion for a specific athletic activity.

Gee's framework gives us an understanding of how identities can be seen as dynamic, discursive, socially situated performances that mediate and are mediated by literacy practices.

When the identity performances of youths using digital media are discussed in theory and research, the notion of "digital natives" is frequently invoked. Prensky (2001) argues that technology has become essential to young people's lives and identities, and that their dependence on digital technologies for entertainment, socializing, and information gathering and sharing makes them distinct from older generations, the "digital immigrants" (2001, p. 4). Prensky's argument resonates with a growing body of scholars who have attempted to document the distinct technological needs and expectations of emerging generations of young people (Bennett, Maton, & Kervin, 2008; Hawkins & Oblinge, 2006; Jenkins, Purushotma, Clinton, Weigel, & Robison, 2006).

DATA COLLECTION AND ANALYSIS

Shane's case study is drawn from a yearlong qualitative case study of an English classroom in a new technology-rich high school during the 2010/2011 school year, exploring the research question: What identities did students compose as they alternately resisted and embraced the use of digital media in the writing classroom?

There were five categories of data included in this larger study. A member of our research team videotaped 24 hours of small group and large group discussion during the six-week unit, which constituted our first set of data. Our second data set included the Twitter feed from all fifty students in the class. Each student was assigned a character from *The Things They Carried* (O'Brien, 1990), a book about the experiences of American soldiers in Vietnam. Each was asked to tweet in character at different points throughout the novel. The Twitter feed was the result of approximately four hours of in-class tweeting produced over the course of the unit. Twenty-five poems written in pairs by all fifty students were also included in the data set. Towards the end of the unit, students wrote poems about the experiences of the soldiers in *The Things They Carried.* Students were required to incorporate some of their own and/or their classmates' tweets into their poems. The fan fiction projects completed independently by all fifty students constituted our fourth data set. Students were invited to write fan fiction pieces in which they created potential prequels or sequels to *The Things They Carried.* Finally, we collected Ning postings from all fifty students in the class. The class Ning was used as a site where students responded to reflective prompts that Becky posted. Students also used the Ning to post their fan fiction projects and poems, and provide feedback to one another in response to these pieces of writing. Students posted an average of two times each week on the Ning.

For Shane's case study and this chapter, we relied on the following data, a subset of the data set for the larger study:

- Shane's tweets.
- Shane's poem.
- Shane's fan fiction project.
- Classmates' Ning postings in response to Shane's work.
- Shane's Ning postings and reflections.
- The thirty-eight minutes of classroom video footage in which Shane appears.
- The video project described in the introduction for the *Literacy in Our Lives* unit at the beginning of the year. While most students posted their videos on the Ning, Shane posted his on YouTube.
- A twenty-minute interview with Becky in which she shares her impressions of and experiences with Shane.

Our data analysis involved using qualitative coding procedures informed by grounded theory (Charmaz, 2006; Strauss, 1987; Strauss & Corbin, 1998). We began by engaging in open coding in order to conceptualize and label our data. We used writing "incidents" (Charmaz, 2006, p. 53) as the unit of analysis for our initial coding; we coded Shane's poem, fan fiction piece, each of Shane's individual tweets and Ning postings, and each Ning posting written by one of his classmates in response to Shane's work as single incidents. Shane developed his *Literacy in our Lives* video with eight discrete episodes, each with a different storyline, setting, and focus. Each episode was coded as a distinct incident. We also coded the transcript of the combined thirty-eight minutes of classroom video footage in which Shane appears and is engaged in conversations with classmates. Each of Shane's contributions on the video was coded as a single incident.

Our initial open coding aimed to capture the various identities that Shane performed in response to the Becky's writing invitations. When possible, we used in vivo codes (Charmaz, 2006) taken directly from Shane's own discourse. Following our initial open coding, we engaged in the process of selecting and identifying core categories, systematically relating them to other categories. Categories were determined inductively using the constant comparative method (Charmaz, 2006; Glaser & Strauss, 1967). Interpretative memos written by the researchers and the use of our "team meetings as memos" (Strauss, 1987, p. 130) helped with both the identification of categories' properties as well as the need to integrate categories with other categories (Charmaz, 2006; Glaser, 1998). The research team ultimately identified three categories to describe the various identities that Shane performed: (a) Shane the comedian, (b) Shane the subversive, and (c) Shane the artist. Below we describe the ways in which each of these identities is performed within (and against) specific pieces and modes of writing.

Shane the Comedian

Shane the comedian might be best illustrated by his *Literacy in our Lives* video project in which Shane reveals insights about himself as a writer. As the video unfolds, viewers quickly realize that the script he has written to guide his video narrative about himself as a writer is completely tongue-in-cheek. At one point, for example, Shane speaks directly to the camera and introduces himself as a "gamer" who likes to "use his… writing to communicate with people [his online opponents] to see how they react to things." In the next scene, we see Shane sitting at his laptop pretending to be in the throes of an intense battle with an online opponent, when he stops suddenly, pretending to have read an offensive message

sent to him by his challenger, to which he responds, "What? Oh, *I'm* the noob? No *you're* the noob, kid!"—employing a term that, according to urbandictionary.com, refers to a gamer who uses "cheap tactics." Pretending to be insulted by a critical assault upon his character, Shane feigns indignation, his ego injured, all to produce humor.

Shane's identity as a wit with a somewhat mordant sense of humor would be, according to Gee's identity framework (2001), a discourse identity—one that relies on acknowledgement and endorsement of others, as Shane himself cannot achieve such an identity on his own. By definition, a discourse identity necessitates that others recognize and sanction that identity. Shane capitalizes on the social networking tools that Becky has incorporated into the unit to help him establish and sustain this identity. He also employs his comedic identity to help him negotiate another – that of Shane the subversive.

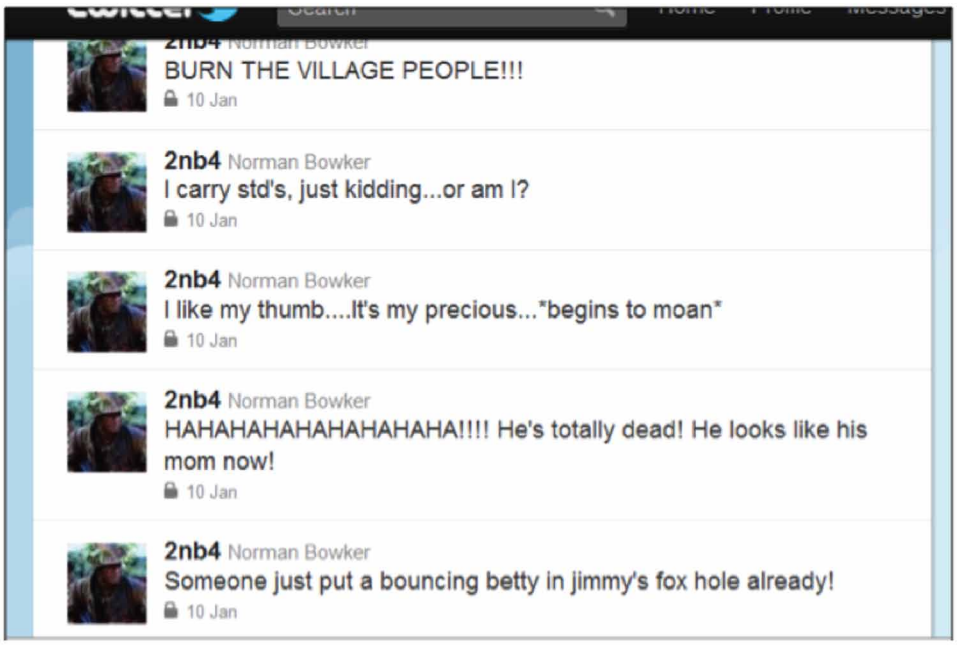
Shane the Subversive

Shane the subversive is often enacted by Shane the comedian. As he works to achieve the status of class clown, he engages his wit to forge an identity of one who can undermine while apparently engaging in school literacy practices. This can be illustrated by a segment of Shane's *Literacy in our Lives* video project. In this segment, Shane appears to be writing in a notebook and greets the viewer by saying, "Oh, hello. I didn't see you there. I was just doing some serious writing on the American Revolutionary War… This is my best work yet." In this excerpt Shane parodies the "serious" academic writer investigating a "serious" intellectual topic, the Revolutionary War. However, he is mocking writing assignments on boring school topics, such as the Revolutionary War, when he says dryly, "my best work yet." In so doing, Shane positions himself as a comedian and subversive in the class, one who will complete assignments, but on his own terms. As a subversive, he taps an audience of those alienated from school, those who have felt disengaged from and bored with school writing, and those who would rebuke rather than embrace identities as academics.

Shane's use of parody to achieve subversion resurfaces in the unit on *The Things They Carried* as well. One of Becky's goals for the unit, developing empathy for the experiences of those in war, was cultivated by inviting students to assume the persona of characters in the book, walking in their shoes as they read. Using Twitter, each student/ character was to write to other student/characters, responding as events in the text unfolded. Shane tweeted as Norman Bowker, a soldier in *The Things They Carried.* (See Figure 1) Unlike Norman Bowker, Shane amuses himself and others by inserting a series of one-liners into the conversation. He uses tweets to shock and amuse readers: "BURN THE VILLAGE PEOPLE!!!" This comment does not reflect Norman Bowker's sympathies, but does represent Shane's attempt to invoke humor by taking an idea to its extreme. He pushes the idea of a soldier's commitments to serve his country to the level of absurdity, issuing an endorsement for slaughtering innocent people that can only be perceived as ridiculous. Shane pushes the boundaries to produce humor by adding sexual innuendoes as well. "I carry std's, just kidding…or am I?" Norman Bowker, a very private person, would not be inclined to discuss this topic, sexually transmitted diseases, or his status as a carrier, in a public forum. Nonetheless, Shane can't resist the opportunity to entertain himself and his peers with inappropriate comments, and his next tweet ups the ante on inappropriate dialogue by suggesting masturbation: "I like my thumb…It's my precious…begins to moan."

Shane's tweets suggest the work of a creative spirit seeking to entertain his peers with a series of parodies of soldiers—over-the-top one-liners, off-color and out of character for Norman Bowker, his assigned character. Nonetheless, he invokes the thumb, villages burning, Jimmy's fox hole and dead

Figure 1. Shane's tweets from the perspective of a character in The Things They Carried



soldiers in his Twitter feed, legitimately referencing the text even as he subverts the Twitter activity, ostensibly complying with the assignment. Shane's identity performances in the Twitter activity resonate with those of his video, his literacy practices leveraged for the roles of subversive and comedian.

Shane does not always employ comedy to communicate subversion, however. He did take an oppositional approach at times. For example, in one of Shane's Ning prompts, Becky asked students to reflect on the ways that Becky used Twitter in class for the character role play. In response, he unapologetically and candidly stated, "I don't play those games." Shane's resistance to tweeting was fueled, at least in part, by his frustration with the assignment. Reflecting on the Twitter activity in the class Ning, Shane said:

I think [tweeting in character] a waste of time, and we shouldn't do it. I have learned how Twitter is basically useless within these situations. It will not be taken seriously, and I do not blame anyone for doing so. It would have been better to write short stories in the mind of what we thought would have been our character. I will never know why the class thought it was a good idea to use Twitter.

Shane elaborated that the distinguishing features of Twitter—140 letters per message—and of the assignment—responding as a character, rather than a reader—were too constraining, producing artificial discourse that couldn't be taken "seriously." As a result, Shane took the liberty of using the Twitter activity to reinforce his subversive identity.

Shane used his writing on the Ning, in Twitter, and in his video to perform resistance to many of the attributes ascribed to that of the typical "good student" who complies with the teacher's wishes and expectations. In so doing, Shane refused what Gee calls the institutional identity, one available to Shane by the "laws, rules, traditions, or principles" of school (Gee, 2000a, p. 7).

Shane the Artist

Shane the artist is best illustrated through his work on his fan fiction project and poetry assignment. Shane's fan fiction piece was five pages single-spaced, more than twice as long as any other fan fiction piece created by his classmates. The text was also remarkably rich in details with a raw intensity that, while unpolished and a bit awkward at times, showed his promise as a writer and his ability to empathize with the military:

The sounds of blade meeting skin and bone was so clear, if you closed your eyes you could see what was happening like an echo of sound to a bat showing the way. Our squad and enemy's squad were only half their numbers when this collision began. In just seconds of the collision the path was blood soaked, no longer a light brown dirt color it's now a dirty dark blood trail.

Shane's use of vivid imagery renders a graphic image of death involving all of the reader's senses: "The sounds of blades meeting skin and bone" compels readers to hear the sounds and view the violence of battle, "this collision," producing a "blood-soaked" path, "dirty" and "dark," with the vestiges of battle. Although Shane's piece was twice as long as most others, it drew feedback from 25 of his classmates when posted on the Ning. Only one student's project attracted more feedback, drawing comments from 28 students. Shane's classmates responded to his fan fiction project with overwhelming praise:

- This is awesome. i [sic] always love your stories, shane [sic]. there [sic] my favorite. please [sic] be a writer when you grow up.
- if [sic] you do not become an author i'm [sic] going to punch you in the face [sic] you do just as good writing as some of the books that im [sic] reading now and they were written by old people [sic] i [sic] think you should try to write as much as possible [sic]

Student responses suggest that Shane has made a name for himself as a writer early on, i.e., "I always love your stories," and "If you don't become an author, I am going to punch you in the face." As Gee says, his peers "recognized" (2000, p.99) him as a writer, and Shane was clearly pleased to receive the accolades: "Thank you! Every time I hear things such as what you said it inspires me to write even more." This dialogic episode illustrates what Gee refers to as "discourse-identity," that is, traits rendered only because of and through dialogue (2000, p.101). Shane stands as the artist because his peers valued his work, their praise convincing him that he was, indeed, a serious and talented writer.

Once students finished the Twitter activity, they worked collaboratively to create a poem in response to *The Things They Carried*. While the poem that Shane and a classmate composed clearly provided Shane with an opportunity to enact his creative artist identity, he also used it to engage his subversive talents. Although the poetry assignment required students to incorporate their own and their classmates' tweets from the Twitter activity, Shane's poem, entitled "I Fall Forever," did not comply with these instructions. The following excerpt reveals the poem's somber tone:

- After war there's never a good story to come back with.
- You don't value life any more nor any less.
- The home you expected to come back to has been burned.
- You only have a new perspective upon death.
- You realize how it surrounds you and how futile you are in its gaze.

The poem represents a serious attempt at capturing the feelings of the soldiers as they return from war; and this text, as well as the fan fiction text, embody those sentiments. When asked to comment on the class Ning about his favorite part of *The Things They Carried* unit, Shane explained:

The main thing I loved overall was the poetry section of this project… The main thing I love to do is write [sic] and especially poetry at the moment. When I'm able to be creative, it seems like the perfect project to me. I would love to have more creative writing projects like this in the future… The more I write it seems as though the more creative I become and the more my mind evolves into something outstanding.

Shane, the artist, revels in sharing his work with others, not just to have an authentic audience, but also to relish the accolades that the audience can bring. Having received numerous compliments from classmates on his fan fiction project on the Ning, Shane responded to his admiring fans with gratitude. Throughout the unit, when extended writing invitations by Becky that he considered suitable for a serious writer, such as the fan fiction project and the poetry assignment, Shane thrived on his fandom, relying heavily on their feedback for motivation and inspiration. As with his comedic identity, Shane used social networking tools to discursively construct an identity as the artist, a gifted writer.

DISCUSSION

Shane's case study traces the ways in which social networking tools, literacy practices, and identity performances converge in the classroom, challenging dominant pedagogical assumptions about using new technologies in the schools to engage learners. The prevailing logic is that students who are digital natives are proficient using new media tools for literacy practices outside of schools; so if teachers bring those tools into the classroom, then those students will become engaged with school literacy practices, and the problem of failing students will be largely resolved. Shane's case helps clarify the fallacy of this thinking. This line of reasoning assumes that literacy practices are defined by the practices themselves and not altered by the contexts in which they are used. Prensky (2001) would likely consider Shane to be a digital native, given that he self-identifies as a gamer, posts videos on YouTube, and ostensibly engages in the types of digitally mediated leisure activities that we associate with the "iKid Generation" (Stevens, 2012). However, when invited to tweet within the context of a class assignment, the identities he performs in his writing are not those that one would associate with the tweets of a digital native. The identities that a tweeter performs when tweeting, for example, are not dictated by the online space – Twitter.com – but rather by the context in which he or she is tweeting (i.e., a class assignment). The social norms of leisure tweeting (e.g., expressing one's opinions in a way that allows for strong identity performances) were in direct conflict with the ways in which Twitter was appropriated in Becky's classroom, where a strict adherence to the assignment guidelines would have disallowed any self-expression or strong identity performances of one's own. Shane, of course, found a way to challenge those constraints and registered his lack of engagement with the Twitter assignment even as he ostensibly completed it, reinforcing his identity as a subversive and comedian.

As K-12 educators clamor to find meaningful ways to engage student in digital literacies (Downes & Bishop, 2012; Prensky, 2010), a number of experts warn against attempting to motivate students simply through the introduction of conspicuously "trendy" forms of new literacies in formal institutions (Lankshear & Knoebel, 2004). In fact, research suggests that young people do not necessarily want to use technology in institutional settings such as schools in the same manner as they do at home (Loh-

nes & Kizer, 2007). As Tapscott and Williams (2008) assert, young people's "appetite for authenticity means that they are resistant to ill-considered attempts by older generations to 'speak their lingo" (p. 54). Shane's refusal to tweet in character serves as a testimonial to this point.

"Authentically" appropriating literacy practices into new spaces defined by very different historical, social, and cultural norms (i.e., schools) seems like a paradox. Consider fan fiction writing, for example. Fan fiction, or any kind of fandom, for that matter, by definition must materialize from the fans themselves. It is a social practice that is not bound by external rules, but rather governed by internal appeals (Jenkins, 2008). Those who engage in fan fiction are members of what Gee refers to as "affinity groups" (Gee, 2001, 2007). In such groups, "people are committed through their immersion in practice [and are] recruited as resources for the group, *not as identities that transcend the affinity group itself*" (Gee, 2007, p. 207, emphasis added). Within these parameters, a fan fiction writing invitation that is governed by "external rules," in which students are positioned as "fans" of a text that was chosen for them, and that, as with Shane, could be used as a way to showcase one's talents, ostensibly for the purposes of forging an identity as a writer that "transcends" those of the other participants, are not the same practices in which members of fanfiction.net (an online site where millions of fan fiction writers produce and consume fan fiction) engage.

This raises another question: How can educators appropriate digital tools and practices into their classrooms in ways that are neither inauthentic nor incongruous with the cultural norms of the native spaces of those practices and the social identities of their students? Teachers are being challenged to find ways to support their students in developing 21st century literacies that are essential for succeeding in a digital world (International Reading Association, 2009; National Council of Teachers of English, 2008). According to numerous scholars (Gee, 1999; Helsper & Eynon, 2009; Jenkins et al., 2006), these literacies are not natural by-products of the ways in which most "digital natives," students, are using digital technologies outside of schools. How, then, can teachers appropriate digital practices for their classrooms in ways that don't sabotage their authenticity and that don't lead students to feel frustrated and alienated? These are the issues that Shane and his multiple identity performances challenge us to consider as we conceptualize what it means to compose in 21st century classrooms.

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Chapter 18
Evaluation of Situations Causing Split of Attention in Multimedia Learning Environments via Eye-Tracking Method

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ABSTRACT

In this chapter, situations that can cause split of attention in multimedia environments were determined via eye tracking method. Fixation numbers, heat maps and area of interest of learners were analyzed. As a result of these analyses, design suggestions were determined for multimedia environments to provide focusing attention to content without split attention effect. Visual and auditory resources should be provided simultaneously. Visual information should be supported with auditory expression instead of texts. Images such as videos, pictures and texts should not be presented on the same screen. Texts provided with pictures should be presented via integration to each other instead of separate presentation of text and picture. Texts provided with videos should be presented via integration to each other instead of separate presentation of text and video. Images should be given via marking important points on images to increase attention.

1. INTRODUCTION

In learning environments, many studies revealed that learners showed higher learning performances in the environments with audio-based animations than in static environments (Plass, Heidig, Hayward, Homer and Um, 2013; Lin, Hung and Chang, 2013; van Genuchten, Scheiter and Schüler, 2012; Kühl, Scheiter, Gerjets, & Edelmann, 2011). In the studies performed by Huff, Bauhoff and Schwan (2012), Cierniak, Scheiter and Gerjets (2009), Liu, Lai, and Chuang, (2012), they found out when text and pictures were

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not integrated together, applied test scores of people learning with split attention effect decreased. On the other hand, simultaneous presentation and presence of semantic harmony between them should be considered when animation and narration is used together (Širanović, 2007; Mayer, 2009).

In multimedia, presentation of texts visually rather than aurally prevents split of attention (Bayram and Mutlu-Bayraktar, 2012; Schmidt-Weigand, Kohnert and Glowalla, 2009; Seufert, Schutze and Brunken, 2009). It was highlighted that learners needed more expressive education and guidance to manage split attention situations better (Agostinho, Tindall-Ford and Roodenrys, 2013). In addition to these, it is emphasized that preparation of effective presentations in multimedia has positive effects on prevention of cognitive load, focusing of attention correctly and emotional and perceptual processes such as motivation and these effects are reflected on perception and transfer performances (Plass et al., 2013; Moreno & Park, 2010; Plass, Moreno and Brünken, 2010).

1.1. Split Attention Effect

Attention is loudly and clearly to embrace one of objects or thoughts appeared simultaneously in the mind. When it comes to attention, it is understood to give up others in order to deal more effectively with some things (James, 1983). Attention is defined as concentration of mental effort on sensory or mental events by Solso, Maclin and Maclin (2008).

Diversification of stimulants while providing information to learners is effective in terms of attracting attention. However, attention is divided while providing these stimulants and mental efforts of individuals can be directed to different parts (Mayer, 2001).

People can learn better in the environments that words and pictures are integrated and provided close to each other physically and formally. In the environments which information is provided from multiple sources, split attention effect does not arise in the case of that sources are quite clear and they are integrated without any need for further explanation (Ayres and Sweller, 2005). Extra information that is not integrated with other sources decreases learning performance of student and constitutes unnecessary memory space. In Web-based education, more effective results are obtained when verbal and visual information is provided together. Presentation of this information close to each other without separation prevents split of attention (Sweller, 2004).

While learners are studying information from multi-source presentations, giving information as integrated provides learners to understand better. Information that is not presented in accordance with this principle causes split of learner's attention for two different tasks. For instance, it is thought that trying to read text results in split into two different tasks while animation is operating (Sorden, 2005). In addition, learners watching visual contents have to simultaneously combine number of features such as perception-oriented style, form or direction with movements of objects moving from one place to another on screen. It is stated that movements and changes in objects draw attention and prevent to focus on actual content (Hillstrom and Chai, 2006). Besides these, it is emphasized that preparation of effective presentations in multimedia, prevention of cognitive load and accurate focusing positively affect learners' emotional and perceptional progresses such as motivation and it is reflected on cognition and transfer performances with this effect (Plass et al., 2013; Moreno and Park, 2010; Plass, Moreno and Brünken, 2010).

In presentations that texts and pictures are provided together, it is known that giving text below picture as an explanation is enough, but it is thought that more effective results can be obtained when text is integrated to picture. In this case, picture and text is put into information process. In presentations that

animation and expression is provided together, simultaneous presentation and semantic harmony between them should be considered (Širanović, 2007; Mayer, 2009). The first study about split attention was carried out for geometry education by Tarmizi and Sweller (1988). In the study, samples were described via two types of geometric forms. Performances of problem-solving strategies with the samples that were provided with geometric shapes integrated directly with information and the samples that information was given below shape with stages were compared. In the second environment which shape and text were provided separately, it was found that attention of learners was divided between shape and text and they needed to make more effort due to cognitive load when compared to other environment.

Eye tracking method which is one of the innovations used to put forward the principles considered for prevention of split attention effect in multimedia learning designs having text and picture combination provides to obtain more precise results from studies. In recent studies, it is emphasized that eye tracking method should be used to provide findings based on more precise evidences (Liu, Lai and Chuang, 2011). It appears that eye tracking method is quite effective especially in multimedia learning environments that visual and verbal information is provided together (Yang, Chang, Chien, Chien, and Tseng, 2013; Molina, Redondo, Lacave, and Ortega, 2013; Alkan, 2013). In many studies based on multimedia learning environment theory, data are based only on test results and comments remain incomplete in terms of cognitive processes. Especially in studies carried out about attention, lack of eye tracking data causes not to obtain clear results. Comments about design according to only expression of individual or test results are not enough to explain cognitive processes. Therefore, eye-tracking method is used in the studies aiming to examine multimedia learning environments (Mason, Tornatora and Pluchino, 2013; Bayram and Mutlu-Bayraktar, 2012; Liu, Lai and Chuang, 2011). For this purpose, results have been strengthened via eye tracking method within the scope of the study.

1.2. Eye-Tracking Method

Eye tracking method provides eye movement data about focused areas while people following content on screen, objects that they ignore and they are disturbed (Underwood and Radach, 1998; Russell, 2005). Eye tracking measurements are quite valuable in terms of supporting and verifying the results previously produced in multimedia studies. Moreover, eye movements deeply provide qualitative and quantitative data about processing information by users. This method helps to find individual differences via tracking eye movements and to interact with source provided (Liu, Lai ve Chuang, 2011).

1.3. History of Eye Tracking

When we look at the history of eye tracking methods, studies about examination of eye movements were performed via direct observations in the 1800s. Then, eye movements were tracked on an aluminum indicator using a kind of contact lens. The first eye tracking more convenient than other methods was developed via a principal based on use of beam reflected from eye and recorded as a film. Buswell examined eye movements about reading and viewing picture in his two different studies (Buswell, 1922; 1937). New studies about eye tracking were carried out in the 1950s and 1960s. Experiments were carried out especially about attention and related issues (Yarbus, 1967).

In the 1970s, new researches especially about ‘reading’ were performed in studies about eye tracking (Rayner, 1998). In the study about eye tracking carried out during problem solving process by Hunziker (1970), visual problem solving displayed on glass plate was filmed.

Researches that were performed in the 1980s and 1990s and were thought to provide a base for recent eye tracking studies presented new findings about eye tracking method (Posner, 1980; Deubel and Schneider, 1996; Hoffman, 1998). In the 2000s, studies performed with measurements giving better results with developing technology prove or reject findings of studies previously carried out (Liu, Lai and Chuang, 2011; Russell, 2005). With this method, it is one of the most effective methods to perform usability tests of items such as user interface, menu, graphic (Bazar, 2009; Byrne, Anderson, Douglass, & Matessa, 1999) and web sites (Tüzün, Akıncı, Kurtoğlu, Atal, & Pala, (2013), Faraday, 2001; Goldberg, Stimson, Lewenstein, Scott, & Wichansky, 2002). Upon reviewing previous studies, it is seen that measurements of eye movement variables used to measure and define individual's cognitive activity are used most commonly (Mutlu-Bayraktar & Bayram, 2013, Yang et al., 2013; Jarodzka, Van Gog, Dorr, Scheiter, & Gerjets, 2013).

Screening path of eye, duration spent for looking at various images, focusing areas of visual attention and number of winks are obtained with eye tracking method.

1.4. Eye Tracking Systems and Data Obtained

Eye movements are related to cognitive operations in the brain, so that it provides to obtain information about these operations and processes via observing and interpreting eye movements (Biedert, Buscher and Dengel, 2009). It is quite important that experimental environments prepared with this method measuring cognitive processes should be natural and they should be in a way that participants will not feel like they are in experimental environment. Simple-to-use eye-tracking device located away from should be preferred to the device mounted on head (Namahn, 2000). Within the scope of this study, it was integrated under the monitor in Human-Computer Interaction laboratory and unnoticed eye tracking device was used.

Definitions of some terms used for eye tracking data were listed below (Jacob and Karn, 2003):

Fixation: Fixing eye, looking at object or areas generally with 2-degree distribution threshold and minimum 100-200 ms duration.
Gaze Duration: The duration that eye looks at a certain point via keeping on.
Scan Path: Roaming pattern of fixed gaze on screen (See Figure 1).

Area of interest: Attractive picture or visual environmental area that researcher specifies (See Figure 2).

Heat map: The screens are rated with colors on heat maps according to gaze duration and number (See Figure 3).

In addition to these data, images are obtained from video records saved by cameras found in HCI laboratory. It provides important information via enabling to observe individuals' reactions and behaviors in video and via being an information store including visual and audio sides.

Eye tracking method provides eye movement data about areas paid attention, subjects ignored and irritating things when people follow content on screen (Underwood and Radach, 1998; Russell, 2005). Eye tracking measurements are quite valuable in terms of support and confirmation of the results produced in previous multimedia environment studies. Moreover, eye movements deeply provide qualitative and quantitative data about processing of information by users. This method helps about finding individual differences and interacting with presented source via tracking eye movements (Liu, Lai and Chuang, 2011).

Figure 1. Scan Path Data

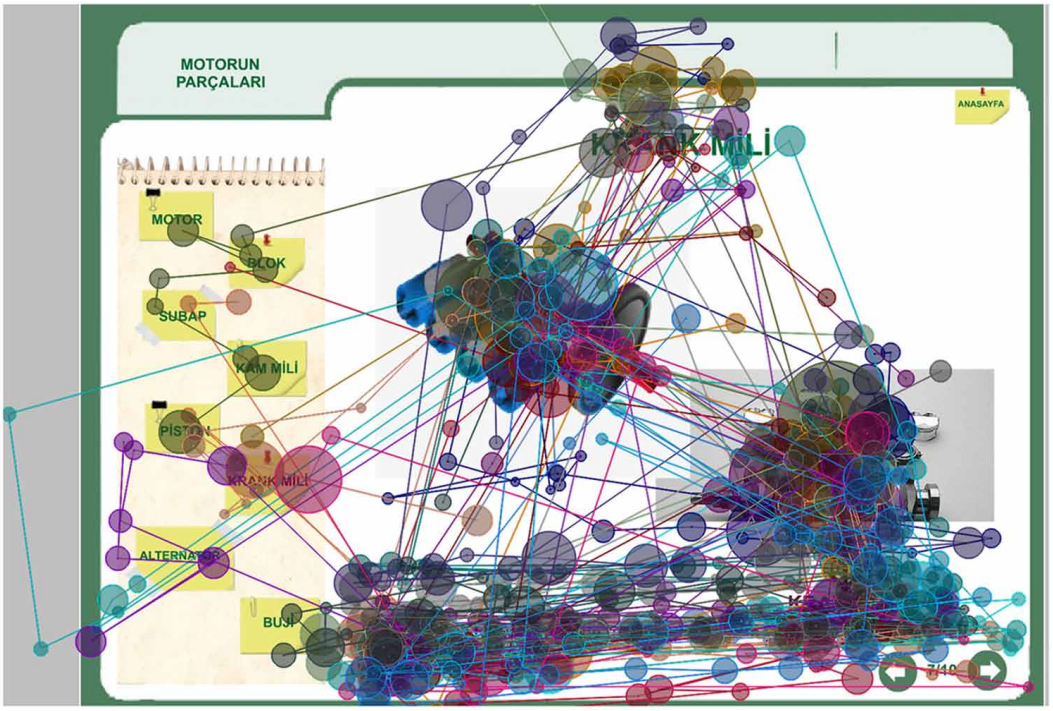


Figure 2. Area of Interest Data

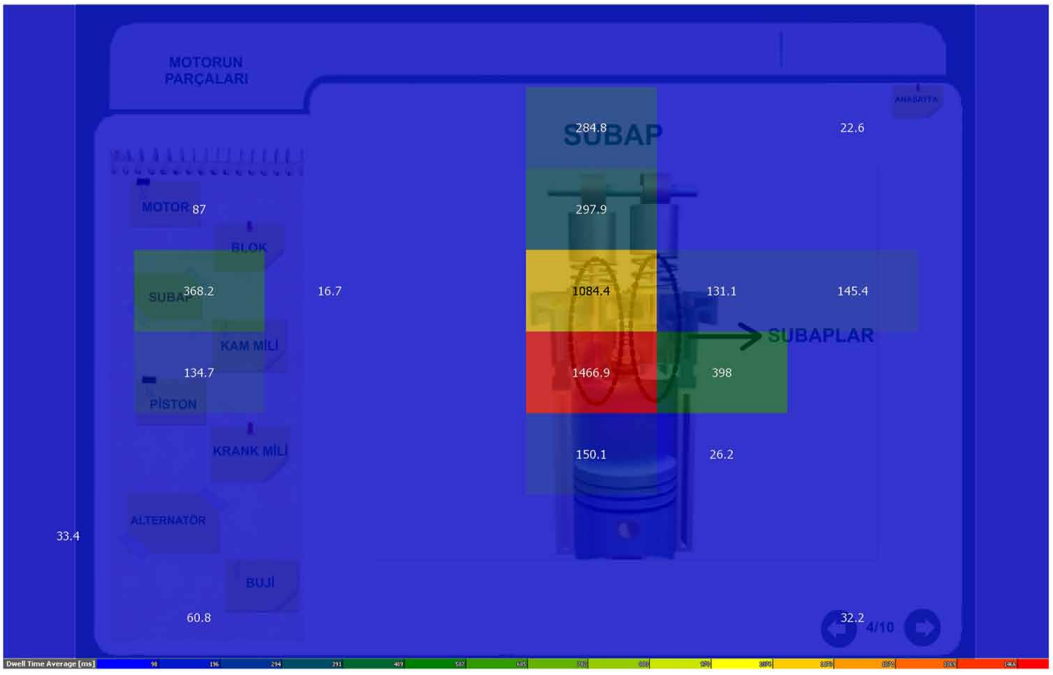
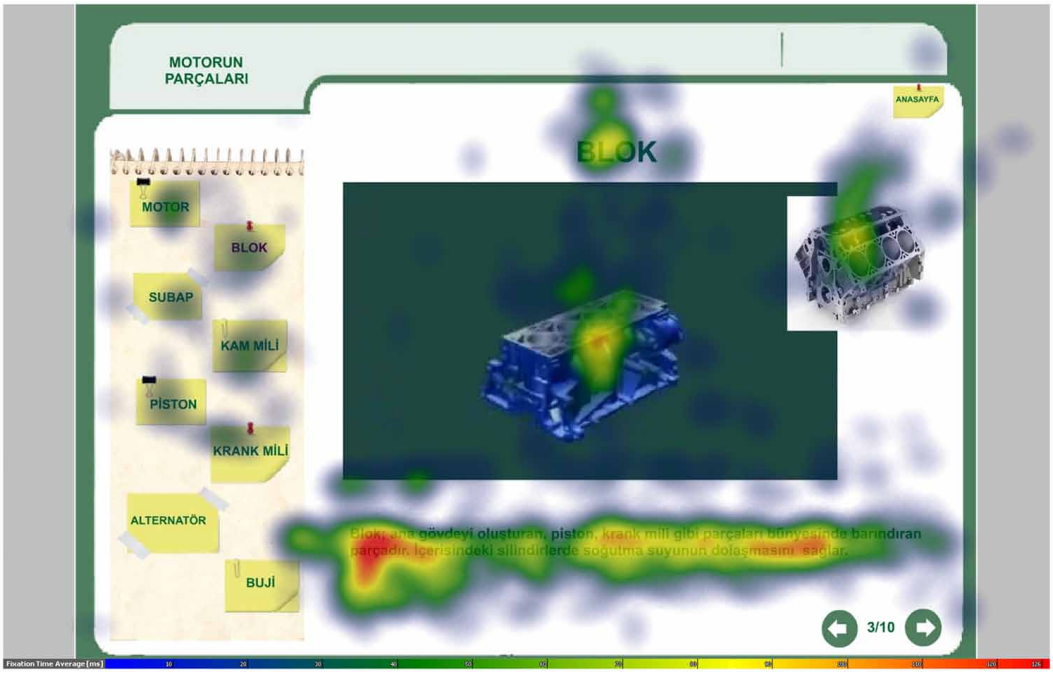


Figure 3. Heat Map Data



Eye movement is related with cognitive processes in the brain, so that it provides to get information about this processes and steps in the brain via observing and interpreting eye movements (Biedert, Buscher & Dengel, 2009). It is really important that experimental environments prepared with this method measuring cognitive processes should be natural and they should be like that participants should not feel they are in experimental environment. Simple-to-use eye-tracking devices located away should be preferred over head-mounted device (Namahn, 2000). Within the scope of this study, an unobtrusive eye tracking device integrated under screen was used in Human-Computer Interaction laboratory.

According to the presentations performed via using information types individually (audio, visual) in learning environments, it was revealed in many studies that the presentations using double information type were more effective (Mayer and Moreno, 2013; Van Genuchten, Scheiter, and Schüler, 2012; Florax and Ploetzner, 2009; Mayer and Moreno, 2002). In addition, presentation of this information near to each other prevents splitting of attention (Crooks, Inan, Cheon, Ari and Flores, 2012; Sweller, 2004, Schmidt-Weigand and Scheiter, 2011). For this purpose, the following research questions were examined.

1. What are the areas on which learners focus more in focused attention multimedia?
2. What are the areas on which learners focus more in split attention multimedia?
3. How are the heat maps of learners during the use of multimedia in focused attention type?
4. How are the heat maps of learners during the use of multimedia in split attention type?

2. METHOD

In the method of the research was survey model. Survey models are the researches that aim to describe past or present situation as it exists and are performed with larger samples according to other researches (Karasar, 2007).

2.1. Study Group

Overall, 27 women and 20 men, total 47 students from Marmara University voluntarily participated in the study. All of the participants were undergraduate students who participated in the project management course in Computer Education and Instructional Technology Department. Students did not participate in earlier experiments in the Human Computer Interaction Laboratory. Their mean age is 21.5. They voluntarily took part in the experiment for extra 10 points about their exam.

2.2. Multimedia Instructional Materials

2.2.1. Focused Attention Multimedia Learning Environment

In this medium, the "motor" lesson contents were prepared as per the Multimedia Instructional Design Principles of Mayer (2009) with the aim of eliminating the presence of split attention causes. This instructional media has been designed as visual and audio kinds with the goal of focused attention, in order to enable the realization of recall. The presentation types have been diversified by supplementing visually presented information with audio explanations. With the aim of focusing attention, images were presented as separate from the video during scenes of video explanations. The information presented in images was thus presented with the objective of offering the explanation in audio and enabling focusing on the image and the explanation. The information presented in the images were supplemented with audio and presented in progression. The texts relevant to the images were presented in an integrated manner to the explained images. The material was designed to allow the self-pacing of the student. The students were presented with operation instructions for perusing the material (See Figure 4).

2.2.2. Split Attention Multimedia Learning Environment

In this medium, the "motor" lesson contents were prepared in audio presentation according to the possibility of the occurrence of split attention effect. Images and texts were added into the scenes containing information presented in the videos. The audio information was prepared to present different sections than those presented as texts. The text descriptions of the images were presented spatially distanced from the images themselves. The application's preparation allowed the student's self-pacing. The students were presented with operation instructions for perusing the material (See Figure 5).

2.3. Eye Tracking Measures

Eye tracking data can provide valuable information about the attention processes of the learners. The participants studied these materials and they were tested individually at the Marmara University Human Computer Interaction Laboratory. It will be completed.

Figure 4. Screenshot of a Presentation from Focused Attention Multimedia

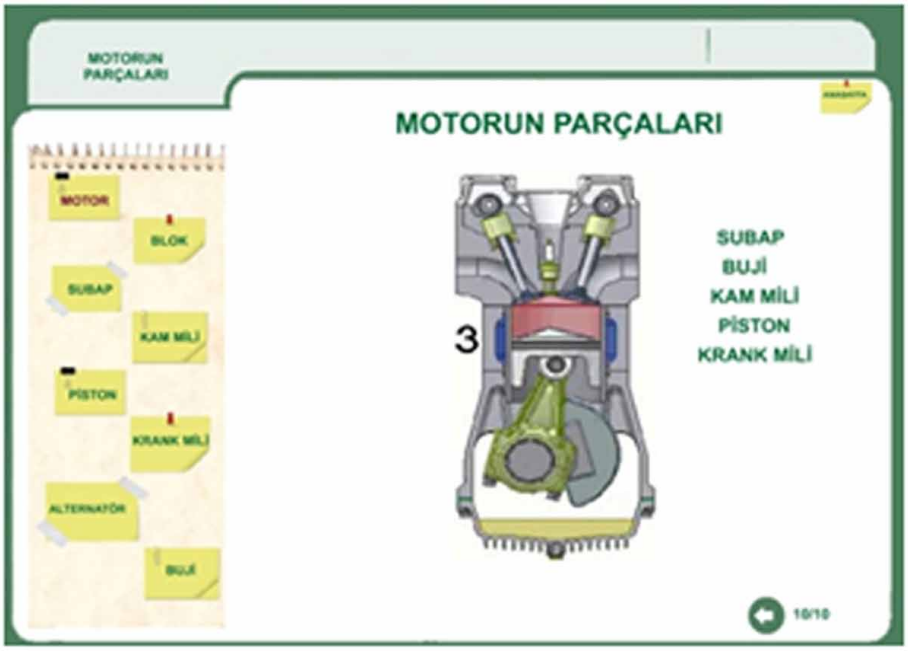
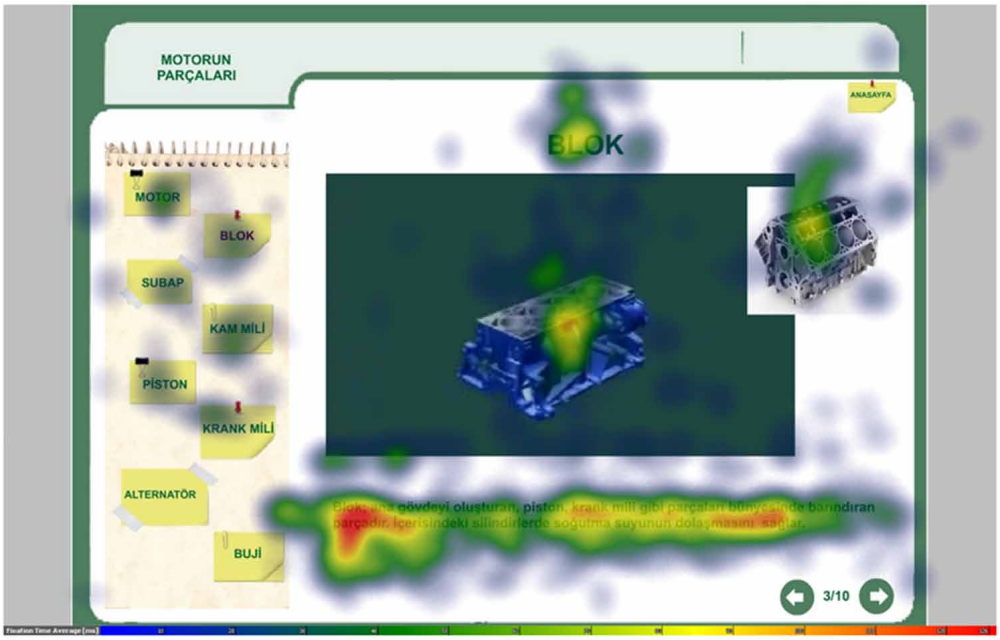


Figure 5. Screenshot of a Presentation from Split Attention Multimedia



In this study, SMI Experiment and Begaze 2.4 programs were used for measuring eye-movement data. After calibration, participants were presented with multimedia learning environments.

2.4. Tools Used During Eye Tracking

The experiments were carried out in Human-Computer Interaction Laboratory used in Computer and Education Technologies Department of Atatürk Education Faculty of Marmara University. Units used in the laboratory:

2.4.1. Cameras

In the test room, one remotely controlled dome camera serving to observe all movements of user, where camera looks at is not understood due to translucent plastic cover on it and one mobile camera serving to show keyboard use (See Figure 6).

2.4.2. Eye Tracking Device and Test Computer

There is an eye-tracking device that gives information about where, how long and how many times user looks at the screen and simultaneously records eye movements during test process. It is connected to a test computer which is linked to the device and user will perform the experiment and to another computer which is found in observer's room and records screenshots of user (See Figure 7).

2.4.3. Observer's Computer

It is found in control room and there is also a computer which screenshot is recorded by software such as Noldus and computer connected to cameras (See Figure 8).

Figure 6. Cameras

Figure 7. Eye-Tracking Device and Test Computer

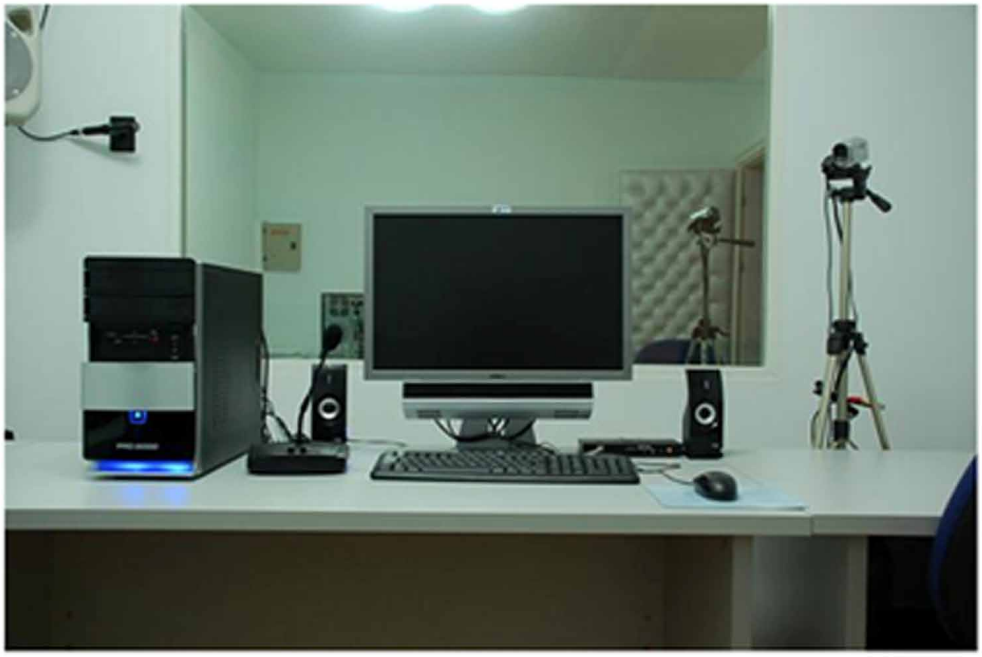
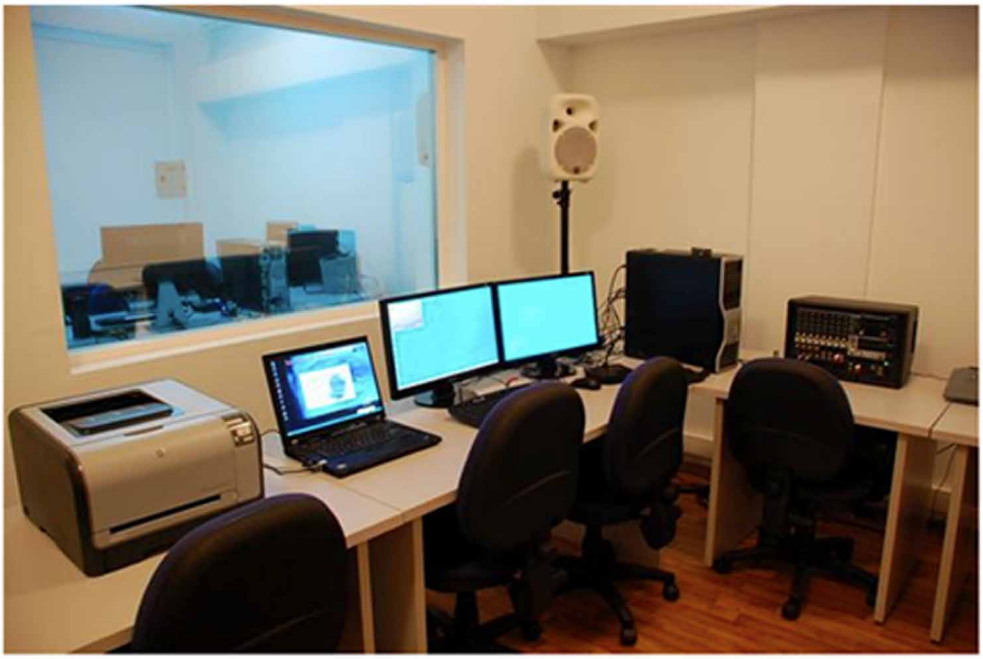


Figure 8. Observer's Computer



2.4.4. Control Unit

There is a control unite which controls 360° pivotable cameras and is connected to monitor showing both image taken by camera and screenshots of computers of observer (See Figure 9).

2.4.5. Microphone and Amplifier

There are microphones in test room and control room for communication between user and observer. Audio recording resolution is amplified by amplifiers (See Figure 10).

Figure 9. Control Unit

Figure 10. Microphone and Amplifier

2.4.6. Sound Isolation

It should be performed to be protected from harmful effects of noise and to create proper use conditions via isolating test room from unwanted sounds during test.

2.4.7. One-Way Mirror

Observers follow behaviors of users via one-way mirror that separates test room and control room.

2.5. Experiment Process

Learners were taken into experiment process in HCI laboratory in the Department of Computer Education and Instructional Technology of Marmara University. The experiment was previously recorded as screen recording with 'SMI Experiment' program in test computer mounted with eye tracking device. This process was performed only once during the research and each participant was studied via this experiment. The experiment was started after calibration of eye. Then, eye movements of students studying focused and split multimedia environments were recorded with eye tracking devices found in HCI laboratory (See Figure 13). The records which were recorded via Experiment 2.4 program and showed

Figure 11. Experiment Process

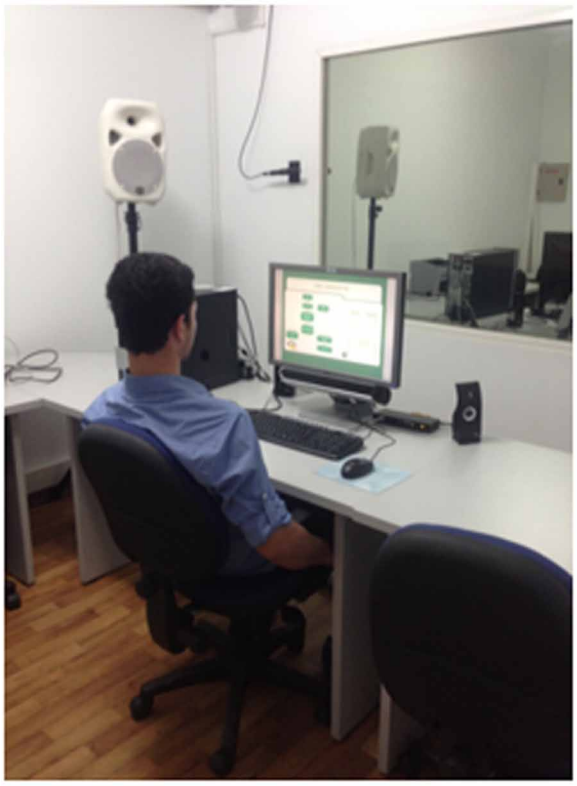
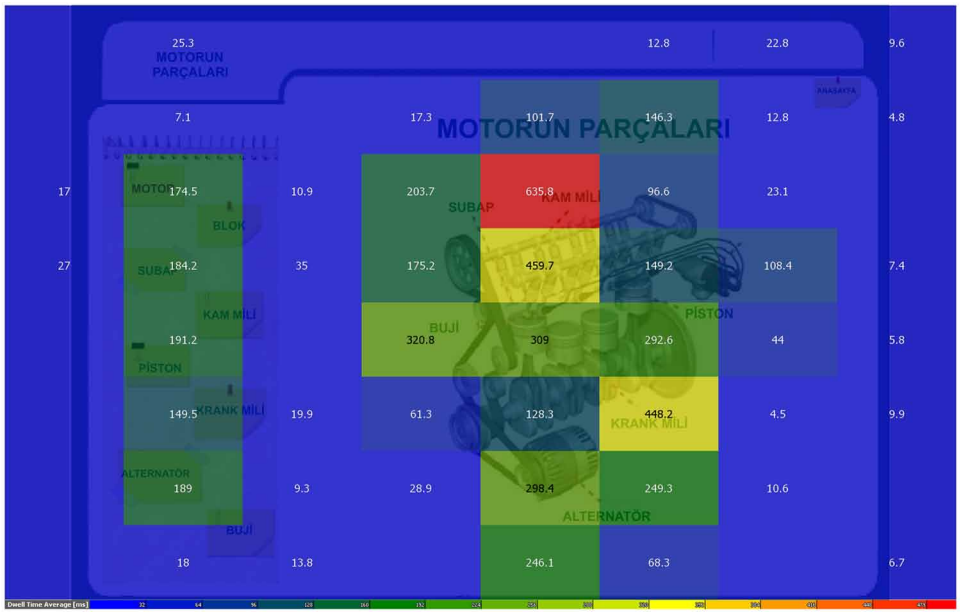


Figure 12. Color Transition for Fixation Number

Figure 13. Fixation Numbers Belonging to the Screen in which Texts were Integrated to Pictures in Focused Attention Multimedia



eye and mouse movements were analyzed via Be Gaze 2.4 program. Fixation, duration and heat map values were examined in the analyses.

3. FINDINGS

In the first research question of the study, eye-tracking data was analyzed to determine the areas on which learners focused more in multimedia designed according to focused attention.

While fixation numbers were detected via eye-tracking device, the duration between stage opening and moving to other page was accepted as beginning. Fixation numbers were detected during the duration between these two times. While the areas having more focus are marked with red on the screen according to total focusing numbers on the screen, the areas with less focus are marked with blue.

On the screen which names of motor parts were presented as integrated into picture and video, it was aimed that students focused on both of them without any split of attention between text and picture.

When eye tracking data was evaluated, it was seen that students mainly focused on pictures, then on texts and menu buttons (See Figure 13).

On another focused multimedia screen that audio expression and video were used, it was aimed to make fixation on actually described part in the video via images. So that it was aimed to prevent split of focuses of learners on other objects in the video. When eye tracking data of this screen is evaluated, it is found that learners focus more on the object described in the video. Then, they focus on name of the object and menu buttons (See Figure 14).

In the second research question of the study, Eye-tracking data was analyzed to determine the areas that learners focused more in multimedia designed according to split attention. When eye tracking data obtained for the screen used for video, text and audio expression is evaluated in multimedia learning environments which emergence of split attention effect is possible and motor and its parts are described, it is seen that learners focus more on texts and fixation numbers are more in texts than in picture or video. It is seen that learners' attentions are split between picture and video and use of texts as well as audio expression makes focusing difficult. This situation affected learner performance as a result of emergence of effect of extremeness (See Figure 15).

When eye tracking data belonging to the screens that names of motor parts in picture or video are presented without integration into pictures is evaluated in multimedia learning environments which emergence of split attention effect is possible, it is seen that attentions of learners are split between picture and text. It is found that they focus more on texts then on picture and buttons according to fixation numbers (See Figure 16).

Figure 14. Fixation Numbers Belonging to the Screens which Described Object is Marked in Focused Attention Multimedia

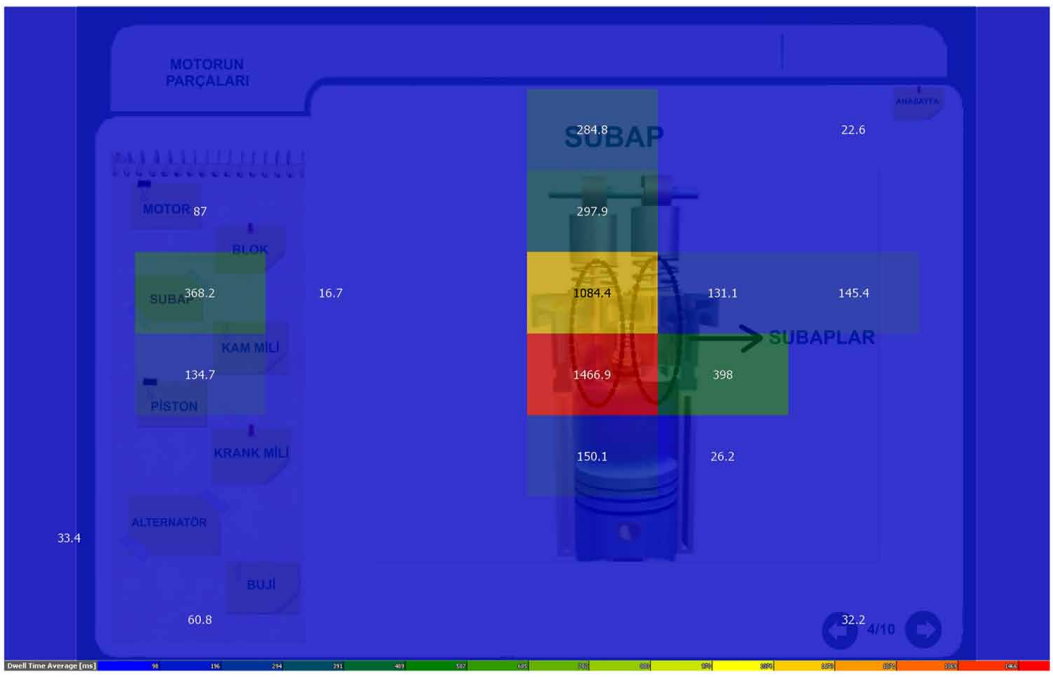


Figure 15. Fixation Numbers Belonging to the Screen which Video, Text and Audio Expressions are Present in Split Attention Multimedia

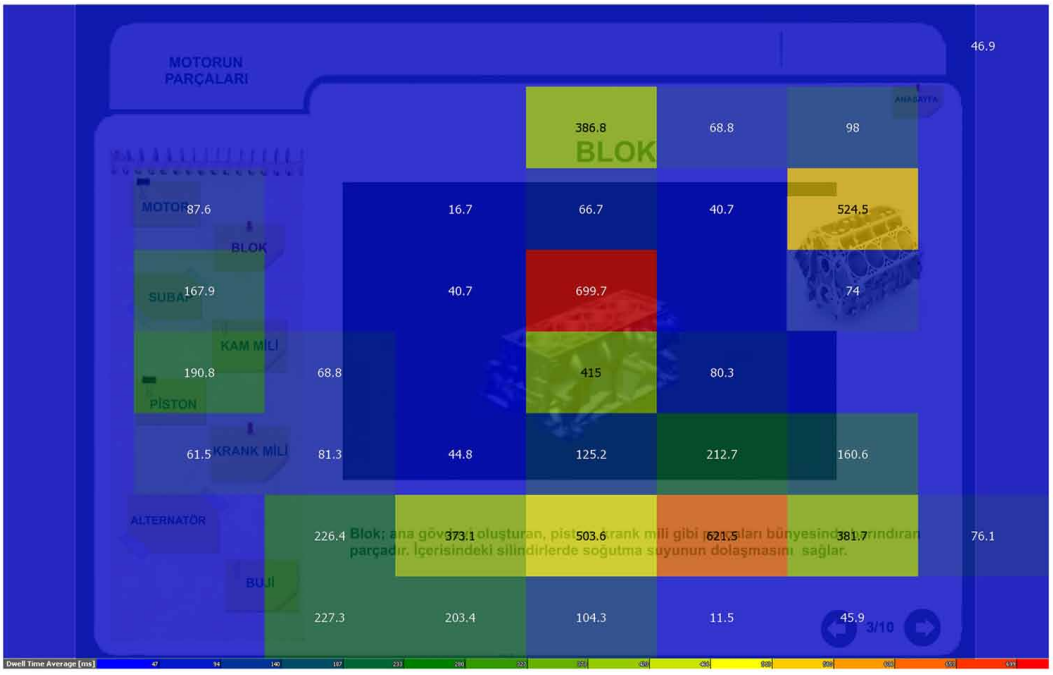
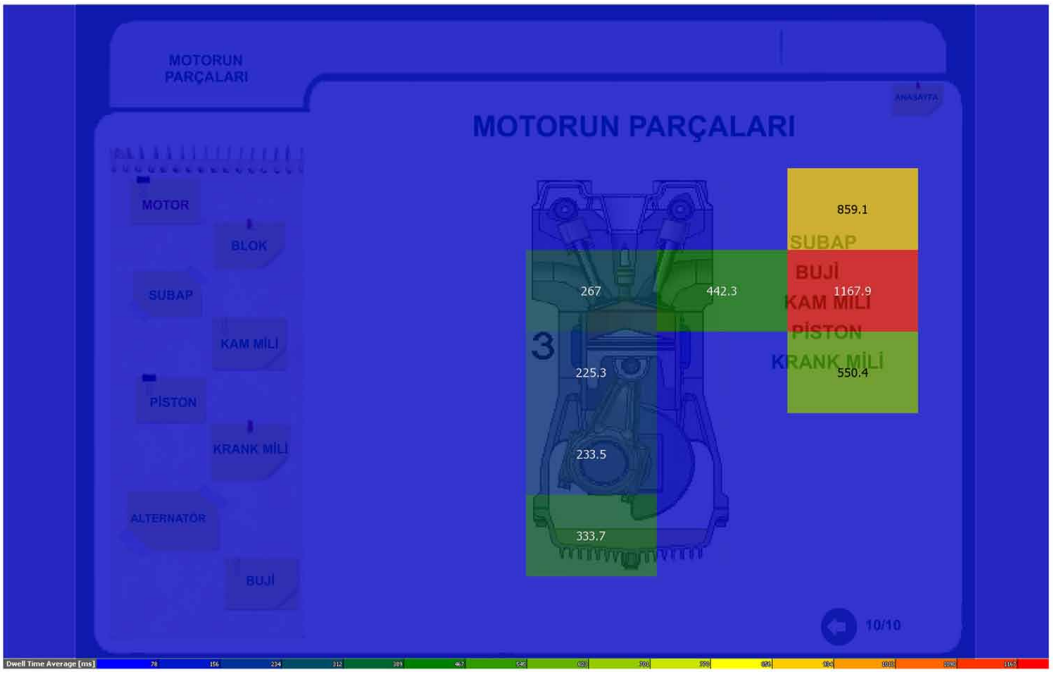


Figure 16. Fixation Numbers Belonging to the Screen in which Texts are Separately Presented from Video in Split Attention Multimedia



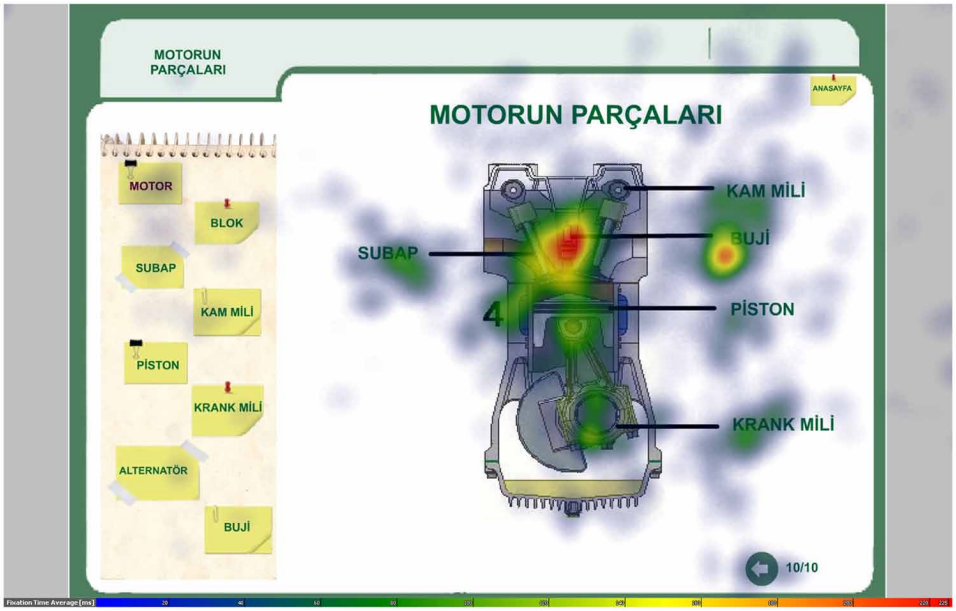
In the next research question of the study, eye-tracking data was analyzed to determine heat map during use of multimedia in focused attention type by learners. Another analysis type for processing the data obtained from eye tracking is heat maps. The screens are rated with colors on heat maps according to gaze duration and number. After opening screen, the most focused area on interface for related objects can be detected. While heat map images on the screens were being obtained, the duration between stage opening and moving to other page was accepted as beginning. Heat maps were established with constant gazes during the duration between these two times.

While the areas having more focus are marked with red on the screen, the areas with less focus are marked with blue. Color transition for heat maps are presented in Figure 17.

On the image in focused attention multimedia, it was aimed that learners focused on both the text and picture without attention split on the screens which texts containing names of motor parts were integrated into the picture. When heat maps are evaluated according to eye tracking data, it is seen that learners focus more on pictures then on texts and menu buttons (See Figure 18).

Figure 17. Color Transition for Heat Map

Figure 18. Heap maps belonging to the screens which texts are integrated into pictures in focused attention multimedia



In focused attention multimedia, it was tried to perform focusing via marking on actually described part in video. Therefore, it was aimed to prevent attentions of learners to split into other objects in video. When the heat maps about the eye tracking data belonging to this screen are examined, it is seen that learners focus more on the object marked in the video. Then, they focus on name of the object and menu buttons (See Figure 19).

Eye tracking data was analyzed to determine heat maps in the progress of use of multimedia by students in split attention type. When heat map about eye tracking data obtained for the screen that video, text and audio expression were used was examined in multimedia learning environments which emergence of split attention effect is possible, it is seen that learners focus more on texts than on picture or video. It is seen that learners' attentions are split between picture and video and use of texts as well as audio expression makes focusing difficult. This situation affected learner performance as a result of emergence of effect of extremeness (Figure 20).

When heat map belonging the screens that are presented as names of motor parts in picture or video are not integrated into pictures is evaluated in multimedia learning environments which emergence of split attention effect is possible, it is seen that attentions of learners are split between picture and text. It is found that learners focus more on texts, then on picture and buttons (See Figure 21).

In focused attention multimedia, the part was marked in the video to increase focusing on motor part being described with the video. This marking was not performed in split attention multimedia. In this situation, focusing is dispersed on the video and it is not focused on the part being described (See Figure 22).

Figure 19. Heat Map Belonging to the Screen in which the Object is Marked in Focused Attention Multimedia

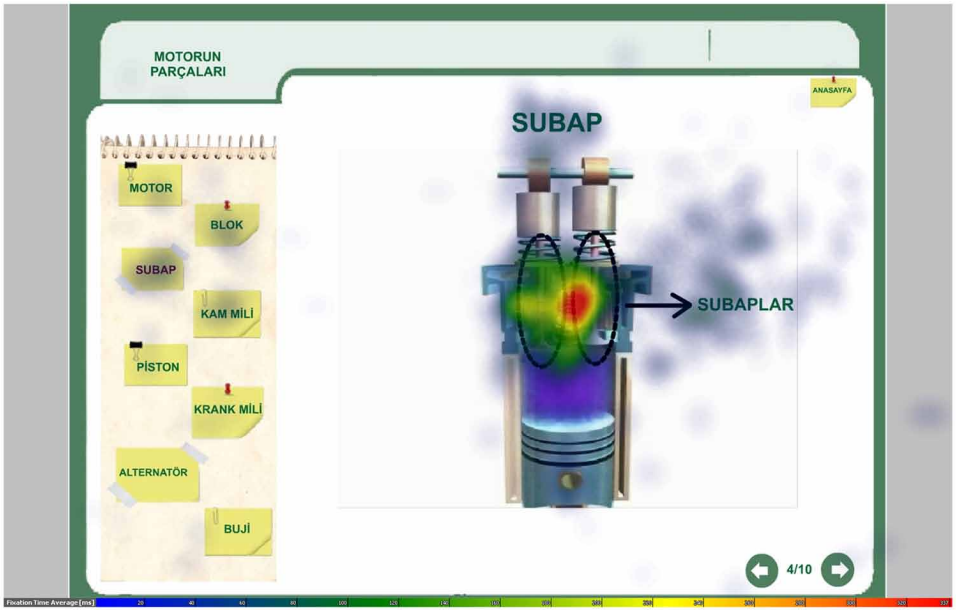


Figure 20. Heat map belonging to the screen that video, picture and audio expressions are present in split attention multimedia

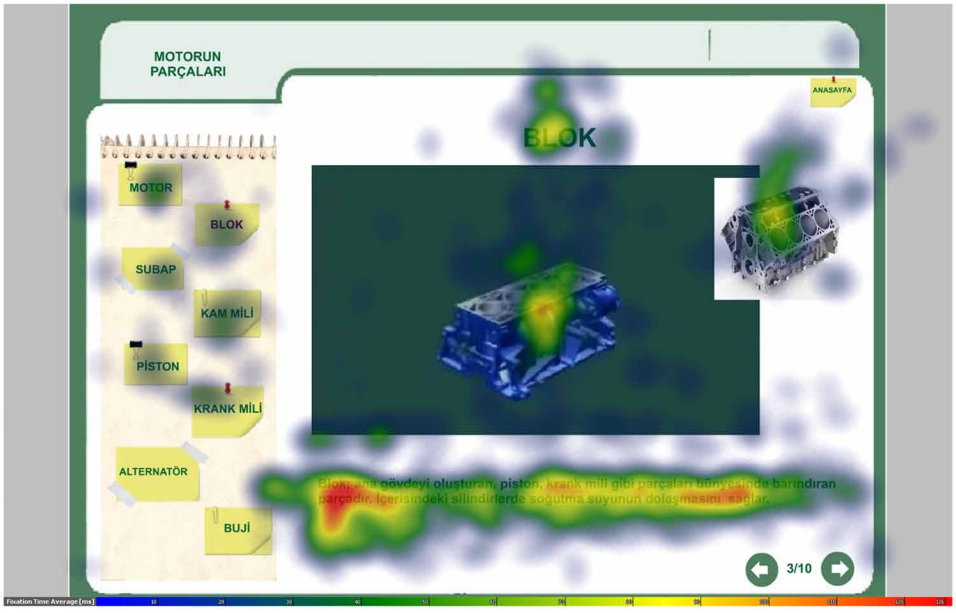


Figure 21. Heat Map belonging to the Screen that Texts and Pictures are Separately Presented in Split Attention Multimedia

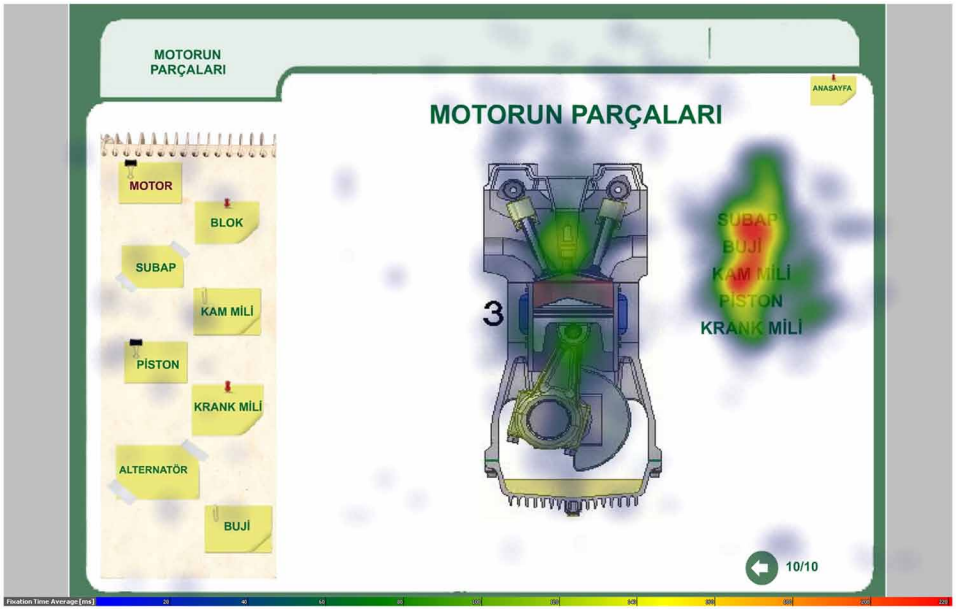
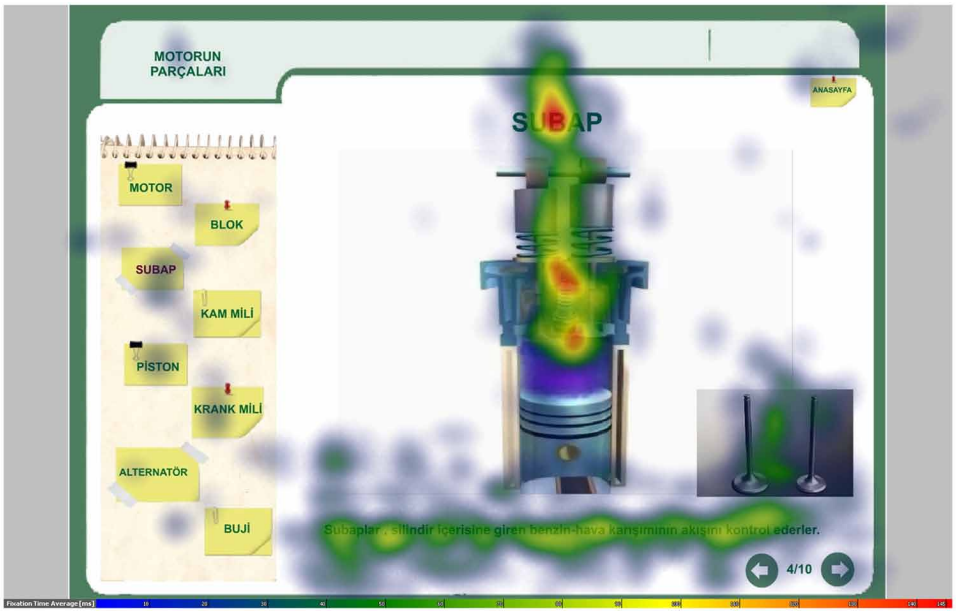


Figure 22. Heat Map Belonging to the Screen that is Presented without Marking the Object in Split Attention Multimedia



4. RESULTS

Use of different sources such as picture, text and audio in learning environments enriches education environments. Especially online learning environments as tools assisting rapid development and spread of knowledge support learning. In developing online learning environments, interactive learning process is generated between content and learners. Environments used aim to provide configuration of knowledge via keeping students active during learning process.

In e-learning environments, many studies revealed that learners showed higher learning performances in the environments with audio-based animations, also text and pictures were integrated together (Plass, et al., 2013; Lin, Hung and Chang, 2013; van Genuchten, Scheiter and Schüler, 2012; Liu, et al., 2012; Huff, Bauhoff and Schwan, 2012; Kühl, et al., 2011). On the other hand, simultaneous presentation and presence of semantic harmony between them should be considered when animation and expression is used together (Širanović, 2007; Mayer, 2009). In this study, it was similarly found out that restoration performances of learners were higher in the environments with presentation of integrated visual and verbal presentation type information than in the environments without this integration. On the other hand, simultaneous presentation and presence of semantic harmony between them should be considered when animation and expression is used together (Širanović, 2007; Mayer, 2009).

According to eye tracking data obtained about the screens which picture, video and texts are presented together, one of the results is that learners focus more on video or pictures in focused attention multimedia. Focusing on video and pictures by learners was provided without split of attention. In the study performed by Yang et al. (2013), the results showing that average fixation time and average data processing time are longer in areas with pictures show parallelism with the study. On the other hand, in

the study carried out by Liu, Lai and Chuang (2011), they revealed that learners focused better on video in the environments that texts were presented with narration, rather than visually.

It was found that markings made to aim drawing attention to a certain point on images had contributions to recall performances of learners. In the study carried out by Chen, Wang, Chen and Chen (2014), it was seen that learners showed better performances with the use of visually emphasized presentations and visual markings. In two studies performed by Ozcelik, Arslan-Ari, & Cagiltay, (2010) color coding method was used in learning environments prepared via using markings and its positive effects were presented among the results via eye tracking data. Increase in learning with color-coding was performed with accurate positioning of pictures and texts related with each other concurrently.

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KEY TERMS AND DEFINITIONS

Attention: The nervous system function that provides selecting only in need stimuli.

Eye-Tracking Method: It's a eye movements data collection method used for while individuals follow the content on-screen where pay attention to the areas, which elements are ignored, to determine what they are uncomfortable.

Focused Attention: It is the concentration of attention on a specific part of the information.

Multimedia: It's a media where words (as textual and narrative) and images (photographs, animations or videos) as they are used together. It's an environment which text, image, audio, animation, video or a combination of these used together.

Multimedia Learning: For the presentation of certain learning content text, graphics, animation, photography, video and audio of the different symbol systems complement each other in a way that is integrated.

Split Attention: Attention is divided between two simultaneous inputs.

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Chapter 19
Toward Digital Inclusion:
Digital Divides and New Media Literacies[1]

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ABSTRACT

This chapter addresses the relationships between social inclusion and digital divide(s), mainly focusing on the conceptual frameworks that provide the basis for rethinking the relationship between technological, social, and human factors. Redefining the digital divide has deep consequences on the theoretical and empirical framework we apply to the digital divide and to the related social inclusion processes. It is widely acknowledged that the label digital divide can be partially misleading, because it is mostly emphasizing a binary dimension (haves vs. have not) and a mere technological dimension. In order to achieve a clear operational definition of the digital divide, we should avoid some misleading myths characterizing the debate and focus on the complex relationships between technological, social, and human factors (a dichotomous conceptualization, a narrow understanding of the technological factors involved, a technological deterministic approach), adopting, instead, an enabling technology approach. Therefore, the authors introduce a multilevel model for analyzing digital divides (Comunello, 2010), with a main focus on new media literacy (the model considers not only mere technology availability, but also real access, advanced reception practices, technical skills, content production, networking skills). Finally, they review some empirical methods for studying the digital divide, trying to underline how a more nuanced framework for analysing the digital divide can be adopted by empirical research.

INTRODUCTION[2]

The digital divide is an internationally recognized issue today: unequal diffusion of ICT (Information Communication Technology) is a problem of global relevance in a world where social systems were radically changed by Information Technology. Knowledge, production, finance, education, social and

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political relations are affected by this technological revolution. Nevertheless, the presence of such technologies has created new social inequalities.

Providing a specific definition of the digital divide is a complex task. Scholars have been trying to identify specific dimensions in order to analyse such increasing gaps in the distribution of ICT (Servon, 2002). These do not only refer to differences between the North and the South of the world, but also to differences to be identified within the more developed societies: the so-called social divide (Norris, 2001). Such inequalities are determined by geographical context (whether urban or rural), socio-economic status, educational level and ethnic origins. The digital divide has been originally identified with disparities in technology access, dividing so-called haves and have not, according to a binary logic that could be applied to either subjects or countries (James, 2003). Afterwards, the concept of the digital divide underwent a conceptual and empirical transformation. Digital divide today is a multifaceted concept, embracing to a number of dimensions: not only technology access, but also literacy, contents and services are other important elements to be considered (DiMaggio, Hargittai, Neuman & Robinson, 2001; Gunkel, 2003; Warschauer 2003, 2007).

Theoretical and empirical experiences made it possible to modify the frameworks used for analysing the digital divide in the international context. Scholars underline that 'standard recipes' cannot be applied to different contexts: in order to reduce the gap between technologically advanced countries and poorer ones, a context-aware framework has to be adopted (Rodriguez & Wilson, 2000; Wilson 2004; Wilson & Wong, 2007).

Equally, when addressing so-called intra moenia divide (the social divide, in Norris' 2001 words), the analysis has gradually shifted from a quantitative approach, aimed at detecting the presence of ICT and its availability to individuals, to a qualitative approach, aimed at identifying to what extent the lack of such technologies is heavier for the disadvantaged. Nowadays, scholars are focusing on how ICT can contribute to reducing social marginalization (social exclusion) and to increase community cohesion (social inclusion).

The main objective of this work is to highlight how ICT can strengthen the processes of social inclusion. In contemporary societies, both social inclusion and social exclusion are not only based on economic marginalization, but also on relational and cultural exclusion; the cohesion of a social system is highly dependent on the participatory dimension, from both a civic and political perspective. Moreover, socio-cultural integration strongly depends on how inclusive the social context is.

In order to operationalise such theoretical concerns, we will introduce a multilevel model for analysing the digital divide, focusing not only on technology access, but also on digital literacy. We will also review some empirical methods for studying the digital divide, trying to underline how empirical research can benefit from a more nuanced framework for analysing the digital divide.

ACCESS AND BEYOND: ENABLING TECHNOLOGIES[3]

It is widely recognized that, after more than 15 years of debates, the very notion of the digital divide needs to be reconsidered (Selwyn & Facer, 2010). A rising number of scholars are questioning the label digital divide, adding in their books' titles expressions like rethinking, redefining, reconceptualizing or beyond (Warschauer, 2003, 2007; Mossberger, Tolbert & Stansbury, 2003, etc.), or proposing the idea of a second order digital divide (Hargittai, 2002; van Dijk & van Deursen, 2010), going beyond the dichotomous first order conception; others introduce new concepts, such as digital inequality (DiMaggio

& Hargittai, 2001), zones of silence (Potter, 2007, or use it combined with other expressions, such as digital exclusion (Selwyn & Facer, 2010).

We certainly agree with these authors: for a better understanding of our topic, we need to abandon any techno-centric approach and any dichotomous vision that can be found in traditional digital divide literature. We would, therefore, need more analytical definition. Nevertheless, as many authors do, in this chapter we will continue using the label digital divide, mainly with regards to its recognizability and its widespread adoption even outside academia, in order to maintain an adequate level of consistency and comparability between different researches, and to keep a shared means of communication with policy makers and activists worldwide.

Similar concerns may appear as a mere theoretical matter, without any practical relevance. On the contrary, theoretical concerns can have deep consequences on the frameworks adopted by policy makers. Adopting a techno-centric perspective (or a dichotomous vision of the digital divide) will lead to projects that will hardly meet their intended users' needs. As Warschauer points out,(the) same types of problems occur again and again in technology projects around the world, which too often focus on providing hardware and software and pay insufficient attention to the human and social systems that must change as well for technology to make a difference. (Warschauer, 2003, p. 6)

By addressing such conceptual issues, we have to be fully aware that "Perhaps the greatest gap is the wisdom gap – the gap between the information revolution's inherent complexity and our capacity to comprehend it. We need a multidisciplinary and comprehensive framework for analyzing the information revolution" (Wilson, 2004, p. 36).

For a better understanding of the digital divide, the main elements to be reconsidered are, in our opinion, the following: (a) the widespread dichotomous conceptualization, that juxtaposes information haves and information have nots; (b) a narrow vision of the digital divide itself, that identifies it with mere technological access (or the lack of it); (c) a narrow vision of technology, that identifies ICT with a small set of devices (namely, personal computers) and conduits; (d) a techno-centric and technological deterministic perspective, that under-emphasizes social and human factors involved in technology adoption and usage. As we will see, these points are strongly related to each other.

Before introducing the enabling technology perspective, which in our opinion helps to conceptualize the complex relations between technological, social and cultural factors, we will briefly discuss the preceding points. (a) The dichotomous vision of the digital divides, that juxtaposes (information) haves and have nots, has been introduced at the very beginning of the debate (NTIA, 1995). The have nots model claims technological deprivation and proposes a framework where people are either in or out, (b) implicitly assuming that the only dimensions to be considered are technology availability and access. This leads to oversimplifying frameworks for technology projects (assuming that the only important element is providing technology to people), and to their consequent frequent failures (as described, among others, by Warschauer 2003; Raiti, 2007 Medhi, Sagar & Toyama, 2007). As Dahms (2010) points out,

The concept of the 'digital divide' should be seen as part of the problem rather than as part of the solution. Therefore, the sooner this concept - and with it the binary categories and the 'one size fits all' simplified model of 'development' - is discarded, the better. (Dahms, 2010, p. 440)

Following Warschauer, conceptualizing the digital divide in dichotomous terms "can be patronizing because it fails to value the social resources that diverse groups bring to the table" (Warschauer, 2003, p. 7). More recently, reflecting on the challenges of participatory cultures, with a special focus on young

people in western countries, Jenkins et al. (2009) also refuse any binary dichotomy: "We would be wrong [...] to see this as a simple binary: youth who have technological access and those who do not" (p. 13).

As van Dijk (2005) points out, we are dealing with a "spectrum of access, ranging from those with full access using the best available technology in a mass market, in the developed countries (broadband, these days) to the truly unconnected" (van Dijk, 2005, p. 32). At least with regards to the western world, where there seem to be few barriers to mere technology access, but also in growing areas of so-called developing countries, the have nots category should be integrated with the want nots model, where the so-called motivational access plays a major role. Surely, deprivation and lack of motivation are difficult to distinguish. Nevertheless, some of the categories of non-users introduced by van Dijk (2005) show that access to technology cannot be considered a linear process. The dropout category (firstly studied by Katz & Rice, 2002a & 2002b), for example, describes people who have used the internet in the past, but no longer do so. They have had material access to technology, and may be even still living in a connected household, but stopped using it, mainly due to motivational ("not interesting") or literacy-related ("too hard or complex") problems (Katz & Rice, 2002b, pp. 75–78).

The want nots category identifies people who are not materially deprived, but who are nevertheless excluded from every advantage deriving from internet use. If we were to consider them only from a dichotomous perspective (haves vs have nots), most of them would belong to the haves category, as technology is mostly available for them, especially if they are living in western countries. They are digitally and even socially excluded (for the difference between the two concepts, see Selwyn & Facer, 2010), even if they would be hardly be included in the have nots category. That is why we need a more nuanced model, considering not only technology availability and formal access, but also the wide variety of variables that contribute to real digital inclusion. We will introduce a multilevel model for analyzing the digital divide in the following paragraphs.

For a better understanding of the concept, moreover, we should consider the digital divide as a moving target. (c) We cannot adopt a narrow vision of technology, identifying ICT with a small set of devices (namely, PCs) and conduits. What can be considered as a new technology changes at a dramatic speed, and we cannot limit policy or scholarly interventions to a limited set of technologies. What used to be an important driver of digital inclusion at the beginning of the digital divide debate (dial up internet connections, end-nineties personal computers), for example, constitute today, at least in the western world, the basis for digital exclusion. Today, in western societies, the public debate identifies the digital divide with the lack of broadband connection (Cooper, 2010; Davison & Cotten, 2010; Jackson et al, 2010), while some governments are already studying how to implement Next Generation Access Networks (NGAN) (for a first, influencing research on NGAN, addressing challenges, opportunities and possible business models and project financing strategies, see Caio, 2008). Moreover, we live in the era of Ubiquitous Computing (Weiser, 1993; Greenfield, 2006), where multiple devices guarantee constant connectivity, anytime and anyplace, with a growing importance of mobile communication (see Castells et al., 2007; Katz, ed., 2006). Therefore, our analysis cannot only focus on personal computers, but should also consider every device guaranteeing to its user connectivity, access to information and digital inclusion. Many ICT4D projects, even in developing countries, are nowadays based on mobile communication (and even on the mobile internet, see Castells et al., 2007, pp. 215-243).

If the goal is social inclusion, instead of simply providing hardware and software to target populations, moreover, a wide variety of further technology should be considered. Older technology, such as broadcast media, can effectively be applied for providing useful information to people who do not access

the internet on a regular basis. Namely, healthcare information, education programs, information on agriculture and trade has been broadcasted through television and radio throughout the world.

Furthermore, ad hoc technologies, specifically designed for their intended users' needs, can represent effective solutions for context-specific problems. The Simputer, for instance, represents an example of how ad hoc technologies can meet local needs: its software is designed to facilitate illiterate people using them, adopting an intuitive (and culture-specific) graphical interface and speech-recognition software. An important role in meeting local (social and cultural) needs, indeed, is played by user interface design. The (western) concept of user-friendliness, for instance, cannot be universally applied to every culture in the world: what can appear as completely friendly and intuitive to a western user could sound obscure and counter-intuitive to users belonging to different cultures (on context-specific and text-free user interface design, see Molony, 2007 Medhi, Sagar and Toyama 2007).

Adopting a more nuanced conceptualization of the digital divide, instead of the widespread dichotomous vision (a), refusing to assume mere technology availability or access as the only goals of any digital inclusion project (b), rejecting the idea of universally optimal equipments, that should be provided worldwide (c), refusing any technological deterministic approach: all these points are grounded on the enabling technologies approach, identifying technology domestication processes (Silverstone & Hirsch, 1992; Kraut & Brynin, 2006; Haddon, 2007). Following Silverstone (1999), "Technologies, it must be said, are enabling (and disabling), rather than determining" (p. 21). Technology access is not a priority in itself: it becomes a priority if it enables social inclusion and if it addresses people's needs.

In Keniston's words,

If ICTs are useful at all, it is as a potential instrument in meeting other human, social, cultural, economic, or political purposes […]. Information technologies should be introduced when (and only when) they constitute the most effective available way of meeting basic human needs and fulfilling fundamental human rights. Information and communication technologies can have a positive role in development. But ICTs are neither a panacea nor necessarily the first line of attack in combating poverty, misery, injustice. (Keniston, 2004, pp. 21-22)

RETHINKING DIGITAL DIVIDE AND SOCIAL INCLUSION[4]

Both social inclusion and exclusion are directly connected to the individual's possibilities of having better or worse standards of living, as they indicate the difference in the ability to gain access to material resources and reveal inequalities between social actors in terms of socio-economic status.

The concept of social exclusion generated as complementary to the underclass research studies was carried out by Myrdal (1963) and was immediately included in sociological analysis. Its consideration as an area of intervention for sociological practice implies a shared understanding of what it means to be included within specific social contexts (Paugam, 1996; Borghi, 2002). Both areas of study are related to the rise of the welfare state and the welfare society. Within the general debate on poverty, social inclusion and exclusion are rather complicated to be empirically analysed, since they are based on relational and social categories.

The concepts of social exclusion and inclusion have remarkably evolved over time and refer now to the most important spheres of social life, from the macro-economic to the micro-relation levels. In his research studies on social inequality, Myrdal started to analyse social exclusion by examining the loss of

access to relative prosperity and the end of the aspirations for the future. Wilson (1991), by expanding this setting, created a dichotomous view of social exclusion, focusing not only on marginal economic positions, but also on social forms of isolations; Silver (1993 & 1996) carried out basic comparative research studies on exclusion, based on its opposite, i.e. belonging and participation (social inclusion); moreover, social problems engendered by migration flows have been increasingly addressed (Engbersen, 1995).

Research studies on inclusion have been centered on two specific areas: the individual level (social exclusion or inclusion perceived as failure of the subject; Wilson, 1996) and the social system level (social exclusion or inclusion perceived as a problem faced by state institutions). During the '90s, research studies on the individual level began to analyse not only the subjective socio-economic status, but also the changing perception of inclusion and the sense of unease generated by the label of exclusion (Dubet & Lapeyronnie, 1994). When examining exclusion, particular attention should be given to social isolation, a phenomenon that has a double effect on identity: it reduces social contact and/or limits relations to a small circle.

Dynamics of social inclusion/exclusion aim to analyse the impact that these processes have on the most basic dimensions of social life (Bourdieu, 1980). The integrated analysis of exclusion from fields such as political participation, cultural practices (understood as patterns of behaviour and socially recognized values), and the labour market is an important challenge for sociological investigation. Today, social inclusion presents itself as a multidimensional concept that affects different spheres of individual sociality: therefore, it is not only related to economic resources, but also to the quality of social relations, the degree of cohesion and the sense of belonging to a community (Phipps, 2000).

Contemporary research studies divide social inclusion into five categories (personal, social, cultural, political and economic inclusion) that can provide emotional and material resources; without them, the subjects could be significantly disadvantaged in terms of quality of life (Bourdieu, 1986; Lin, Cook & Burt, 2001). ICT constitutes an essential inclusion tool, for at least three reasons: it provides the above mentioned resources; it allows people, who are potentially at risk of exclusion, to make up for the shortage in the categories above; it affects both the macro-social and the individual sphere (Durieux, 2003). It should be emphasised, though, that individuals can experience different degrees of social inclusion in their lives and deal with some of the five categories at different life stages and for longer or shorter periods of time (Abrams, Hogg & Marques, 2005).

The strong link between ICT and social inclusion in contemporary societies has been analysed by wide ranging literature covering politics, culture, education, labour market institutions, social relations, physical well-being (Cummings & Kraut, 2002; Selwyn, 2004; Selwin & Facer, 2007). According to Van Dijk (2005), people that are excluded from the digital world, and thus excluded from the participatory perspective, are destined to become second- or third-class workers, students, or consumers. If these premises are taken into account, providing an adequate access to ICT becomes one of the main tasks for governments in contemporary societies. This could ensure a growing number of individuals the beginning of a virtuous process of inclusion and, more importantly, the experience of a social inclusion "diet", which could allow them to find their own way to take part in social life. On the contrary, the inability to exploit these technologies condemns the individual to a process of progressive social exclusion (Castells, 2001). In the case of the European Union, the Riga Declaration emphasises the importance of ICT for social inclusion as well as the need to expand its access as an essential part of the fight against exclusion.

Social inclusion is determined by a number of factors, which can be analysed from different perspectives, as in the case of studies on education, social welfare, and social psychology. Moreover, it is complicated to clearly separate the above-mentioned categories, since they often influence one another,

as in the frequent connections between economic status and personal well-being or between inclusion and culture. Social mobility limitations, especially from an economic and educational perspective, have a major role in exclusion processes, mainly if associated with other variables such as gender and urbanization levels. Marginalization and exclusion related to socio-economic status and education are more difficult to overcome than the forms of exclusion that can be experienced in other fields (namely, social and cultural exclusion), where changes are more likely to happen over the long term (Helsper, 2008).

According to the Oxford Internet Surveys (OxIS), the relations between social exclusion and ICT can be studied using five specific dimensions and using a series of related sub-sectors (Dutton, Helsper, 2007). Namely: personal resources, with three sub-sectors related to health, psychological well-being and individual values; cultural resources, with four sub-sectors corresponding to gender, ethnicity, religion, social generation and language; the social area, divided into two sub-sectors related to relationality and to the scope/range of personal interests; the political area, which includes both civic and political participation; the economic area, divided into sub-sectors such as employment, income, education and urbanization. A sub-sector can be defined as a branch of a large body of research. Sub-factors can explain ICT-related social inclusion only if they are all taken into account; on the one hand, this approach enables scholars to avoid 'access tyranny', understood as a dichotomous assessment of ICT diffusion that only considers the degree of technology access in a given social context; on the other hand, following the five C model in digital inclusion (Bradbrook & Fisher 2004), i.e. connectivity, capability, content, confidence and continuity, such an approach emphasises qualities such as experience, knowledge and individual skills.

While most scholarly work is currently focusing on included subjects, exploring internet diffusion or access, it would be necessary to study subjects who experience a complete digital exclusion, or subjects that are in need of 'mediators' in order to access digital technology (Anderson, Brynin, Gershuny & Raban, 2007). Finally, scholars are sometimes facing intermittent users (van Dijk, 2005): people that use ICT in no continuous way, creating discontinuous contexts of digital inclusion and exclusion (Anderson, 2007).

E-INCLUSION BECOMES, THEREFORE, ONE OF THE KEY POINTS OF PUBLIC POLICIES ON SOCIAL INCLUSION

Besides aiming at reducing isolation and social exclusion (by providing an increasing use of ICT, easier access and increased useful services to customers), these policies will increasingly look at using technology to promote integration and social cohesion (Smith, 2009).

A MULTILEVEL MODEL FOR ANALYZING DIGITAL DIVIDES[5]

In order to operationalize the conceptual framework proposed in the preceding pages, we have introduced a multilevel model for analyzing digital divides, focusing on five main steps (for a broader illustration of the model, see Comunello, 2010)[6]:

1. Technology availability (or formal access).
2. Real access.
3. Reception practices.
4. Technical skills and content production.
5. Networking skills.

As the internet becomes part of our everyday life (Wellman & Haythornthwhaite, 2002), formal access (technology availability, at the micro and macro levels) has to be considered, to some extent, a prerequisite, but it does not guarantee real access (the second level of the proposed model), as shown by the already mentioned *dropout* category (people with formal access who stopped using the internet, Katz & Rice 2002a & 2002b; van Dijk 2005). In fact, while macro-level formal access can be considered as a prerequisite, micro-level formal access derives from a mixture of macro-level conditions, socio-economical considerations and motivational elements (van Dijk, 2005), the last being strongly related to the following steps of the proposed model. Van Deursen and van Dijk (2008), for instance, while introducing a multilevel model including material access, motivational access, skill access and usage access, underline its cumulative and recursing nature. Surely, these characteristics also apply to our model.

For technology to really make the difference, anyway, even real access is not enough. This is particularly true if the main goal of any technology project is not technological availability itself but, instead, social inclusion.The third level of the proposed model focuses on the skills that are related to reception practices. To effectively use new media, a large variety of competences are involved, including not only traditional literacy (reading and writing), but also information processing, multi-tasking, hypertextual reading, multimedia reception.The fourth level introduces the skills involved in production, both referring to technical skills (software programming) and to content production skills, that are showing a rising importance in relation to the growing attention surrounding *user-generated content*, grassroots information, etc.

Finally, the fifth level refers to the vast field of computer-mediated-communication, and to the ability to use technology to interact with other people for personal, political, economic purposes, for knowledge creation and dissemination, or for maintaining long distance ties. While the increasing popularity of social network sites (boyd & Ellison, 2007; boyd, 2008; Lenhart, 2009) shows that there is a growing interest in articulating and managing digitally-mediated social relationships, networking skills do not only apply to such kinds of platform: they refer, instead, to the broad variety of technologically-mediated environments that enable social relations (including synchronous and asynchronous platforms, such as email, chat and instant messaging, etc.). Following Rheingold (2002), "A new kind of digital divide ten years from now will separate those who know how to use new media to band together from those who don't" (p. xix).

As we will see in the following paragraph, the third, fourth and fifth levels all refer to different aspects of the broader concept of new media literacy that represents one of the core elements for fostering social inclusion through digital media.

NEW MEDIA LITERACY AND DIGITAL INCLUSION[7]

For digital technology to really make the difference, from a social and cultural point of view, formal and effective access is not enough. What really matters is how people use technology, what purposes are ICTs used for, users' awareness levels, peoples' ability to fully participate to information society (or to participatory culture, Jenkins et al., 2009), in broader terms. Advanced reception practices (our third level), technical skills and content production (our fourth level) and networking skills (the fifth level) all need high levels of what has been defined as *new media literacy*.

While techno-enthusiasts have tried to separate digital skills from the traditional meaning of literacy (arguing that for twenty-first century society traditional alphanumerical skills tend to lose their importance), new media literacy also includes traditional competencies. Following Jenkins et al.,

New media literacies include the traditional literacy that evolved with print culture as well as the newer forms of literacy within mass and digital media. Much writing about twenty-first century literacies seems to assume that communicating through visual, digital, or audiovisual media will displace reading and writing. We fundamentally disagree. Before students can engage with the new participatory culture, they must be able to read and write. (Jenkins et al., 2009, p. 19)

In fact, for people to acquire a full citizenship in our society, the very concept of literacy has to be reconsidered, also including digital literacy. Indeed, the set of competences commonly defined as new media literacy should be identified with a broad definition of "twenty-first century literacy" (Jenkins et al., 2009, p. 20).

The importance of new media literacy has been underlined both by scholars adopting a *second level digital divide* perspective, and refusing dichotomous models (Di Maggio & Hargittai, 2001; Hargittai, 2002; Warschauer, 2003; Selwyn, 2004; van Dijk, 2005; Warschauer, 2006; Dunn & Johnson-Brown, 2007; Hargittai, 2008; Dunn, 2010) and by digital media scholars focusing on young people's attitudes towards technology and proposing media education as a central element of any educative process (among others, Livingstone, 2003; Buckingham, 2003; Jenkins et al., 2009, Livingstone & Helsper, 2010).

Van Deursen & van Dijk (2010, pp. 280–281) underline that little scientific research has been carried out on the topic; most of it has been realized in small educational contexts, asking interviewees to self-assess their skills. From the few large-scale empirical researches, however, emerge "dramatic differences of skills among populations, also among populations of countries with broad new media diffusion" (van Deursen & van Dijk, 2010, p. 281).

As we deal with a constantly changing environment, it is hard to identify a specific set of competencies that constitute the core of new media literacy. Considering the growing importance of user-generated content, for instance, so-called web 2.0 (O'Reilly, 2005) is surely shifting the focus from mere reception practices and technical skills to content production skills, while the increasing popularity of social network sites and computer-mediated-communication environments (growingly used in personal and professional relations), is emphasizing the importance of networking skills. Scholars have tried to introduce operational definitions of digital literacy: while there is an overall agreement on macro-categories, we are still looking for a shared definition of a concept that is at least partially co-evolving with technological and social innovation.

Warschauer (2003) suggests that the main skills needed to work with computers and the Internet are the following: computer literacy (a term that appears to be oversimplifying), information literacy (a variety of skills in manipulating information, involving both technical skills and broader competencies), multimedia literacy, computer-mediated-communication literacy. Dunn & Johnson-Brown (2007) define information literacy as the variety of skills needed to retrieve, access, critically evaluate and effectively use information. Van Deursen & van Dijk (2010) propose a framework including:

- **Operational Skills:** The skills to operate digital media;
- **Formal Skills:** The skills to handle the specific structures of digital media, such as menus and hyperlinks;
- **Information Skills:** The skills to search, select and evaluate information in digital media;
- **Strategic Skills:** The skills to employ the information contained in digital media as a means to reach a particular personal or professional goal. (van Deursen & van Dijk, 2010, p. 281).[8]

While preceding authors mainly focus on new media consumption and on computer-mediated-communication, Livingstone also emphasizes information production. Following her perspective, media literacy can be defined as "the ability to access, analyze, evaluate and create messages across a variety of contexts" (Livingstone, 2003, p. 3). In Livingstone's words, information production was a key element even in (traditional) media literacy, because through it people acquire a better understanding of the medium. Moreover,

The internet par excellence is a medium which offers hitherto unimagined opportunities for ordinary people to create online content. To exclude this from a definition of media literacy would be to greatly under-utilize the potential of the internet for the public. (Livingstone, 2003, p. 3)

Focusing specifically on (Western) young people's awareness of participatory culture, Jenkins et al. (2009) suggest that digital literacy should not only include traditional literacy, but also technical skills ("They need to know how to log on, to search, to use various programs, to focus a camera, to edit footage, to do some basic programming and so forth"). Like Livingstone (2003), Jenkins et al. underline the continuity between traditional (mass) media literacy and new media literacy: students should "acquire a basic understanding of the ways media representations structure our perceptions of the world" (Jenkins et al., 2009, p. 20).

Jenkins et al.'s, definition of participatory culture[9], in fact, includes elements that deal with the fourth and the fifth levels of our proposed model: (digital) content production and technologically-mediated social relations are core elements of contemporary culture. Therefore, twenty-first century literacies do not only include the competencies listed above: they "should be seen as social skills, as ways of interacting within a larger community, and not simply an individualized skill to be used for personal expression" (Jenkins et al., 2009, p. 20). According to authors, core media literacy skills can be summarized as follows: "play, simulation, performance, appropriation, multi-tasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, negotiation" (Jenkins et al., 2010, p. 56).

Some scholars have repeatedly emphasized young people's *innate* digital skills, rhetorically opposing a new generation of *digital natives* with former generations of *digital immigrants* (Barlow, 1997; Palfrey & Gasser, 2008; Prensky, 2001; Tapscott, 1998 & 2008). They assume that digital natives can acquire these skills naturally, on their own, without any adult intervention. In fact, recent empirical research has shown great skill divides even among young people, underlining that the acquisition of a high level of new media literacy is hard to obtain without any guidance; moreover, adults and teenagers share a wide range of new media usage practices (Bennet, Maton & Kervin, 2008; Buckingham, 2008; Herring, 2008; Ito, 2008; Margaryan & Littlejohn, 2008; Lenhart, 2009; Jenkins et al, 2009[10]). The above mentioned skills are complex and cannot be acquired naturally. Beetham, McGill & Littlejohn (2008) propose a *learning literacies* framework, encompassing "the range of practices that underpin effective learning in a digital age" (Beetham, McGill & Littlejohn, 2008, p. 8), addressing a set of competences that are

continuously changing. Jenkins et al. (2009) and van Dijk & van Deursen (2010) propose effective means to overcome digital skill divides, even among young people, in order to broaden digital inclusion and strengthen twenty-first century participatory culture.

MEASURING THE DIGITAL DIVIDE[11]

Empirically studying the digital divide appears to be highly problematic. First of all, the digital divide has different consequences in different parts of the world. Secondly, while it is relatively simple to measure technology availability, it is far harder to produce reliable measures for levels three, four and five of our proposed model.

As technology availability has to be considered a prerequisite for further levels of digital inclusion, monitoring ICT penetration worldwide, using quantitative methods (Chinn & Fairlie 2006 & 2007), is surely a priority. On the other hand, however, a deeper understanding of digital inclusion, especially in developed countries, requires in-depth studies, based on qualitative approaches, about individual or group non-inclusion (Hargittai, Robinson & DiMaggio, 2003; Wilson, Wallin & Reiser, 2003). As we have seen in the preceding paragraph, providing a precise definition of digital literacy is a particularly complex task. Even more complex is measuring people's literacy levels. Similarly, the very concept of digital inclusion is hard to define and measure properly. In the following paragraph, we will review some empirical methods for studying the digital divide, focusing on approaches that adopt complex frameworks for analysing the digital divide, thereby refusing any dichotomous vision of the topic.

It is certainly not easy to understand how these technologies expand worldwide, how they fit in different social contexts, which differences between countries they further, nor it is easy to understand what phenomena of cultural, social or economic convergence are in place. Most of the research studies carried out so far (strongly affected by the data available) consist of descriptions of (a) ICT diffusion, (b) specific issues affecting disadvantaged countries (such as the diffusion of telecenters and internet points), (c) and innovative/successful local projects.

Such analysis has failed to identify a standardized definition of the digital divide. Moreover, over fifteen years of investigation have shown that different social systems relate to ICT differently: each country seems to follow its own way of approaching technologies. This is not only due to various social or economic reasons, but also to the influence of a heterogeneous set of variables including demographics and different geographical environments. We are therefore forced to study two hundred countries with two hundred different ICT diffusion experiences: often, interesting research studies are reduced to a fragmented description of initiatives that are not always successful or completed (Wilson, 2004). Rather than pursuing a 'standard recipe' for the analysis of the digital divide, we need instead a flexible framework that can be adapted to different backgrounds and experiences based on a unique research methodology; such a framework is to be used both operationally and comparatively in the analysis of ICT diffusion (Anzera, 2005).

As far as the first (merely quantitative) approach is concerned, Calderaro (2010) specifies the main techniques to study ICT availability or access. He refers to the following variables: number of Internet users, Internet Penetrator Index (number of internet users compared to the population of a country), relations between GDP per capita and number of Internet users, geographical distribution of Internet Hosts, distribution of Internet Protocols (IP). While these procedures may be able to analyse certain phenomena related to the digital divide, a great deal of criticism can be raised against the deterministic

idea that a rise in technology access is enough for the digital divide to be bridged. Moreover, it would be legitimate to raise doubts on both the validity and the methodological relevance of some of the data considered (Alampay, 2006; Cammaerts, Van Audenhove, Nulens, G. & Pauwels, 2003; DiMaggio, Hargittai, Celeste, & Shafer, 2004; Hargittai, 2003; Warschauer 2003).

Indeed, in digital inclusion research, this approach proved to be too simplistic; due to the multidimensionality of the concept, a research study on the digital divide needs to be carried out in conjunction with other social and economic indicators of social malaise. Barzilai-Nahon, Gomez & Ambikar (2010), for example, proposed a conceptual framework for detecting the digital divide, known as ICI (Integrated Contextual Iterative approach), that is based on the integration of several variables and the contextualisation of ICT in a given social context. This approach proved to be particularly useful in identifying unique factors that have a high impact in a particular social system, emphasising the importance of certain variables over others.

Following Wilson and Wong (2007), the digital divide should no longer be considered as a *neutral* process, that only depends on technology access; on the contrary, it has to be related to negotiations and political discussions. Their approach, known as NTN (Negotiating The Net), assumes that ICT policies are essential for evaluating the expansion of ICT and the increased use of the internet in various social contexts. The term negotiation, as understood by Boyer et al. (2005), defines an interaction between multiple parties in which a number of heterogeneous actors try to reach a mutual agreement on a matter of common interest. The actors involved can be very different, representing not only government institutions, but also economic, bilateral, multilateral institutions, NGOs, research institutions, etc. There are of course many other important variables related to these processes, such as technological progress, GDP per capita, existing infrastructures, education level, etc. Nevertheless, according to NTN, the first element to be considered, in order to explain the spread of ICT, is the political one, to be understood as government action (e.g. the implementation of policies that can facilitate access to technologies).

NTN is not the only approach to consider political variables as central. The World Bank and USAID have long recognized that the crucial element to be taken into account when examining ICT diffusion rates is indeed political action. Nevertheless, NTN creates a framework for the analysis of negotiations, known as CNI (Critical Negotiation Issues), which, to date, is not taken into account by any other similar approach. This framework does not only guide scholars in conducting individual case studies, it also enables them to look at different research studies in a comparative manner. CNI establishes a number of issues with which each country, sooner or later, will be faced with; it also includes issues that are expected to affect the actors involved in the negotiations. Depending on how they are addressed, these issues are supposed determine how ICT will spread in a given country. The CNI framework consists of four main categories (public policies, access, national models for ICT development, key technologies in development processes). They correspond to strategic issues of major importance, in which twelve critical categories are contained: public policies relate to privatization, liberalization and market regulation; the access category is linked to issues concerning the monopoly of prices, as well as access regulation (access restrictions) and physical access to ICT; the national model of ICT development is related to the ICT integration strategy in the development process of a country and is connected to the following: the degree of adhesion to Information Society, universal access to ICT, the ability to set up consistent policies and their implementation. Being very much in use in the context of developing countries, the CNI structure highlights relevant socio-political aspects, in comparison with the old models known as "technology first".

These two examples show that the digital divide can be understood only if considered as one out of various aspects of social inequality, and not as an isolated factor; the analysis of the digital divide must therefore be supported by other social, economic and political variables and must not only be related to technology access and its deriving benefits (Mossberger, Tolbert & Stansbury, 2003).

This empirical pattern is also valid for the analysis of the dynamics of social inclusion and digital inclusion. As mentioned above, Van Dijk (2005) proposed a research scheme that identifies four main areas: *motivation, material, skills and use*. Following such a framework, analysing digital inclusion means addressing multiple social issues, without limiting the analysis on single ones. The analysis of the *motivational* sphere, for instance, examines the reasons that lead a person to use ICT and, at the same time, helps to identify the motivations that make individuals refuse using such technologies; the *material* sphere is divided into physical access to digital technologies and conditional access, involving elements such as fees, passwords, belonging to an organization, etc; *skills* deal with competence degrees in the use of ICT; lastly, the *use* dimension examines factors such as time, number of applications used, use of broadband and possible creative/active use of the Internet. This pattern may foresee the presence of other variables which may be of interest in studies on digital inclusion; such factors can be the quality of internet connections, the identity of the subject, the self-perception of their skills in handling ICT (Eastin & La Rose 2000), the ability of applying to ICT skills that are not directly technology-related (transferable-skills), the location from which people access technology (Helsper, 2008), the protection of their data over the Web, the anxiety related to ICT use (Durndell & Haag, 2002).

Research studies carried out in the past, as well as more recent investigations, suggest that the empirical analysis of the relation between social inclusion and digital inclusion can be achieved only by working on a multidimensional basis. The use of such an approach is motivated by the urgency to assess and address the issues related to the digital exclusion, as its effects may become increasingly harmful; contemporary societies, reflecting Merton's 'Matthew effect' tend not only to favour those who experience a stronger digital inclusion, but also to further implement their potential. Therefore, using multidimensional methodologies ('beyond technology access') is essential if we are to avoid a dangerous enlargement of the *digital-inclusion divide.*

FUTURE TRENDS[12]

As we have seen above, new media literacy is an essential point to overcome the so-called *second level digital divide*. New media literacy is a moving target, constantly evolving according to technological and social innovation. Participatory cultures, for instance, request a more complex set of competences than previous digital environments. In the preceding paragraphs, we have introduced a multilevel model for analyzing digital divides. According to the recent literature reviewed above, levels four and five are acquiring a growing importance.

For a better understanding of the social and cultural issues involved in digital inclusion, we need a *flexible* definition of new media literacy that should be able to evolve consistently to technological innovation, without losing the analytical detail needed to design appropriate new media education interventions. Moreover, we need more research on this topic, in order to better identify (and quantify) the digital skills divide, covering context-specific, age-specific, cultural-specific divides. We also need to experiment and evaluate digital literacy programs, in different contexts and adopting different methods, to define the most appropriate ways to define the basis for a broader digital inclusion.

Finally, we need to better integrate multidimensional theoretical frameworks and empirical research; we need to experiment and evaluate complex research methods, based on the theoretical frameworks proposed above. We need to further develop empirical research on digital inclusion, integrating quantitative and qualitative approaches, in order to acquire a deeper understanding of the phenomenon; and we need to formulate more specific hypothesis and research questions, in order to empirically verify and validate such theoretical frameworks.

CONCLUSION

If we adopt an enabling technology perspective, emphasizing social inclusion instead of digital media availability, and refusing any dichotomous vision of the digital divide, we need to adopt multidimensional frameworks for analyzing the digital divide. New media literacy, indeed, plays a major role in fostering a full and effective access to digital technology, contributing to digital inclusion.

From the perspective of social inclusion, digital inclusion is a matter of great importance on which public policies will be remarkably focusing in the near future; indeed ICT, by improving the quality of life of some subjects, increases the marginalization of other individuals or social groups. Nevertheless, social exclusion and digital exclusion, although apparently destined to coincide in the long term, are not the same thing. Social inclusion, in fact, can not be only determined by a wider access to technology, nor can digital inclusion be analysed separately from other factors that contribute in creating either social welfare or marginalization. When studying the digital divide, we need to take into account the links between ICT diffusion and a series of social, economic and political aspects of society. Similarly, the evaluation of digital inclusion requires considering multiple aspects, such as community context, financial resources, domestication strategies, socio-cultural variables, and ICT availability and use.

There is no magic formula to examine the relation between ICT and social inclusion; only an integrated approach, taking into account the specific characteristics of the addressed social groups, can highlight relevant aspects of this phenomenon.

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KEY TERMS AND DEFINITIONS

Enabling Technologies: Technologies that enable a wide range of Information Society services or activities, contributing to address people's needs.

Label of Exclusion: A process involving young people that are subjected to cultural exclusion and experiencing alienation and low self-esteem.

Networking Skills: The skills involved in using technology as a tool for communication and social relations (e.g.: using technology for interpersonal communication, or to build and manage social networks).

New Media Literacy (or Digital Literacy): The ability to use new media (or digital media), with regard both to reception practices and to active content production and distribution.

Qualitative Research Approach: Research method based on the idea that social phenomena can be studied gathering and analyzing information in as many forms, chiefly non-numeric, as possible. It tends to focus on exploring, in detail, small numbers of cases that are considered interesting or illuminating, and aims to achieve 'depth' rather than 'breadth'.

Quantified: Measured, expressed numerically and analyzed with statistical methods.

Quantitative Research Approach: Research method based on the idea that social phenomena can be.

Social Divide: The observation of the hiatus between the information rich and poor in each nation.

Technology Availability: The opportunity, at a micro or a macro level, to materially access technology at reasonable prices, whether at home, at work, at school or in public places (public institutions and/or commercial outlets).

ENDNOTES

1 The chapter is the result of a process of dialogue and sharing of ideas between the authors. The attribution of each paragraph is indicated each time.
2 By G. Anzera.
3 By F. Comunello.
4 By G. Anzera.
5 By F. Comunello.
6 For an early version of the proposed model, see Anzera & Comunello (2005).
7 By F. Comunello.

[8] Authors also propose a method to study new media skills, based on a laboratory test that involved 109 Dutch people, offering interesting data on all the above mentioned categories of skills, and suggesting strategies to overcome the digital skills divide (van Deursen & van Dijk, 2010).

[9] "A participatory culture is a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one's creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices. A participatory culture is also one in which members believe their contributions matter, and feel some degree of social connection with one another (at the least they care what other people think about what they have created)" (Jenkins et al., 2009, p. 3).

[10] "Talk of digital natives may make it harder for us to pay attention to the digital divide in terms of who has access to different technical platforms and the participation gap in terms of who has access to certain skills and competencies or for that matter, certain cultural experiences and social identities" (Jenkins et al, 2009).

[11] By G. Anzera.

[12] By F. Comunello.

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Chapter 20
"Virtual Reality" Reconsidered

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ABSTRACT

The term 'virtual reality' is used widely in contemporary culture to evoke the false worlds of the imagination digital technology has enabled us to create. However, the term itself remains ill defined, particularly amidst recent developments in theories of virtuality and reality that have left contradictory marks on VR. The phrase 'virtual reality' has become problematic, and is in need of a reconsideration for its continued relevance. This chapter assesses the term throughout its development and in the context of other theorisations such as cinema and cyberspace that have dominated recent digital theory. Taking the Deleuzian expansion of the Virtual and the Lacanian expansion of the Real, the chapter interrogates the constituent processes of VR to suggest a new mode of conceiving the technologies in terms of a parallax between virtual-real and physical-digital within contemporary thought, which will then be applied to a conceptual framework for digital creative practices.

INTRODUCTION

Within the many varied, and often incongruous, theories of digital technology and its culture there are two strands of the discussion that have emerged in which the very terms of the field are challenged. These are centred on the problematic notion of 'virtual reality' that has dominated cultural depictions of the digital world, usually taking either 'virtual' or 'real' in an expanded definition to draw out a deeper understanding of the fundamental differences, connections and interdependency between physical and digital spaces. Digital media has called into question the appearance of 'reality', forcing all theories of contemporary culture to take into account the possibility of other spaces with which the (physical) human subject can engage. There is a need to expand and intersect current discussions of the relation between virtual and real by exploring the antagonisms that arise through developing both sides of the term. This chapter will therefore readdress the term 'virtual reality' in the context of ongoing debates in philosophy, technology and creative practice in a discussion of subjectivity in contemporary digital society, to insist on a constant re-evaluation of the terms used in such a discussion and their ramifications for its application in digital media and creative technologies.

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The expansion of the term 'virtual' often takes into account the definition developed by Gilles Deleuze (2004a; 2004b) as a surface that is not actual but with which the subject can engage. This has been applied to digital media as an alternative to the conflation of 'virtual' as 'digital', as is implied in the labels 'virtual reality' or 'virtual worlds', to instead connect the fluidity of digital surfaces to consciousness in a relation consistent with other generative effects within the structures that form the idealist element in Deleuzian philosophy. Anna Munster (2006) emphasises the role of affect by placing the virtual as a part of the materiality of the digital. While this work and others take important steps towards establishing the problematic of embodiment, the focus on the materiality of the digital obscures its relation to consciousness and leads back into limited use of the term 'real'. There is a clear Deleuzian influence in Munster's work, and both Deleuze and Félix Guattari are referenced heavily in relation to the virtual, as well as notions of flow, diagram and time. Between the two expanded terms, however, there remains little crossover in current literature. Rob Shields (2003), Brian Massumi (2002) and Andrew Murphie (2002), for example, all utilise the Deleuzian virtual while persistently conflating it with the digital, and largely fail to mention the real outside of its direct and 'common sense' connotation of the physical.

How the individual relates to the plethora of potential realities available in contemporary society and its philosophies (physical, digital, social, semantic, oneiric) can be understood in redefining the term 'real' according to Lacan (1977), particularly as applied to cultural phenomena by Žižek (2008a). Writers such as David Gunkel (2010) have furthered this notion, drawing out the real across physical and digital worlds as the hidden causality (for example, quantum wave functions, DNA or bits of computer code) that underpins the appearance of objective reality. This real is inaccessible and terrifying, embedded within the psychoanalytical construct of contemporary subjectivity. Throughout the field, the antagonism between virtuality and reality persists as a theoretical pariah between physical and digital reality, media and creative processes. Žižek's (2012) own discussion of the matter simply places Deleuze's virtual as Lacan's real. While acknowledging the importance of the reality of the virtual opposed to 'virtual reality', Žižek confuses the nuances of the two processes within consciousness and their functions in the generation of contemporary subjectivity, creativity and society. The antagonistic relation between the real and the virtual, in the expanded sense of both terms, will form an integral method of analysis throughout the chapter, and reconciling Žižekian and Deleuzian philosophies will provide an informative step towards understanding the relation between virtuality and reality.

This chapter will separate and explicate the two expanded terms, defining the Real as the presupposition governing the way reality 'really' appears to us and the virtual as the forces outside of actualisation that nevertheless impact upon reality. From this theoretical exposition, a discussion can be raised concerning the redefinition of our relation to digital technologies under such terms. Digital media in general and virtual reality in particular are commonly associated with processes of simulation. Indeed the phrase 'computer simulation' dominates the lexicon of many technological applications with a focus on representing the physical world within digital space. However, in the context of this expanded set of terms, the digital appears as a simulation-of-simulation. That is, where simulation is, according to Baudrillard (1994), an appearance with no link to reality, the appearance on the computer screen is precisely defined by the reality of computer code.

This turn – in which digital space can stake at least an equal claim to reality as the physical universe amidst the breakdown of material certainty seen in quantum physics, genetics and poststructuralist linguistics – enacts an ontological levelling between physical and digital worlds, and in particular their manner of appearance to human subjects. Both of these processes are present within physical and digital worlds, necessitating a separation of the virtual from the digital and the real from the physical, towards

a consideration of the shifts between spaces that construct contemporary subjectivity. This shift will be explained according to Žižek's (2009) ontological notion of parallax, applied to the differences between physical and digital worlds, in order to theorise a creative and subjective application of digital technologies. When both terms, virtual and real, are viewed in their relations to one another occurring within consciousness, it is their differing modes of assemblage that defines the parallax of the digital. This is based on the manner of subjective presupposition underlying each 'reality': matter for physical, code for digital. Levelling these realities enables freer modes of discussion to emerge across cultural artefacts in physical and digital media, constructing a critical space for a more open debate of the creative application of digital technologies.

The chapter will thus form a critical overview of past and current discussions of virtual reality in the field of digital media, suggesting innovative modes of interrogating the creative potentialities of digital media. While the discussion will focus on the role of VR in relation to the individual consciousness, as a creative extension of thought and alternative realm for the mind to inhabit, VR exists also as a site of potential social exchange. The critical and creative use of VR, however, extends beyond the mere interaction between individuals that constitutes the social arena. The multiplicity of a collective assemblage of creativity demonstrates the same fundamental relations as the internal assemblage of the individual subject across physical and digital worlds. The discussion will therefore apply the individual subject to a collective subject of enunciation of a potential future post-individual society whereby VR offers new spaces of blurred boundaries for minds to move freely and for creative potential to emerge between individual consciousnesses. This will draw towards concluding remarks that offer a new definition of virtual reality, a challenge to established modes of thinking digital media, and a call for a constant re-thinking of the terms with which we construct our engagement with digital technologies within our subjective position between ever more permeated virtual realities.

ORIGINS AND DEVELOPMENT

In order to assess and reconsider the position of virtual reality today, and its impact on future directions for technological innovation, artistic creation and thought, the development of the term and its scholarship must first be traced in a critical history of VR as a technology and virtual reality as a term. While there were pre-digital attempts at constructing mechanical immersive displays, the beginning of this history as a working VR technology using computers rests in 1965 with Ivan Sutherland's revolutionary, if unwieldy, 'Sword of Damocles' project. While not labelling his device as VR, Sutherland described a vision of the potential for this new technology:

A looking glass into a mathematical wonderland…There is no reason why the objects displayed by a computer have to follow the rules of ordinary physical reality…The ultimate display would, of course, be a room within which the computer can control the existence of matter. (Sutherland, 1965, pp. 506-508)

The aim was to create not replications of physical space, nor even imaginary worlds, but the rearrangement and redefinition of reality itself. Despite this revolutionary vision, it took over twenty years for the term virtual reality to emerge, coined and popularised by Jaron Lanier in the mid-1980s (Heim, 1998, p. 16). Where Sutherland had emphasised control over matter, Lanier's focus was on the mind, resulting in an image of VR as part of the increasing array of computerised communication tools, specifi-

cally for the sharing of the imagination in multisensory, immersive constructs (*Ibid.*). The ontological implications of VR were first considered directly by Michael Heim in *The Metaphysics of Virtual Reality* (1993), which sought to define this "new layer of reality" (p. 118). While the terms virtual and real are not developed beyond the simple opposition of digital and physical, the various constituent processes, potentialities and perils of VR are situated in the text's position regarding VR technology's early development. Heim's placing of the virtual as a supplementary or expanded dimension of conventional reality echoes the early work in cybernetics, which sought to expand human intellect (Ashby, 1957; Licklider, 1960; Engelbart, 1962), drawing some initial remarks on the impact of VR technologies in redefining our modes of thinking.

However, the ontological expansion of VR remained in the minority, as futuristic visions of technology were quickly subsumed by practical application. Increasing availability led to an interest in VR from not only technologists and theorists, but from the finance and entertainment industries. Howard Rheingold's text, *Virtual Reality* (1992), displays this tension, with an optimistic outlook on the use of the technology limited by reducing the manipulation of matter to staging physical reality (in, for example, surgery or particle physics), reducing creative expression to its entertainment value. Further work on the nature and impact of VR technology appeared in texts by, for example, Alan Wexelblat (1993) and the National Research Council (Durlach & Mavor, 1995). In this latter text, "some psychological considerations" (pp. 93-110) focuses on the nature of control, reducing the human to an operator, and the construction of telepresence, reducing subjectivity to a measure of 'realism' against illusion, in technologies designed largely for communication over creativity. While the collection does acknowledge the need for studies of human behaviour and the implications of VR on social structures, the project of scientists serving industrial and governmental aims creates the impression that any such developments would be rapidly patented and/or weaponised.

These developments in technology and our conception of it were drawn swiftly into the exploitation of VR by business (in, for example, Thierauf, 1995; Chorafas & Steinmann, 1995) to improve communication and productivity through the manipulation of the mind by corporate interests: not a cybernetic expansion but a machinic reduction of humans to productive devices, a lasting stain on the evolution of the virtual. This reductionist tendency, of both VR technology and its relation to human users, is furthered in Frank Biocca and Mark Levy's collection (1995), which focuses on VR as "a tantalizing communication medium" (p. vii). While this simply places the virtual as a digital space of whimsy opposed to physical Reality, it recognised the limitations of VR technology of the time, with its "look and feel of a prototype" (Biocca, Kim & Levy, 1995, p. 13), and highlighted the constant need for innovation, even placing the early VR dream as an unachievable goal, a "techno-Godot" (*Ibid*.) for which we will always be waiting. While this is framed in a discussion of VR as an entertainment tool, the consideration of social implications overtly introduced the role of desire in our relation to VR, shedding a critical light on the earlier vision of Sutherland as the constant striving by humanity for control over the reality in which it resides.

The first critical reconsideration of the term appeared in Heim's later text *Virtual Realism* (1998), which criticised the "pale ghosts of virtual reality, invoking "virtual" to mean anything based on computers" (p. 3). Yet he was not attempting to expand or develop the term but, rather, to insist on a purer definition as "a technology, not simply a nebulous idea" (p. 2). Within his "pragmatic interpretation of virtual reality as a functional, non-representational phenomenon that gains ontological weight through its practical applications (p. 220), however, emerges a negotiation of the relation between virtuality and reality. Thus, while this middle ground of 'virtual realism' between techno-utopian idealism and fear of a loss of reality to technology may reduce the conception of VR to a technological position under the

domination of the 'primary reality' of physical human experience (p. 218), Heim's discussion formed an instructive step in discussions of the term, opening up the value judgements of the technology's potential impact. The importance of our social and cognitive relation to VR began to emerge even within the limitation of the label. Heim's bold claim for a definition of "the "real" virtual reality" (p. 6) based on "immersion, interactivity and information intensity" (p. 7) reveals the need to bridge the "intrinsic remoteness from direct human experience" (Heim, 1993, p. 18) with, not only accurate graphical rendering that leads to the techno-Godot of "data idealism" (Heim, 1998, p. 139) lost in a spiraling desire for perfect sensory replication, but new modes of thinking our relation to technologies, further emphasizing their role in shaping human thought.

The lack of expansion of the VR label itself throughout the 1990s – even by Heim, the so-called 'philosopher of cyberspace' (Lovink, 1994) – did little to alleviate the need for Peter Fisher and David Unwin (2002) to state that "although, and perhaps because, 'virtual reality' is a very trendy term, neither 'virtual' nor 'reality' is either well defined or strictly appropriate" (p. 1). Even this criticism of the term, in a text applying VR as a tool for the field of Geography, states the problem but not the solution, settling again on a strictly technological definition: "the ability of the user of a constructed view of a limited digitally-encoded information domain to change their view in three dimensions causing update of the view presented to any viewer, especially the user" (*Ibid.*). The increasing recognition, for example by Richard Brice (1997), of the "interdisciplinary nature of multimedia and VR development" (p. 6), led to a splintering of VR across fields, necessitating the perpetuation of a simple, technological, practical definition that could be applied in engineering and design contexts. William Sherman and Alan Craig (2003), for example, lay out a design-based approach focused on the application of technology with clear aims (a convincing and 'realistic' immersive experience) and a limited consideration of theoretical positions (other than perhaps the informational theory approaches that appear as an unquestioned truth of computer science) in favour of a practical manual. The notion of 'understanding' VR is here the ability to follow design conventions in achieving successful business-serving outcomes, constructed from a view of 'realism' as a debate between a full simulation of physical realism (adhering to all the rules and limitations of our own physical world) and a visual realism that allows for 'magical' occurrences and the staging of imaginary situations (Sherman & Craig 2003, p. 384), referred to as a clearly defined and restricted scheme of the "realism axis…a continuous line proceeding from highly verisimilar to highly abstract" (p. 213) against which the virtual (and VR in particular) can and should be measured.

However, this scientific positivism applied to a practical design mentality demonstrates that even within the constant limitation of the term virtual reality there is a process of contextual specification that results in a variation of its implications and use. This problem had been identified as the increasing tendency towards "as many 'virtual realities' as there are researchers actively involved in VR" (Brodlie et al., 2002, p.7), an acknowledgement by other fields (here Geography) of their problematic interaction with VR due to the interdisciplinary, fragmented and ill-defined nature of virtual reality as a term. However, the response to such issues is often a lowest common denominator of accepted conventions, highlighting but accepting the limited the view of the term(s) outside of their application to specific relevant aspects of other fields. Indeed, the term virtual reality became largely reduced to such a limited scope as a specific technological tool throughout the early 2000s, and by the mid-2000s had become subsumed in the widening array of terminologies and theoretical trends through which digital technology was being discussed. As a unified term, it appeared that virtual reality had lost its impact, after its sensationalist and liberal use in advertising and its fear-mongering distortion in cinema and popular culture (for example, the oft-cited dystopic view of an oppressive future under the machinic regime of

sentient VR in *The Matrix*). The position of VR in relation to these emerging and developing terms must therefore be interrogated before the constituent elements of virtuality and reality can be renegotiated towards a contemporary context.

OTHER PERSPECTIVES

With the general positioning of VR as a specific technology within the increasingly diverse manifestations of digital media, it is necessary to situate the term in the context of other conceptual formulations of the digital against the physical world, in terms of our interaction with, relation to and position between both spaces. The domination of mass media by the cinematic tradition, with its inclusion of the 3-D immersive technologies and photo-realistic computer graphics that could leap developments in VR greatly forward, has entrenched its hegemonic position over explicitly digital media in general and VR in particular. As Nicholas Gane and David Beer (2008) have suggested, VR has never been able to overcome the dominance of the screen (p. 57), not only in terms of the physical necessity of screen-based apparatus but also in terms of the structures of the digitised gaze. Lev Manovich (2001) carries this filmic view further into his theoretical framework of digital media and VR technologies, writing that "with a VRML interface, nature is firmly subsumed under culture. The eye is subordinated to the kino-eye. The body is subordinated to the virtual body of the virtual camera" (p. 83). This reduces VR technologies to a subservient role within interactive cinema, referencing the trend that of the "virtual camera" in computer interfaces that uses cinematic language and techniques as a visual toolkit for digital representation (pp. 80f; 298f), subsuming the virtual and the computer generated images associated with VR under the cinematic process. This fusion of distinct processes within filmic mass media engrains the dominance of cinematic language that limits a new, genuinely digital mode of thinking. Manovich doesn't expand term virtual, but rather conflates virtual with digital[1] and echoes earlier design-based texts by referring to the 'reality effect' as a marker of reference to the physical world. Manovich (2013) repeatedly displays a preoccupation with "view control" (p. 75) and imposing (or constantly reasserting, forbidding any development of new language) a cinematic language on the digital. While he does admit another way of working in, for example games (pp. 193-4), this is placed as secondary to his filmic project as a practitioner and theorist of interactive cinema placing cinema as "*the* cultural interface" (Manovich, 2001, p. 86). Alexander Galloway (2012, p.1) acknowledges both Manovich's influence and limitations, as does Mark Hansen (2004, p. 33) in highlighting Manovich's clear investment in cinema as a theoretical framework. The failing of Manovich's framework demonstrates the wider shift away from writing about VR in itself towards its inclusion as part of 'new media'. While this has, despite Manovich's own limited use of the terms, led to the expansion of the notion of the virtual in VR, as part of the general development of debates concerning the virtuality of digital technologies and cultures, it has diminished the critical attention to VR in general as its own term. The term 'new media' has sought to supplant specific discussions of digital technologies and their social and cognitive uses in an attempt to construct a common language that has succeeded only in a mass conflation and limitation of terms under pre-established fields.

This shift into 'new media theory' has been characterised by an increasing obsession with embodiment. This view is already seen in Heim's (1998) definition of VR in relation to 'virtual realism' focusing on "substituting the primary sensory input with data received produced by a computer" towards a state where "the user identifies with the virtual body and feels a sense of belonging to a virtual community"

(p. 221). This emphasises telepresence and artificial reality incorporating a full body immersive experience detailed and accurate enough to create a suspension of disbelief. This suspension is apparent in Katherine Hayles's (1999) conception of virtuality, reasserting Donna Haraway's position (1985) in an explicitly (digital) technological context, as "the cultural perception that material objects are interpenetrated by information" (Hayles, 1999, p. 13). The focus on the body has penetrated VR in the form of the avatar, the embedding of the gaze into a representation of the human form to replace the lost physical frame in digital space. This system of interface now dominates digital environments such as Second Life, as well as the computer game medium with the third-person view and focus on the avatar in popular MMORPGs such as *World of Warcraft*. Mark Hansen (2006) appears to make some progress in establishing the emerging need to discuss "a fluid interpretation of realms…a mixed reality stage", yet limits himself to "the central role played by the body in the interface to the virtual" (p. 2). This is based on the same error as Hayles in defining the virtual as a filling of (physical) space with information rather than either the creation of new spaces (as is the conventional design/technological view of VR) or a mode of viewing and creating spaces within thought (as is presented and elaborated in this chapter). Anna Munster (2006) makes a conscious and purposeful effort to reinsert the body and affect into the digital, placing virtuality as a part of materiality rather than as a force of framing and function in relation to our perspective on a given world. This work, with its focus on "the point of intersection that digital flows have with issues of embodiment" (p. 24), remains entrenched within the materiality that furthers the dominance of physicality of the digital in any system where embodiment becomes the key concern. This tendency has coincided with the development of new media as a term (see, for example Hansen, 2006), drawing the focus even further away from the specificity of terms such as virtual reality in the fusion of cinematic and embodied gazes as the presiding cultural interface.

There is a clear Deleuzian influence in Munster's work, and both Deleuze and Guattari are referenced heavily in relation to the virtual, as well as notions of flow, diagram and time. While this begins to question and expand the notion of the virtual in virtual reality, it does so only through its emphasis on embodied materiality and the dominance of the 'real' reality of the physical. This move is seen also in the work of Massumi (2002), who engages with a more explicit confrontation with the virtual. Here the problematic role of the body is emphasised in the relation to the virtual, when he writes that "a word for the "real but abstract" incorporeality of the body is the *virtual*." (p. 21). Massumi makes a necessary move into the body as a conceptual tool rather than material object, but adds a series of conflations between the Deleuzian conceptual Body without Organs and the specific physical body; and between the virtual as a function of thought and as digital technology. Within a scheme of the body, the division of virtual and real cannot escape an alignment with physical and digital, and all its attendant hierarchies. Žižek (2012), cultural philosopher of the elusive Lacanian real, is instructive here in the struggle against what he labels the "imbecilic inertia of material reality" (p. 127). We must broaden our scope of the body, and materiality in general, to reconsider the relation of VR to consciousness and subjectivity. A starting point for this shift appears in Žižek's (2009) statement "I never "am" my body" (p. 227), in direct opposition to Maurice Merleau-Ponty's (2002) claim of the body as "our general medium for having a world" (p. 146), an oft quoted trope in scholarship concerning the body and the digital. This entails a move beyond the embodied view of technology as a prosthetic for humanity, in a return to the early conceptions of cybernetics as a tool for expanding intelligence, in the context of this expansion of virtuality and reality as relations of consciousness. As Massumi (2002) describes the postbiological self-modifications of the obsolete body in the art performances of Stelarc, our task is that of "extending intelligence beyond the earth" (p. 99): the positioning of the mind itself as a virtual reality in a physical digital hybrid.

Such a consideration of cybernetics, which underpins the fundamental relation between human consciousness and its extension by both the technologies themselves and the symbolic realms they bring into being, draws into focus the implications of VR as sensory feedback, evident in early conceptions of information processing including a human subject within the system. While stemming from a limiting view of VR, from the fields of design and engineering, the alignment with the early cybernetic vision of expanding the human mind suggests an innate step towards the cyborg subject as a technological posthuman (although perhaps, here and more generally, a cognitive superhuman). By reinserting Sutherland's aim of the control of the human mind (via computer technologies) over matter, we approach what Nick Bostrom and Anders Sandberg (2009) conceive as "intimate links between the external systems and the human user through better interaction…less an external tool and more of a mediating "exoself"… embedding the human within an augmenting "shell" such as wearable computers or virtual reality" (p. 320). Yet this state is not merely applicable in a digital environment, for the same virtuality is present in the physical world. Beyond the confines of embodiment, the embedding of a subjective perspective, demonstrated in VR, within any 'reality' always creates a 'shell' of augmentation, be it a sensory or abstract construct, allowing for interaction with a world through the mediation of thought. By expanding the human mind, we can expand the potential environments with which humanity can interact. Indeed, the lesson of early cybernetics is that we must first rethink the relation of thought to itself if we are to engage with the abstract and alternative worlds that VR could enable (rather than the anthropocentric reality mimicking our own current situation that often dominates VR culture). While this is in danger of recalling the fictional extension of abstract spaces for increasing intelligence exemplified to disastrous consequences in the 1992 film *The Lawnmower Man*, the quest for transcending both the current limits of human thought and the barriers between human and computer, physical and digital, reaffirms the role of VR as a 'techno-Godot'. This constant process of desire for expanding ourselves alongside the development of technology enforces a constant questioning of the terms by which we are operating, thus the influence of cybernetics on VR has and could still assert the need for a rethinking of our relation to such technologies and the spaces they can create.

The impact of cybernetics and the need to reconsider our conceptions of space in VR leads to a discussion of the cultural influence of cyberspace. While cybernetics has suffered a limiting conception as prosthetics (after Haraway and with the need for practical applications such as replacement limbs for the privileged physical human body), and VR has been limited in scope through its connection to specific technologies, cyberspace has undergone the opposite process. Emerging as a term (Gibson, 1984) at approximately the same time as virtual reality, cyberspace has become a greatly abstracted notion that is perhaps itself in need of further reconsideration in a contemporary context. However, while VR's reinterpretation has often been a simplification to enable a more precise use across disciplines, the interdisciplinary nature of cyberspace has been discussed and developed in its cultural role. Nevertheless, simultaneously symbolising the transmission of information across global computer networks and the imaginary spaces with which we envisage contemporary virtuality, cyberspace has, like virtual reality, succumbed to a commodification in advertising and mass media that has rendered its position disparate, imprecise and confused. John Perry Barlow (1996) claims cyberspace as an independent "civilization of the Mind", while Manovich (2001) rejects the notion of a singular cyberspace, stating that "virtual spaces are most often not true spaces but collections of spaces…there is no space in cyberspace" (p. 253), and Don Ihde (2012) suggests that cyberspace is merely "the technological capacity to bring the remote near" (p. 326). The underlying 'reality' of cyberspace is tackled more directly by Žižek (1999), stating that "how cyberspace will affect us is not directly inscribed into its technological properties;

rather it hinges on the network of socio-symbolic relations which always-already overdetermine the way cyberspace affects us" (p. 123). This acknowledgement of the impact of pre-existing structures of culture and thought (for example, the pressures of industry and defense on the development of technologies, or the determination of digital interfaces by the cinematic tradition) suggests a need to *re*think the conditions under which cyberspace is constructed. This is furthered by David Gunkel's insistence on the need to 'hack' cyberspace as a term:

Cyberspace is, from the moment of its fabrication, radically indeterminate. It comprises an empty signifier that not only antedates any formal referent but readily and without significant resistance receives almost every meaning that comes to be assigned to it. (Gunkel, 2000, p. 815)

The term cyberspace itself, as well as its continued and developing use, must be constantly reconsidered. The same applies to virtual reality in its role beyond a specific technology, as the process of creating new and alternative spaces for the mind to inhabit. This relation to the mind spreads from the individual to the collective and indeed to its function within society as a whole. Thus, in order to constantly 'hack' the terms under which the discussion of VR occurs, we must reconceive the framework within which we think such (physical, digital and cognitive) spaces in order to rethink and redefine the role of these technologies in the future of our society.

The position of VR and other computer technologies in society brings into question the availability of and access to such technologies and the inclusion or exclusion of individuals from the emerging cultures surrounding them. The 'digital divide' was first discussed in a series of three reports by the US Department of Commerce (1995; 1998; 1999) that recognised the unequal access to both computer technology and internet infrastructures across various different boundaries and social divisions. The 2003 World Summit on the Informational Society brought the necessity of a resolution to the digital divide to the global arena:

We are also fully aware that the benefits of the information technology revolution are today unevenly distributed between the developed and developing countries and within societies. We are fully committed to turning this digital divide into a digital opportunity for all. (World Summit on the Informational Society, 2003)

While this statement sets out the intention to overcome the inequalities created by computer technologies, the social implications of the massive global increase in technology remain a key division in contemporary society. Such a situation places VR firmly within the realm of the technological 'haves', and any cognitive advantages or conceptual freedoms that the technologies enable remain the purview of an elite few. The causal relation of the technology to such divisions, however, is questionable. The vision of early cyberneticians and VR technologists and theorists is of an improved society, expanded intellect and ultimately control over reality for all human beings. David Gunkel (2003) had again, and in the same year as the World Summit, suggested the need to rethink the conditions and assumptions under which we define these technologies, stating that "the 'digital divide' is originally and persistently plural…there is not one digital divide; there is a constellation of different and intersecting social, economic, and technological differences" (p. 504). This disruption of a simple binary between 'haves' and 'have nots' emphasises the complex integration of technology within society, and the pre-existence of societal inequality that placed the technologies in an always already divided world. We might also extend

these notions to VR itself. There is not one virtual reality (or concept of) for us to access as an alternative space but rather a series of processes, each of which forms a virtual reality in the ever expanding multiverse of subjective experience. Gunkel explains that "it is, then, not a matter of finding the 'right' theory and applying it consistently, but of using theory dynamically to open the 'digital divide' to critical reflection" (p. 517), which again emphasises the need to constantly rethink our relation to and conditions for technologies such as virtual reality. Rather than the establishing of a rigid binary hierarchy, as can be seen in the persistent privileging of the physical over the digital, of 'real' reality over virtual reality, there is at work a hyperbolic expansion of the digital metaverse: an increasingly complex web of access, censorship, ownership and subversion through which humans struggle to navigate. This new mode of plural reality requires a not only new set of technological tools and literacies, but a new mode of consciousness concerning the underlying Reality of contemporary virtual society: a new understanding of our relation to virtual reality.

THE VIRTUAL

The first step in a genuine reconsideration of virtual reality must be a renegotiation and new understanding of its constituent conceptual components. The virtual, often conflated with the term 'digital' in contemporary culture and theory, has received a great deal of attention in expanding its definition and impact beyond and within digital technology. The work of Gilles Deleuze (2004a) has here been of greatest relevance to the field in developing the term as a relation of abstract processes to human thought and its relation to the world. His definition of the term places a strong link to the mental realm of the Idea as "pure virtuality" (p. 349). Deleuze emphasises the virtual as a series of relations within an Idealist construction, suggesting an alternative space or mode of viewing the world built on difference as a process. He further states that, in the passage from Ideal to material, "the actualisation of the virtual… always takes place by difference, divergence or differenciation" (p. 265). Thus conceived, the virtual appears as the manifestation of thought itself, the differential relations that bring specific thoughts into being as the coalescing of an Idea. Within Deleuze's linguistic constructions of society and reality, this virtuality is not a part of the material universe, nor our knowledge of it, but rather an adjacent space of the mind in which consciousness occurs as a process. Therefore, "whatever totalizations knowledge may perform, they remain asymptotic to the virtual totality of *langue* or language" (Deleuze, 2004b, p. 58), that is, no matter how detailed an image of the actual material universe we may strive to achieve, the virtual remains forever approaching yet separate from such a space. Massumi (2002) elucidates this as the limits of consciousness, as a construction of language shaping thought, writing that "it is only by reference to the limit that what approaches it has a function: the limit is what gives the approach its effectivity, its reality. The limit is not unreal. It is virtual. It is reality-giving" (p. 147). This supports and expands Deleuze and Guattari's (2004b) own definition of the virtual as being "real without being actual, and consequently continuous…an "alternative continuity" that is virtual yet real" (pp. 104-5). In this development and elaboration of Deleuze's theoretical position in collaboration with Guattari, there emerges the space, separate from the material world, of a "virtual cosmic continuum of which even holes, silences, ruptures, and breaks are a part" (p. 106). This complete reality in itself, in the space of the abstract and the Ideal, displays the "virtual continuum of life" (p. 122) that forms the differentiating relation of consciousness to the world.

In the relation of the virtual realm of the Idea to consciousness as a linguistic construct,[2] Deleuze and Guattari write that "the abstract machine of language is not universal, or even general, but singular; it is not actual but virtual-real; it has, not invariable or obligatory rules, but optional rules that ceaselessly vary with the variation itself, as in a game in which each move changes the rules" (p. 110). This machinic functioning of the virtual brings it close to the common usage of the term (in, for example, the conventional definitions of VR) as synonymous with digital, but Massumi (2002) warns us "not to confuse the digital with the virtual" (p. 142), and it is in Deleuze and Guattari's placement of the virtual as a process that constantly changes its own rules[3] that we see an overt confrontation with the rigidity of binary logic. Whereas the language of computer code precisely defines digital reality as a necessary condition of its ability to function, the virtual in consciousness acts as the underlying process of abstraction that allows thought to occur as such in free singularities detached from actualisation. The problematic relation between virtual and digital lies in the implications of Deleuze's opposition of the virtual to the real. Shields (2003) states that "the virtual is often contrasted with the 'real' in commonsensical language by many writers who have not paused to examine the implications of the terms they are using" (p. 19), yet Shields himself offers only a one-sided expansion of these terms focusing, as the title of his text suggests, on the virtual under an application of Deleuzian theory to economics and risk, opposing the virtual to the concrete in economics and to the abstract in culture (pp. xvi; 17) while still struggling with an inconsistent conflation of digital and virtual when speaking of online communities and environments. The move beyond the 'commonsensical' has occurred unevenly, searching for a term against which to situate the virtual.

Munster (2006) offers a similarly confusing manoeuvre (p. 90-1), taking the Deleuzian opposition of the virtual to the actual rather than real in contrasting realism to fantasy and the imaginary. While Massumi (2002) also warned against the reduction of the digital from "really apparitional" to artificiality or simulation (p. 137), there is often in his work a conflation of the 'real' with analogue in writing about materiality and physicality. This establishes a clear hierarchy within thought, expressed as the "excess of the analog over the digital" (p. 143) and the structure under which "digital technologies have a connection to the potential and the virtual only through the analog" (p. 138). Massumi even goes so far as to write of the "superiority of the analog" (p. 133), seeming to suggest that the digital is explicitly *not* virtual, but rather that the virtual is inherent to all physicality (and only physicality, or only appearing in the digital as an extension of the physical). While the reality of the digital is computer code (possibility rather than virtuality), our experience of it (the way it appears to consciousness) relies on the shift from static data to information as flow. Here the virtual re-emerges as a function of difference in our relation to the digital world. Munster (2006) opposes "the reductive maneuver [sic] of situating digital technologies as the cause of virtual experiences…in the early cyberculture frenzy surrounding high-end VR technologies" (p. 92), but in separating the virtual processes in both physical and digital spaces she replaces virtual abstraction with the dominance of the actual physical body. In emphasising the role of the virtual apart from its common usage in digital media, Munster, Shields and Massumi bring about a reduction of the virtual to only the physical, and by extension reduce the virtual to one part of the real (in the conflation of real with physical/material). We can oppose this with Haraway's (1992) suggestion that "the virtual is precisely not the real" (p. 325), which displays the counter operation of reducing the virtual (conflated with the digital) to an effect, counterfeit or state of paranoia in which articulation (which can be seen in as the Deleuzian function of the virtual) grinds to a halt. Murphie (2002) operates a levelling effect under a discussion of virtuality, stating that "'everything is real', especially VR. Or real 'enough'" (p. 193). This 'real enough' epitomises the assertion of a limited and familiar view of the real

even within the questioning of reality under new regimes of virtuality. These opposing views all operate through an uneven reduction of the virtual in relation to the real: the virtual as part of the real; the digital as part of the analogue; the artificial against the 'real' physical world; or everything subsumed under an approximate 'reality'. Gane and Beer (2008) highlight this problem of drawing together different theories which place the virtual as simulation (p. 108), as the hyperreal which blurs its boundaries with the real (p. 12). The virtual, in itself and particularly in its relation to discussions of digital technologies (in general as well as more explicitly its impact on VR), requires further consideration and a definition built in contact with an expansion of the real.[4]

This chapter defines the virtual as the role of consciousness in perpetuating itself; the subject as process; the function-function of consciousness in which the subject imagines and posits its own functioning. This function forms an axis of becoming, based on the desire that leads always towards the real, yet never achieves its goal, in what Deleuze would call the virtual as an asymptote or attractor to the real. While this Deleuzian virtual must be taken into account as a function of immateriality operating within the Ideal realm of thought – as the substance of cognition – its position within a schema of real and actual that relies too heavily on objectivity limits its direct transferral onto the terms brought into question across the physical-digital divide. The virtual here is more closely placed as the enunciating position of thought, a "statement of desire" (Deleuze, 2004b, p. 17) for both reality and consciousness of it. Within this structure, the subject "imagines himself to be a man merely by virtue of the fact that he imagines himself" (Lacan, 1977, p. 142). It is the functioning of consciousness that bars the subject from itself. This is the grand illusion of consciousness, covering over the inherent alienation of the subject from itself, concealing the position from which the human subject views a given reality with the surface of consciousness upon which such a reality appears. The virtual thus takes on the role of the big Other, the structure of desire that is always-already in the unconscious (p. 130). This is the predicate for the enunciating subject which exists only within its own symbolic structures of thought. It is the virtual that makes consciousness always-already false and, somewhat paradoxically, enables the subject to conceive of the substance of objective reality that obscures the internal positing of the assemblage of worlds, thus Žižek's (2007) conclusion: "reality always-already was virtual" (p. 193). Indeed, all worlds are formed and all of subjective reality defined by the constant process of desire as the virtual functioning of consciousness. As desire, what Deleuze and Guattari (2004a) define as "a process of production without reference to any exterior agency" (pp. 170-1), the virtual both sustains the illusion of objectivity in relation to the subject and enables the subjective self that "exists only on the basis of the misrecognition of its own conditions" (Žižek, 2008b, p. 73). The virtual is the function-function of consciousness [f(f(…))], its functioning *as such* essential to the assemblage of worlds and the creative formation of subjective reality.

THE REAL

There is still a need to reinsert a rupture between the virtual and the real, to assess the antagonism within the term virtual reality. To do this will first require an expanding of the term 'real'. While the virtual has been elaborated and expanded in the wake of Deleuze, both in itself and in relation to digital technology in general and VR in particular, Gunkel identifies the absence of such consideration for the real:

It is often assumed that the problem with 'virtual reality' – the concept, its various technological deployments and the apparently oxymoronic phrase itself – has been our understanding, or perhaps misunderstanding, of the virtual. The real problem, however, is not with the virtual; it is with the real itself…What is needed is an examination of the common understanding of the 'real' that has been operationalized in these various discussions and disputes. (Gunkel, 2010, pp. 127-9)

There is here the need for a new understanding of the real, and the understanding that is suggested is that of Lacan, particularly as interpreted and applied culturally by Žižek (2009). This is a conception of the real as "a pure antagonism, as an impossible difference which precedes its terms" (p. 24), based on Lacan's (1977) placement of the real as an encounter, but an encounter in which "reality is in abeyance" (p. 56). This internal antagonism inherent to reality is the paradox whereby, as the real is approached, it disappears. The real is therefore the reality of the unconscious, the traumatic kernel beneath the limit of virtuality that forms the surface of consciousness.

In this construction of consciousness and the unconscious, the real and the virtual take on a mutual dependence that underpins the need to sustain their antagonistic relationship. Gunkel (2010) states that "for Žižek, then, the real is already a virtual construct, and the difference between the real and the virtual turns out to be much more complicated and interesting" (p. 138), and it is this difference that must be confronted to re-establish the particularities of the term virtual reality. If for Deleuze the virtual is real, then under a Lacanian interpretation the real is also virtual. The interdependence of the two terms, and the inclusion of a mark of each within the other, highlights the simultaneous formation of the two as the simultaneous formation of the conscious and unconscious parts of the human mind. The construction of thought that generates a world that is to be thought, to be contained within thought and without which thought has no object to think, is a looped causality of differentiation that posits itself as the division between virtual and real. If the virtual and real contain one another, and cannot exist separately, it is because the unconscious arises automatically within and as a condition for the surface of consciousness upon which a world (a 'reality') appears. Lacan (1977) writes, "that which makes us consciousness institutes us by the same token as *speculum mundi* [literally, 'mirror of the world']" (p. 75), emphasising the problematic role of the subject inscribed in its own gaze, the loss and stain of reality from which we are excluded even as we leave an ontological mark upon its appearance to consciousness. This is what underpins Žižek's description of the subject as the void within our perception of the world, the stain in the gaze as the constitutive gap in substance (2007, p. 40) or empty structure of the real (2009, p. 8), that is the objectification of the real as lost, the inherent and always failed attempt of virtual consciousness to observe its own unconscious reality.

However, in the context of the digital in general, and VR in particular, the expanded conception of the real in relation to the virtual remains problematic within Žižek's theoretical position, derived from his resistance to digital technology in favour of a materialist dominance of the physical world. While he states that "the crucial point on which the consistency of Lacan's position hinges is thus the difference between reality and the Real" (Žižek 2008a, p. 214), when speaking of the digital Žižek often conflates real and 'real'. With a focus on what Tom Boellstorff (2008) similarly articulates as the fact that "it is not that virtual worlds borrowed assumptions from real life: virtual worlds show us how, under our very noses, our "real" lives have been "virtual" all along" (p. 5), the embedding of virtuality in physical existence and placement of the real as an unobtainable lost causality highlights the framing of reality as a fantasy. Within a critique of the digital resides a desire for and loss of a genuine sense of 'reality'

that perhaps speaks as much to Žižek's own structure of fantasy concerning contemporary ontology as much as the problematic relation between digital worlds and reality. He writes:

In so far as the VR apparatus is potentially able to generate experience of the 'true' reality, VR undermines the difference between 'true' reality and semblance. This 'loss of reality' occurs not only in computer-generated VR but, at a more elementary level…we are dealing with the loss of the surface which separates inside from outside….outside is always inside: when we are directly immersed in VR, we lose contact with reality. (Žižek, 2008a, pp. 133-4)

A development of his position is required if a productive relation of the real to digital technology is to emerge, expanding his critique beyond the physical-digital hierarchy that draws too close to a conflation of physical and real (of actual reality and Lacanian 'reality') as the object cause of desire in his ideological analysis. To situate the real as the reality of a complex social system such as the contemporary digital world, Gunkel (2010) insists upon "a conceptualization of the real that realizes that the real is itself something which is open to considerable variability, ideological pressures and some messy theoretical negotiations." (p. 139). In specific relation to the symbolic realm of the digital, Žižek defines the conditions for the underlying reality of computer code:

… bytes – or, rather, the digital series – is the Real behind the screen; that is to say, we are never submerged in the play of appearances without an 'indivisible remainder'… the emergence of the pure appearance which cannot be reduced to the simple effect of its bodily causes; none the less, this emergence is the effect of the digitalized Real. (2008a, p. 132)

This positioning of the digital real as the underling binary operations presupposed beneath the 'pure appearance' of the interface screen informs our relation to digital computers. We do not perceive the functioning of code, yet it determines our entire digital reality. This functions as the lost object cause of desire, perpetually outside of our perception while defining the conditions under which a perception of the digital can occur. In the endless variation of 1 and 0 in binary logic, this reality is the difference between something and nothing, the inherent lack in the emergence of reality. Across digital and physical planes, this is the hidden nature of reality beneath perception and outside of our virtualising cognition of the contemporary metaverse.

To more specifically assess the real in its relation to the virtual, this chapter defines the real as the void of the contemporary subject, as both the gap within consciousness and the gap of the physical-digital divide. The real, as defined by this chapter, is not only the later Lacanian real (in, for example, Lacan, 1977), but more specifically the *objet petit a* as the objectification of the void and its role in drive. If subjective reality is a void around which worlds form, then the real is the absent or quasi-cause at the heart of the parallax that determines the manner in which reality appears to the subject. This real is not an objective reality, but rather the excessive lack within the subject that presupposes an external causality. However, if, as Žižek (2000) states, "all presuppositions are already minimally posited" (p. 119), then the real is that which is presupposed as lost, what Žižek (2008a) labels the "coincidence of emergence and loss…*objet petit a*" (p. 15). Throughout Žižek's interpretation of Lacan, the real as *objet a* is the excess and lack of an underlying 'real-ity': excess in terms of a mystical beyond or supposed causal force 'without' the subject; lack in its unattainable nature derived from its positing 'within' (and objectification of the void of) the subject. From this position, the real functions according to the logic

of that which is expressed. This is Deleuze's (2004b) conception of sense which "brings that which expresses it into existence" (p. 190), "is essentially produced" (p. 109) and "is always presupposed as soon as *I* begin to speak; I would not be able to begin without this presupposition" (p. 35). Sense manifests the real as a functional logic: that which is expressed, yet cannot be directly confronted; the object of the proposition that is not included in it; the quasi-cause of the void-function. The real is the objectification of unknowable flux within consciousness, and through Žižek (2006) we can thus conclude that "reality is never directly 'itself'" (p. 241). In this way the real portrays a void-function within consciousness, the inaccessibility of the void of subjective reality. The underlying reality of a given consciousness or world is thus formed of its presuppositions within consciousness.

VIRTUAL REALITY

Žižek's discussion of the physical and digital defines Deleuze's virtual precisely and only as Lacan's real. This attempt to draw together the two theorists who are often considered opposed, while acknowledging the importance of the reality of the virtual over 'virtual reality' (Žižek, 2012, p. 3), conflates the nuances of the two processes within consciousness and their functions in the generation of the subject. The antagonistic relation between the real and the virtual, in the expanded sense of both terms is integral to reconciling Žižekian and Deleuzian philosophies as well as the term virtual reality, in a necessary move towards a theory of the digital founded upon the antagonistic relation between virtuality and reality. Deleuze (2004a) states that "the virtual is not opposed to the real; it possesses a full reality by itself" (p. 263), and without opposition we are not seeking a resolution or synthesis of the two terms. Rather, it is the relation of a paradoxical antagonism that is sustained in both physical and digital realities in their difference as such. This difference resides in the subjective perspective from which we denote one world or the other: two modes of thinking our relation to the universe through the interplay of virtual reality. The utopian vision of early VR, as an ideal space in which a freed mind controls all reality, has fallen out of favour amidst the photorealistic aim of mass consumption in digital entertainment. This is a transition towards the reduction of digital environments to what Cline (2012) portrays dystopically as both "an escape hatch into a better reality" (p. 16) and "a self-imposed prison for humanity…a pleasant place for the world to hide from its problems while human civilization slowly collapses" (p. 120). However, it is precisely this more direct (and perhaps abstracted) expression of consciousness that can connect subjectivity with a self-conscious modification of its relation to and definition of virtual reality. The antagonism between virtual and real is less an opposition than a paradox, underpinning the difference between physical and digital modes of thinking and being. Deleuze (2004a) emphasises the role of "difference as the reality of a multiple virtual field, and the determination of micro-processes in every domain, such that oppositions are only summary results or simplified and enlarged processes" (p. 278 [n]). This suggests the need for a new mode of viewing antagonism beyond the problematic opposition of virtual and real.

Between physical and digital worlds, as two modes of being and of consciousness, lies the subject: a perspective caught adrift in the void of both realities. A given world is a specific self-organisation or assemblage of virtual and real. It is the specific ordering and condensing of the functions of consciousness, creating a different knowledge and experience of a world, which brings about the perceived changes between physical and digital realities. This shift in epistemological position that creates an ontological difference between worlds is what we have seen in Žižek's (2009) conception of parallax (p. 17), here

interpreted not as a shift between individual objects *within* social reality but as a parallax *between* realities themselves from within consciousness. Throughout Žižek's work (for example, 2008a) the basis for this framework of parallax and its relation to a machinic consciousness appears in the proliferation of the "always-already" of posited-as-presupposed conditions (p. 184), as well as the Lacan-inspired role of fantasy in cyberspace (Žižek, 1999, p. 104-123) and as "a screen masking a void" in reality (Žižek, 2008b, p. 141). This structure of fantasy supporting the virtual-real relation is of crucial importance in assessing the formation of the physical-digital divide within consciousness. Fantasy, then, becomes the illusory structure between desire and drive that allows the virtual to cover over the void of the real in the continued functioning of consciousness on the surface of the subject. What a critical approach of parallax aims for is the insertion of a ""minimal difference" (the noncoincidence of the one with itself)" (Žižek, 2009, p. 11), under which a distance to our own subjective position can be achieved and the subjective real exposed. To break through the structures of fantasy in relation to digital technology is the task of this conception of virtual reality, confronting the smooth functioning of consciousness in such a way that makes clear simultaneously the parallax relations to physical and digital worlds within subjective reality. By approaching the antagonism between virtual and real, a critical distance can be inserted within consciousness as it beholds its position in the void of parallax between physical and digital worlds. But how do physical and digital worlds form in the relation between virtual and real? Deleuze (2002) equates the actual and the possible to existence and essence (p. 110), expanded into a relation with consciousness by Massumi (2002) when we writes that "intelligence stretches between the extremes of thought-perception, from the actual to the possible, dipping at every connection into the vortex of the virtual" (p. 98). It is the simultaneous relation between virtual-real and existence-essence (as actual-possible, which we will call here 'existence-meaning' as a more appropriate conception of the digital world built entirely upon symbolic structures without a pre-existing noumenal value). Between these two axes is the shifting perspective of parallax that forms the virtual-reality of both physical and digital worlds: the structure of desire and the lost presupposition of a universe for the contemporary subject to inhabit.

The physical mode of subjectivity emerges when existence combines with the real, the world as it appears with an absent causality. Following the phenomenological dictum that existence precedes essence, virtual-meaning then occurs as a constructed truth within consciousness and its social relations. The entrance of consciousness into the physical world marks the initial passage from nothing to something, our first concrete existence must be founded upon the objectification of the void in the real. This is the assemblage real-existence, whereby the presupposition of a causal relation between reality and appearance instigates appearance itself as reality, and not only an object's or image's reality but also our own physicality as subjective being. This appearance, objectification and externalisation of the physical leads back into consciousness through the process of signification, the human desire for communication. This is where virtual-meaning is formed, in the process combining the conditions of truth with the functioning of consciousness. As Žižek (2008b) states, "the multitude of 'floating signifiers'…is structured into a unified field through the intervention of a certain 'nodal point' which 'quilts' them, stops their sliding and fixes their meaning" (p. 95). The virtual, as desire and the big Other, acts as this condensing point upon and against which meaning can be certified, wherein "by the mere act of speaking, we suppose the existence of the big Other as guarantor of our meaning" (Žižek, 1991, p. 153). Our interpretation of the physical world relies upon this virtual-meaning. Signification must become manifestation and the subject must form itself in a relation to symbolic truth and presuppose an external validity to such truth in order to engage in the use of individual visual, linguistic and cultural signifiers. This process of

creating a symbolic structure based on a presupposed external physical reality is the cycle of the physical world, whereby each moment passes from perception to thought before the virtual returns to cover over the real as signifiers define the framework for future observations and the signified world expands within a virtualised consciousness.

Conversely, the digital subject condenses when the real combines with meaning, the absolute truth in code. This binary causality only ever has indirect contact with the subject, through layers of programming language and operating systems that are constructed to enable communication. This is brought into virtual existence, not as a simulation but, rather, a simulation-of-simulation; the appearance of appearance instigated by a conscious intentionality linked directly to the underlying machine code (in its most basic form this is the act of 'turning on' the digital device). This inversion of essence before existence still maintains the originary quasi-causality of the real followed by the process of the virtual. The digital world is not built from material substance, but from the abstract and absolute code of the machinic computer. Such a formal, logic-based realm can be considered the fulfilment of McLuhan's (2001) vision of electric technology as "pure information without any content to restrict its transforming and informing power" (p. 57). Binary logic is built upon the purely formal numbers one and zero, exemplifying Deleuze's pure difference and Žižek's minimal difference, functioning as the coalescence of meaning with the real in the fundamental positing of a digital universe. virtual-existence then appears as a realm of the imaginary in the superficial light of the interface screen. The purity of such a 'perfect' imaginary world based on formally 'perfect' logic fails at the very moment of engagement. The subject as physical being is seldom able to detach itself, neither sensorially nor cognitively, from its analogue existence. Memories of 'real' places seep in, 'realistic' graphics hook our imaginations back into already established functions of (false) consciousness, concealing what Manovich (2001) insists as a position in which "synthetic computer-generated imagery is not an inferior representation of our reality, but a realistic representation of a different reality" (p. 202). Here Baudrillard's (1994) scheme of the final phase of simulation proves instructive as "its own pure simulacrum…no longer of the order of appearances, but of simulation" (p. 6). While VR is often viewed as such a mode of simulation, the apparent virtuality of existence in the digital is constructed directly from the real of computer code, precisely defined by an absolute reality. Thus VR spaces are not an imaginary realm of pure appearance but rather an appearance of appearance concealing the truth of binary logic. A further phase of the image must be added in the context of VR: the mask of appearance *is* reality. This is the operation that Žižek (1991) identifies as unique to humanity, in which we "deceive by feigning to deceive" and therefore "effectively *become* something by pretending that we *already are* that" (p. 73). In digital environments this is the process by which we accept the clear virtuality of existence, in the opacity of the interface under a necessary suspension of disbelief, creating a mask of appearance that hides the direct causal relation between the reality of code and the 'virtual reality' on screen. Here we move beyond pure simulacrum as a result of simulation, towards a simulation-of-simulation. It is for this reason that the placing of VR as a tool for accurately 'simulating' physical reality entirely misses the point of the function of virtual reality at an ontological level. We should not consider virtual-existence as an illusory or imaginary interpretation of physical real-existence, for the relation of real to virtual does not here imply a judgement of truth. Rather, the digital image should be regarded as an illusion of appearance, the simulation-of-simulation whereby phenomena precisely are their signification in the primary causality of computer code. The virtuality of existence returns to the real in concealing such presupposed code beneath the sensory data that appears on screen, a shift from signification of something in reality to a reality of signification as such. In the wake of the poststructuralist breakdown of symbolic structures, and subsequent resurgence

of a nostalgic fetishisation of physical materiality, it is tempting to view digital environments such as VR as an empty signification of pure appearance, the epitome of Baudrillard's simulacrum. In the interplay of expanded notions of virtuality and reality, however, the apparent 'virtuality' of the digital is the appearance of virtuality itself; the illusion of VR is the structure by which it appears as pure appearance.

AN ART OF PARALLAX

Within this expanded notion of virtual reality, integral to our conception of both physical and digital worlds, a re-application to digital technology is required if the theoretical developments are to inform our relation to actual technologies and their use in contemporary and future society. As Deleuze and Guattari (1998) suggest, the task is that of "acting counter to the past, and therefore on the present, for the benefit, let us hope, of a future" (p. 112), a sending forward of ideas as an infinite critique of society rather than a specific set of practical activities. This application of a futuring of thought can occur most strongly in new modes of understanding creative practices. There has long been a strong link between VR and art. Not only does the generation of digital worlds require a creative input at the visual level, but VR theorists quickly identified the critical role of artistic practices in the social impact of the technologies. Nicholas Negroponte (1996) identified that in VR and other digital technology "the real opportunity comes from the digital artist providing the hooks for mutation and change" (p. 224), and Heim (1993) has also suggested that "perhaps the essence of VR ultimately lies not in technology but in art" (p. 124). These statements highlight the necessity of creative interventions to rethink our relation to technology and thus evolve our future relation to both physical and digital worlds. Here we see that Žižek's (1999) call to "traverse the fantasy in cyberspace" (p. 102), while emphasising the need to overcome the structures of fantasy between the virtual and the real, does not go far enough. Rather than, as he suggests, using VR as a place in which to stage and confront the psychological issues of our physical selves, there is now the need in our increasingly digitised society to traverse the fantasy *of* cyberspace, to view the parallax of the physical-digital antagonism and our position within it. The critical power of digital art lies not in creating specific sensational worlds but in challenging the mode of viewing the worlds it creates, building an analytical encounter into the frames it constructs, and through this to challenge our subjective viewpoint on all worlds.

This process by which art can make visible the parallax perspective that defines our individual virtual realities is always a process of re-framing. Žižek (2009) explains that "the minimal parallax constellation is that of a simple frame: all that has to intervene in the Real is an empty frame, so that the same things we saw "directly" before are now seen through the frame" (p. 29), and it is the role of art to make clear such a frame through which the virtuality of our perspective can be penetrated in order to make contact with the subjective real that underpins our experience of any given world. The artist of parallax views both sides of an antagonism at once, portraying simultaneously two perspectives with no common language (p. 129). In relation to the virtual reality of digital and physical modes of thinking and creating, this entails the construction of new perspectives from which to view and gain critical distance towards the interplay of virtual and real in the inversion of existence and meaning. Baudrillard (1994) states that "the universe of simulation is transreal and transfinite: no test of reality will come to put an end to it - except the total collapse and slippage of the terrain, which remains our most foolish hope" (p. 103), but in the digital simulation-of-simulation the territory is always-already collapsing and slipping into new assemblages across global computer networks and the many realms of cyberworlds we create.

The role of art in using VR to confront the virtual reality of the contemporary subject and contemporary society can thus be defined as the construction of a position from which to view our own parallax perspective on the physical-digital multiverse. Žižek (2009) states that, for the artist of parallax, "the only action available to him is self-destruction, which is itself a symbolic statement, the only work of art available to him" (p. 128). To unleash a kernel of the real, to bring an objectification of the parallax position into view by simultaneously staging both sides of the antagonism, requires a process of representing, externalising and stripping down (staging and traversing) the structures of desire and identity in subjective virtual reality, destroying the shell of consciousness to see what remains as our position from which the world is viewed and from which thought is thought. This is described by Murphie (2002) as humanity's ability for "extracting the world from the world" (p. 194) through conscious perception (and its disruption by or antagonism with the unconscious). Between the narcissism of excessively attempting to view oneself (as the position from which one views the world(s)) and the destruction of the fantasy supporting the virtual reality of such a self, we approach what appears as a nihilistic solipsism. If it is the subjective viewpoint, the parallax perspective, that constructs physical and digital worlds within thought, then to view the structures of virtual reality necessitates a gesture of withdrawal. This removal of the self in creative digital practices is an attempt to view one's own presuppositions, the always-already there of the subjective position, and thereby view the formation of parallax and the structures of fantasy supporting the smooth continuation of virtual reality. Deleuze (2002) describes "a pure Artist" as one form of the "human being who precedes itself" (p. 11), and in the physical-digital parallax the VR artist must precede its own perspective, the construction of its virtual reality and the fantasy of digital technology, in order to create new experiences through which we might rethink our relation to virtual reality, new technologies and the many worlds they create. For the potential of radical creative collectivity, transitioning from the individual consciousness to the social in what Deleuze and Guattari (1998) hail as a 'people to come' (p. 218), this is the imagining and staging of future perspectives of a genuinely cybernetic post-individual and posthuman consciousness through which the critical and creative power of VR might enact the revolutionary potential that filled its early conceptions, re-emerging in new forms of psychological, social and artistic constructs around new understandings of the framing of the discussion.

CONCLUSION

This chapter has raised new questions concerning the definition of virtual reality. By tracing the history of the term through the technological and cultural developments that have expanded VR into everyday language, the problematic nature of the label virtual reality has been shown to have always included a series of internal tensions surrounding its constituent components of virtuality and reality, and external tensions in relation to other aspects of digital technology. Recognising the hostility of VR theorists, technologists and creative practitioners towards the vague inclusion of virtual reality as a tool for marketing a broader range of digital media and its permeation of the physical world, while opposing the simplified definition of VR as a specific technology not taking into account the cultural expansion and impact of the term, a critical history of virtual reality theory has revealed in the simultaneous expansion and dissolution of the inherently interdisciplinary field of VR research a persistent problem with the limitations of presupposed assumptions concerning the virtual and its opposition to the real. Taking this in its broader cultural context, the impact of other parallel theories and terms has been discussed to situate VR in and

against other theoretical developments of digital technology. The dominance of cinematic theory on VR technology and its inclusion in contemporary culture has been reassessed in order to assert the need for new theories of digital media, and VR in particular, as a cultural and ontological regime in itself. The alternative and more general term 'cyber' has been traced through the concept of a cyberspace back to the earlier developments of cybernetics as an expansion of the human mind, situating VR technologies in their creative potential for constructing spaces of the Ideal. Issues of access to VR and other information technologies were discussed, and their causal role challenged as symptoms of wider societal inequalities, to raise the concerns over the viewing of digital technology in terms of social binaries. These developments have established the need to both assess and move beyond the antagonism of virtuality and reality in reconsidering VR as a technology and a conceptual framework.

The virtual has been analysed in the Deleuzian tradition, drawing out the machinic processes of the Ideal that are at work in both physical and digital modes of existence and thought. Deleuze's conception of the virtual was outlined and elaborated to establish the evolving context of virtuality in contemporary society, while later developments by Massumi and others brought the debate into the discussion of VR technology. Within this extension of virtuality, however, was revealed a reliance on a limited notion of the real, and the opposition of virtual to actual rather than real placed the virtual as part of a broader and more common sense 'reality'. The virtual was therefore redefined in a specifically machinic, functional approach to consciousness as a surface of the Ideal upon which worlds are thought, enabling an antagonism with the real in the processes of thought that allow virtual reality to emerge. The real itself was then questioned under a Lacanian definition, expanded by Žižek and Gunkel in their discussion of cyberculture, reinserting an antagonism between virtual and real without reducing either to earlier common sense and limited notions. The real was explicitly defined as the unconscious, the unknowable void of subjectivity, and placed in a relation to the desire of the virtual as underlying and presupposed drive, Lacan's *objet petit a*. Within Žižek's theory, however, the Lacanian real is placed as the Deleuzian virtual, thus this discussion redefined each term individually to allow the specificity of their antagonism (internal to consciousness) to re-emerge.

With the constituent parts redefined, a new mode of viewing virtual reality was then suggested to provoke not an opposition of virtual and real but, rather, a sustained antagonism within our conception of any 'reality' and the relation of thought to it. Žižek's concept of parallax was instructive here in establishing the ontological implications of subjective epistemological shifts, the relation between the constantly evolving landscape of the virtual surface of consciousness around the void of the real in the unconscious as the position from which consciousness is thought. The unrepresentable position from which the parallax perspective is seen and thought was placed as the emergence of all virtual realities. The emergence of physical and digital worlds was delineated along the inversion of existence and meaning (as a broader term for essence more directly applicable to digital ontologies) as the shifting perspective of digital parallax. The alignment of these two states with virtual and real processes of thought was posited as an original framework of viewing physical and digital ontological difference within consciousness, asserting the subjective viewpoint, and its problems, as the key to our understanding of virtual reality today. The dilemma of representing the position from which parallax (as well as physical and digital worlds) is thought was postulated as the task of contemporary creative practices that engage with digital (including the conventional VR) technologies. This drew further psychoanalytic techniques into a framework of making clear the reality of the subject and society, stripping down the virtual surfaces to represent simultaneously both sides of the antagonism: the surface of physical-digital worlds and the underlying presuppositions that differentiate them and allow them to form. The task was

proposed for contemporary digital artists to 'precede themselves', to bring out the position from which the information society is thought and, fundamentally, to persist in the questioning of the terms under which thought and art occur.

This chapter offers a contribution to our understanding of virtual reality as a technology and a conceptual framework for society and its future development. The discussion is by no means exhaustive, and indeed it is hoped that the arguments presented inspire further elaboration, disagreement, and productive antagonism that continues the reconsideration of the term and its use in creative practices. The resolution of the oppositions between Deleuzian expansions of the virtual and Lacanian developments of the real requires further discussion and resolution, both in terms of the often contradictory, yet linked, theoretical positions themselves, and in their application to digital technology, culture and art. The questions, developments and new positions outlined here are intended as a call for further questioning in theory and a renewed focus in practice on the use of VR technologies and their framing of contemporary society.

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KEY TERMS AND DEFINITIONS

Consciousness: Thought as a machinic process; the self-positing of the subject as a virtuality in thought; the gesture of the cogito; the surface assemblage of the subject.

Cybernetics: 'Steersmanship'; the study of systems with a circular causal feedback loop; the expansion of human intellect with machines; the understanding of understanding.

Cyborg: The human subject between physical and digital worlds; the self-aware expanded cybernetic consciousness; the resolution of the internal antagonisms of the cyborg can be considered a state of posthumanism.

Digital Divide: The disparity in access to technology and information along geographical, ethnic or economic lines.

Existence: The conditions for being; the gaze and the appearance of external objects it denotes; an observed world (either physical or digital).

Meaning: Essence; signification; less what is communicated than the conditions of truth that enable communication; information as this shared process of flow.

Parallax: The relative displacement of objects by a change in perspective; the ontological change in objective reality created by an epistemological shift in subjective position.

Real: The objectification of the void of the contemporary subject, as both the gap within consciousness and the gap of the physical-digital divide. This is linked to the Lacanian *objet petit a* and the perpetual drive of the loss as such that defines desire.

Subject: The perspectival position from which consciousness is thought; the assemblage of consciousness around this parallax void; the individual or collective potential for creative activity and shaping the future of human society.

Virtual: The role of consciousness in perpetuating itself; the subject as process; the function-function of consciousness in which the subject imagines and posits its own functioning. This appears as desire, always moving towards contact with the unattainable Real.

ENDNOTES

[1] Or, rather, reduces the digital to one manifestation of the virtuality of cinema as the logical extension of painting using Deleuze only for his work on cinema (a trend that dominates the elaboration

of the Deleuzian virtual), seeing the necessary development as an expanding of Deleuze's temporal focus towards a spatial consideration which itself only furthers the subsuming of VR by cinema.

2 Here is where Deleuze's "ultra-nominalism" (Norris, 1995, p. 133) develops from Lacan's (2006) view of the prior existence of language in the subject, found by psychoanalysis in the unconscious (p. 413), towards a virtualised simultaneous occurrence of language as the limit of consciousness and the unconscious, the differentiating process that brings thought into being.

3 The 'ideal game' was previously defined by Deleuze (2004b) as "without rules, with neither winner nor loser, without responsibility…this game is reserved then for thought and art" (p. 63).

4 The mutual expansion and re-definition of virtual and real in this chapter would ideally require a reading of both sections 'simultaneously'. However, to construct a linear argument they will be defined separately, the virtual prefiguring the real, before being drawn together in a more detailed discussion of their relation.

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Chapter 21
Design Principles for Crisis Information Management Systems:
From Closed Local Systems to the Web and Beyond

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ABSTRACT

Since Hurricane Katrina, a lot of research has gone into improving disaster management through the use of crisis information management systems (CIMS). There has been much interest in how to design dynamic CIMS, particularly with respect to web-based emergency management systems. In the authors' research, they set out to design and develop a distributed web-based training and research tool for emergency managers and scholars. In order to develop their training system, they needed to simulate the CIMS that emergency managers use during a crisis and with which they could run training and research simulations. This raised the question: What exactly is a CIMS, and how does one design one? In order to answer this question, the authors engaged in nine months of field research at the Miami-Dade Emergency Operations Center in Miami-Dade County, FL. Through their field research and the emergency management experience of one of the authors, they identified several additional design principles for CIMS in today's technological and communication landscape. This paper outlines the resulting recommendations.

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INTRODUCTION

A crisis is defined as "any event that threatens to, or actually does, inflict damage to property or people." (IS -1, n.d.). Crises can be small or large in scale. In large-scale crises, there usually is a significant probability of extreme danger and highly unpredictable outcomes (Leadership in Crisis, 2010). Small- or large-scale crises can occur at any time, and the consequences can be enormous. At the height of the H1N1 influenza outbreak between 2009 and 2010, 61 million people became infected with this virus. In addition, H1N1 caused approximately 274,000 hospitalizations and 12,500 deaths (CDC, n.d.). In 2004, the Indian Ocean earthquake and tsunami affected approximately 5 million people in Indonesia, Sri Lanka, India, and the surrounding areas. Over 280,000 people died, and more than 1 million people were displaced (World Health Organization, n.d.). In the US, Hurricane Katrina was one of the most expensive and devastating natural disasters in American history (Rabkin, 2005). Over half a million people were affected by the hurricane, and the US energy infrastructure was severely damaged (Rabkin, 2005). In 2012, Hurricane Sandy swept through the Northeastern United States. Seventy-two people died and 8.5 million people lost power. More than 650,000 houses were damaged or destroyed (Blake et al., 2013). Hurricanes Katrina, Sandy and other crises clearly show the importance of disaster preparedness. Indeed, much can be improved, especially with respect to training and collaboration among federal, state, and local governments (Agrait et al., 2004; Auf der Heide, 1989; Dorasamy & Raman, 2011; Holguín-Veras et al., 2007; Rabkin, 2005; Waugh & Streib, 2006). Specifically, one area that can be improved is the design of crisis information management systems (CIMS) (Catarci et al., 2011; Grant, 2008; Gryszkiewicz, 2012; Gryszkiewicz & Chen, 2012; Onorati et al., 2011; Turoff et al., 2004).

The remainder of this paper is structured as follows. We begin by discussing differences between CIMS and general information systems. Next, we discuss how CIMS has grown with technology and co-evolved with the web. Following this, we review current theory on the design of crisis information management systems. After that we present our recommendations for CIMS. Finally, we conclude with implications and future directions of CIMS.

BACKGROUND

Evolution of CIMS: Similarity to and Differentiation from Information Systems

What is a crisis information management system? A CIMS is a vehicle that aids in storing, retrieving, analyzing, and organizing information; managing resources; maintaining situational awareness; supporting a common operating picture; establishing and maintaining command and control; facilitating decision-making; and collaborating with other emergency managers and agencies to aid in orchestrating response efforts. CIMS are computer-based software systems and they are, in effect, a specialized type of information system (IS).

IS grew out of the business and management domain (Hirschheim & Klein, 2012). IS historically has been based on designs to provide support for components of the organizations dealing with different types of decisions and processes requiring different types of information, such as transaction processing, accounting and finance, mid-level decision-making, operations management, and strategic planning (Davis & Olson, 1985; Keen & Scott Morton, 1978). Central to these types of systems, and similar to CIMS, was the ability to create and maintain a situational "image" of the firm's status, driving decisions

as events unfolded, such as product demand, pricing decisions, resource deployment, and operational and strategic changes in operational missions, often in the form of databases (Everest, 1986; Martin, 1975). The form of any IS system, consequently, reflects the demands of the environment within which it operates. However, the unique informational demands of crises necessitate system characteristics that are foreign to most non-crises IS.

The roots of CIMS were not in the business sector, but grew out of the public welfare and is the result of harnessing advanced technology applied to the emergency management domain. In fact, CIMS are critical to the public welfare during a disaster. Whereas IS applications may have financially expensive consequences for the organization if not used correctly (e.g. bad investment, regulatory fines, lost customers, etc.), they rarely result in the loss of lives. CIMS, on the other hand, are often used in life-threatening, time-critical situations, and improper use can lead to putting lives at risk.

Another differentiation between CIMS and IS is that IS tends to serve large numbers of users from one organization, while CIMS typically serves a few individuals from many organizations. Characteristic IS applications are often used frequently by the users (but not always), while a CIMS application is used infrequently by its users. As such, typical IS applications, since they are often used infrequently, can get away with being more complicated and having a steeper learning curve. As discussed in the next section of the paper, CIMS, on the other hand, must be very easy to use and to learn.

Additional differences include, but are not limited to: CIMS need to have the ability to add and delete user accounts and modify access controls quickly and easily (within minutes). CIMS need to be malleable and easy to adapt to the current situation. Often times, unforeseen events arise in crisis, and the system needs to be able to adapt easily to a large variety of situations. CIMS need to integrate training systems into them and they should be especially familiar to the emergency managers. CIMS today are typically web-based and distributed, and they have built-in means of access control for information. This enables easy information sharing between various distributed agencies. CIMS need to be inclusive for many types of users; emergency response involves the public, volunteers, businesses, non-profit and non-governmental organizations (such as Catholic Charities, American Red Cross, Salvation Army), donors, first responders, emergency managers, elected officials, and coordinating government agencies. CIMS are used to manage all phases of emergency response; they are used in day-to-day and in crisis situations. CIMS need to maintain situational awareness and a common operating picture to help emergency managers make decisions and manage the response. CIMS is enhanced by integrating social networking, mobile-based GIS, digital media and digital volunteers. Finally, CIMS need to have backup solutions in case of electronic or communication infrastructure damage during an emergency.

IS, on the other hand, do not need to have such critical time restraints on access controls. IS does not necessarily need to be able to adapt to many different situations, and it does not need to be so familiar to the users. IS does not usually span across numerous distributed organizations, so it does not necessarily need to be web-based. IS are typically used in normal day-to-day non-critical operations. Finally, IS can have backup systems, but typically are not as critical if they loose power for a few hours.

Another difference between CIMS and IS is that IS typically has had four distinct levels of application: workers, middle managers, senior managers, and executives. CIMS, on the other hand, may serve three or all four of these types of users in one system at the same time. Finally, IS may be designed for one particular purpose and function. CIMS, on the other hand, is used for a variety of purposes. Indeed, with crisis information management systems, emergency managers need to be able to accomplish a wide variety of functions (see next section).

Evolution of CIMS: Growing with the Technology: A Change in Paradigm

The paradigm outlined in this paper differs from previous paradigms of Emergency Information Systems. There are several reasons for this. First, before the present time, the infrastructure was not available yet to support intense web-based operations. Additionally, personal computers were not as prevalent in many organizations. As late as 2000, as outlined by Jennex (2004), the Y2K emergency management website was congested and non-responsive from too many hits during the Y2K rollover. In contrast, Internet infrastructure was fairly successfully tested and used in the recent Exercise24, in which video (high volume Internet traffic) and geographic information systems were tested and were found to be fairly responsive to a massive quantity of Internet users (Howe et al., 2011). Today, the communications infrastructure can support many more individuals. This coincided with a large portion of the North and Southeastern United States turning to WebEOC, a distributed, web-based management system (WebEOC, n.d.). Additionally, previous CIMS paradigms were template based and used email and voice communications as the main communication methods. Modern CIMS, on the other hand, has many additional elements.

According to an article in Risk Management in 2002 (Davis, 2002), the best CIMS include most of the following features:

- Incident tracking, logging and reporting;
- Automated SOP checklists and plans;
- Resource management (with full database functionality);
- Central command and control;
- Messaging and communications function with tracking;
- Documentation of response actions;
- Contact lists;
- Internet, intranet/VPN and wireless;
- Radio, cellular and satellite;
- Appropriate member participation;
- Automated journaling;
- Access to plans and data;
- Mapping;
- Role-based staff management;
- Linking capability to access Internet sources for weather and event intelligence;
- Hand-held compatibility;
- Fully configurable and scalable;
- Compatible with existing infrastructure, databases, software and e-mail;
- Status boards;
- Executive briefings.

E-Team, one of the leading commercial CIMS, provides the following functionality[1] (E-team, n.d.):

- Incident reporting and tracking;
- Situation reporting;
- Resource and asset management;
- Action planning;

- Critical infrastructure reporting;
- Hospital and shelter status;
- Personnel management;
- Procedures and checklists;
- Intelligence gathering and dissemination;
- Tip reporting;
- Duty and call logs;
- Organization charts;
- CATS hazard modeling interface;
- Crystal Reports interface;
- Real-time messaging and chat.

WebEOC, another leading commercial CIMS, provides similar functionality, including:[2] (WebEOC, n.d.):

- Managing Users;
- Status Boards;
- Exchange information with other WebEOC customers;
- Checklists, Contacts, File Library, Sessions;
- Messages;
- Mapping;
- Audit Logs;
- Import/Export Data (CSV);
- CAP Messaging;
- Status Board/ Form Building Tool;
- Reporting Tool;
- Creating and Running Simulations;
- Chat;
- Remote Boards, Scroller, Alerting, Calendar, Twitter, NWS Weather.

WebEOC further enables users to "manage multiple incidents and daily events, assign and track missions and tasks, provide situation reports, manage resources and prepare incident command system (ICS) and incident action plan (IAP) reports." (WebEOC, n.d.)

Finally, another change has contributed to the paradigm shift in the last 10 years. The pervasiveness of smart phones, tablets, even cheaper computers, and the creation of social media have enabled the public (these can be both victims and observers of the crisis) to participate in the crisis response by sending information about the disaster to others electronically in real time.

Evolution of CIMS: From Closed Local Systems to the Web and Beyond

The use of crisis information management systems to aid in emergency management is a fairly recent initiative. In fact, it is still growing and evolving. The evolution of CIMS mimics the evolution of the web. Like the web, CIMS began its development with systems that centered on organizing, storing, and retrieving information. These early systems used tools such as Microsoft Word, Excel, Access, and

email (Jennex, 2004). Next, we begin to see the emergence of information management systems to aid in maintaining a common operating picture and decision support. These systems were closed and isolated; each organization had its own system, but they were not necessarily connected with other systems in other jurisdictions (Jennex, 2004). Examples of these types of systems include custom emergency information systems (EIS), Sharepoint, E-Team, and WebEOC.

Hurricane Katrina marked a changing point in using information technology to aid in emergency management. Officials realized that they could harness information technology to a greater extent in the relief efforts. Systems began to focus on interconnecting closed, local systems with each other (Nelson et al., n.d.). Here we see the emergence of crisis information management systems federations. Examples of these types of systems include enhanced versions of E-Team, WebEOC (with a WebFusion augmentation), and Sahana Eden (Sahana Software Foundation, n.d.).

The Haiti Earthquake in 2010 marked another pivotal point in emergency management. Organizations began using Web 2.0 technologies, digital media, and smart phones in the emergency response. Web 2.0 technologies feature wikis, SMS/texting, social media, and other social networking and collaboration tools such as Flickr, Facebook, and Twitter. Additionally, through the use of the web, digital media, and smart technologies, emergency managers began leveraging the public in collaboration and participation in the response efforts. "Web 2.0 principles are strikingly applicable to disaster relief since a stricken population can offer the most immediate information about its own conditions. These principles advance the ability of individuals to dialogue and partner with relief agencies, rather than being consigned to the role of passive victims […] Information may be gathered and assembled in an open, democratic fashion." (Nelson et al, n.d). Web 2.0 systems bring together existing trends in information technology for the humanitarian response. These systems include increased usage of digital media technologies and smart phones and tablets by responders to manage humanitarian information, enhanced reporting and distribution of information through local mass media to help aid recipients, and customized innovative digital media tools and platforms applied to coordinate new forms of collective action and problem-solving (Nelson et al., n.d.).

A third pivotal area that emerged in the wake of the Haiti earthquake is with respect to remote public volunteers, also known as digital volunteers (Starbird & Palen, 2011). In addition to formal emergency response, these digital volunteers use Web 2.0, smart phones and tablets and social media tools to self-organize participation in the response. This self-organizing participation in emergency response is also known as crowdsourcing. Tools digital volunteers use to aid in the response include social media, SMS, and reporting and mapping services such as Ushahidi, GeoCommons, and OpenStreetMap (Okolloh, 2009; Perng et al., 2013; Starbird & Palen, 2011; Sutton et al., 2013; Zook et al., 2010).

SUMMARY OF CURRENT CIMS DESIGN PRINCIPLES

In a foundational paper in 2004, Turoff et al. describe principles for the design of a dynamic emergency response management information system (DERMIS), based on premises derived from the historical experiences of the former Office of Emergency Preparedness (OEP).

Another paper by Onorati et al. (2011) describes interaction principles for Web Emergency Management Information Systems (WEMIS). Onorati et al. analyze a set of common and frequent characteristics of WEMIS. They analyze the PIE (Program, Interpretation, Effect) formalism (Dix et al., 2004) with

respect to CIMS and introduce another characteristic to the formalism. The resulting characteristics are observability, predictability, reachability, transparency and meta-communications.

In another pivotal paper on Emergency Response Systems, Jennex (2004) discusses experiences with Emergency Information Systems during the Y2K rollover. In this paper, Jennex advocated that a CIMS should consist of "a database, data analysis tools, normative models, an interface, trained users, methods to communicate between user and between users and data sources, protocols to facilitate communication, processes, procedures, and contingency plans used to guide the response to and improve decision making during the emergency, and a central emergency response command structure."

One of the principal recommendations from Jennex is that training be accomplished on the CIMS and that different organizations be able to work together as one coherent team using a centralized command structure. He also notes that there should be a common terminology among emergency managers. Some of these concerns have been addressed through the adoption of the incident command system, the creation of the Department of Homeland Security in 2002, and the adoption of the National Response Framework in 2008.

Ghoerghe and Vamanu (2001) were early advocates of incorporating Geographic Information Systems and satellite capabilities into CIMS. Gadomski, Bologna, Costanzo, Perini, and Schaerf (2001) advocate using artificial intelligence to create an intelligent decision support system (IDSS) to aid emergency management decision-makers.

In a paper on process management and geo-collaboration among first responders, Catarci et al. (2011) outline 5 requirements for CIMS for first responders. Specifically, these apply to process management systems (PMS), which are systems that first response leaders have on their PDAs that aggregate data from several sources to better orchestrate the crises among first responders. First, they advocate for wireless mobile networks for these systems. Second, since first responders may not have knowledge of the local area, PMSs should be integrated with Geographic Information Systems (GIS). Third, PMSs should allow for large process specifications that are specialized by time according to the specific situation. Fourth, PMSs need to be adaptable; they need to be able to adapt the process execution to possibly changing circumstances and contingencies. Finally, PMS "client tools must be extremely usable and intuitive [...] Systems should be so intuitive that they can be easily mastered after few interaction sessions." (Catarci et al., 2011).

In a paper on Emergency Management Information Systems, Grant (2008) describes a checklist for comparing CIMS. This checklist was derived from a Crew/Operator Support Policy (COSPOL) study funded by the Netherlands. In this report, Grant identifies functions that command and control (C^2) information systems utilize when managing a crisis. They do not list the entire system functions, but for the monitoring and control subset of C^2 information systems, they note data acquisition, situation analysis, and planning and scheduling as part of a command and control crisis information management system.

More recently, Gryszkiewicz and Chen (2012) describe how to integrate various concepts of temporality in crisis information management systems. Specifically, they describe 6 design principles:

- Make temporal relationships between asynchronous activities salient;
- Make information about past crises, and past crisis management events in ongoing crises, easily accessible;
- Add create/last-modification time-stamps to information;
- Indicate how events and activities may develop;
- Give support for emerging information sources.

Gryszkiewicz (2012) adds two more temporal design principles: support the pace of the users' tasks and work, and allow for different users being responsible for the same tasks over time. The first principle allows the system to work more quickly or slowly depending on the needs of the users. For example, in some cases, it may be more efficient to have an online chat with another person rather than to publish and subscribe to messages. The second principle allows for continuity among different shifts of workers to access the information for which they are authorized in order to change over more quickly and accurately during long lasting crisis events.

FOUNDATION FOR ADDITIONAL DESIGN PRINCIPLES FOR MODERN CIMS

Under a grant from the National Science Foundation, researchers from Florida International University, Emory University, and the University of Notre Dame, in conjunction with the highly regarded and experienced Emergency Operations Center in Miami-Dade County, FL, set out to design and develop a training system for emergency managers and for researchers. (Becerra-Fernandez et al., 2007; Nikolai et al., 2009; Nikolai et al., 2010; Nikolai et al., 2015; SimEOC, n.d.). In order to build this system, we needed to simulate the software that the emergency managers were using at the emergency operations center in day-to-day operations and during the management of disasters, and to understand how this system fits within the context of decision and information flows during a crisis.

For nine months, one of us (Nikolai) worked as an intern at the EOC alongside the emergency managers, thus situating herself within the context of the organization (Suchman, 1987). During this time, she participated first-hand in three operational activations – the response to the Haiti Earthquake of January 2010, Super Bowl XLIV, and the Pro Bowl of 2010. Additionally, she documented changes that were taking place with respect to CIMS and how Miami-Dade began developing collateral systems to augment the current software in use at the EOC. Drawing on the detailed information gained over the nine-month period (exercises, training, interviews) supplemented with experience of this author and of another author, who a focused literature review, we propose 12 design principles relevant for CIMS in today's emergency response environment (described below).

Additional Design Principles for Modern CIMS

Design Principle 1: CIMS Should Be Easy to Learn On-Demand

In the middle of a crisis, personnel are dealing with the crisis. Few organizations have the time or resources to train new personnel; their foremost concern is on stabilizing the crisis, not on training individuals (Nikolai, 2009-2010; Sniezek et al., 2002; Turoff et al., 2004; Westfall et al., 2009). In fact, during Exercise Golden Phoenix in 2008, the request from the military liaison regarding technology was "Four buttons max, please. The feeling was that if it required an engineer to operate, it was a distraction and potential danger during a crisis." (Westfall et al., 2009). In addition, liaisons who gather to manage a crisis may be limited in their training with respect to a CIMS. There are several reasons for this. First, the current practice of training through simulation exercises requires that individuals physically have to come to the EOC or other locations to gather for exercises (Nikolai, 2009-2010; Jiri and Björn, 2009). This limits organizations in time, personnel, and budget in the number and type of training exercises that

they can engage in (Nikolai, 2009-2010; Westfall et al., 2009). Additionally, during our field research, we observed that there can be a high rate of turn-over of the liaisons of the organizations, the EOC staff, and other coordinating agencies and elected officials (e.g. the mayor, commissioners, governor, US representatives). This means that often the individuals and organizations must form teams in the middle of a crisis, sometimes by individuals who do not know each other and who have never worked with each other before, or with whom they work on a very infrequent basis. These individuals need to be able to gain access to a system and learn the system within minutes.

An example of this type of situation occurred in the Haiti Earthquake of 2010 (Nikolai et al., 2010). In particular, the Miami-Dade EOC became the lead support agency in charge of coordinating local support to the repatriation efforts. In collaboration with the Miami-Dade EOC, Miami International Airport, the State of Florida's Division of Emergency Management, Homestead Air Force Base was tasked with accomplishing the repatriation. Since Homestead Air Force Base is located approximately 40 miles away from the Miami-Dade EOC, coordination had to be accomplished via remote technologies. The Miami-Dade EOC had to set up and give access to select officials regarding particular information about the crisis. In addition, the Base EOC needed to give access and exchange information about the repatriation of citizens and what kind of medical or special needs assistance victims needed to Miami-Dade EOC staff. Using WebEOC, the Miami-Dade EOC was able to create a status board for viewing access to repatriation status information (with updates occurring in real time) by their Command staff, Homestead Base emergency management staff and other response officials. On the other end, the Homestead personnel had to pick up and learn the CIMS (WebEOC) in a matter of minutes. They also were able to access and update status boards remotely through a remote web-based login.

Design Principle 2: CIMS Should Have the Ability to Add and Delete User Accounts and Modify Access Controls Quickly and Easily, Especially During a Crisis

Since crises may lead to unforeseen needs, CIMS need the ability to expand and contract easily. Each incident has different needs (e.g., resources, personnel, processes, organizational structures) and may require the formation of teams that were not expected in order to manage the crisis. Sometimes new individuals come into the crisis or the exercise who have never been trained on a CIMS (Nikolai, 2009-2010). This is especially helpful in the case of multijurisdictional incidents. In the Haiti earthquake example, the Miami-Dade EOC had to set up and give access to the Homestead Air Force Base EOC. As another example, in 2010, the National Football League's Pro Bowl and the Super Bowl were held in Miami. The Miami-Dade EOC was activated to monitor both events. During the activation, the EOC needed to coordinate with guest state and federal officials who came down to Miami to assist in monitoring the events and to be available in case of an emergency. In addition to regular personnel, Miami-Dade had to set up access and access controls for these guests.

Design Principle 3: CIMS Should Be Easy to Adapt to the Current Situation

What makes managing a crisis so complex is the fact that one cannot plan for everything (Catarci et al., 2011). Crises are often unexpected or they stem from normal situations that unfold in unexpected ways or ways that are beyond the scope of the planned resources available to address them (Leadership in Crisis, 2010). Often individuals and organizations must form teams in the middle of a crisis. Emer-

gency managers and CIMS must be able to adapt to the situation. In the Haiti crisis, Miami-Dade had to create new types of unforeseen status boards and reports in the middle of the crisis. They also had to grant access to particular information to a new group of people as well as to maintain restrictions on the information that the new members had access to.

Design Principle 4: CIMS Should Be Web-Based and Distributed (and Have a Means of Access Control for Information)

This does not mean that the underlying hardware necessarily has to be built into the web or located in different geographic areas, but rather the CIMS should provide an ability for coordinating organizations who may not be in physical proximity to the CIMS to log in to a web-based client and access information for which they are authorized. Again, in the situation with Haiti, the Miami-Dade EOC had to coordinate with the Homestead Air Force Base EOC, which is located approximately 40 miles away from the Miami-Dade EOC. Local EOCs need to coordinate with tribal, state, regional, and federal EOCs and agencies as well. Through the use of their established CIMS, the state of Florida was able to establish interconnected regions with its 67 counties for resource and mission tracking. Through WebEOC Fusion, an augmentation to WebEOC, the Miami-Dade EOC was able to connect and share information with neighboring counties and with the Florida state EOC and other coordinating agencies.

Design Principle 5: CIMS Should Integrate Training Systems into Them or At Least Make Systems Similar to Those with which Emergency Managers are Familiar and which They Use Regularly

This is similar to Turoff et al.'s first DERMIS premise and Jennex's recommendations about training with respect to EIS. However, instead of training *on* a system, organizations should train *with* the system (although training on the system needs to happen as well). That is, training should not be actuated as an event that is distinct from operational use. Rather, training is a capability that is built into the system as a component of usability. Use of the system is best mastered in the context of how it is used in practice. CIMS, for example, may include an integrated training component that simulates a disaster. An example of such a CIMS is WebEOC.

Design Principle 6: CIMS Need to Be More Inclusive for More Types of Users

Managing a crisis is a multi-agency, multi-governmental, and sometimes international activity (Nikolai, 2009-2010; Miami-Dade EOC Activation, 2010, January; Miami-Dade EOC Activation, February; Waugh & Streib, 2006; Zwass, 2010). Emergency response involves the public, volunteers, businesses, non-profit and non-governmental organizations (such as Catholic Charities, American Red Cross, Salvation Army), donors, first responders, emergency managers, elected officials, and coordinating government agencies. At the governmental level, it may involve coordination among local, tribal, state, federal and international agencies (Nikolai, 2009-2010; Nelson et al., n.d.). Current research identifies many CIMS for first responders (Incident Commander (Incident Commander, n.d.), RimSim (Campbell & Weaver, 2011), WORKPAD (Catarci et al., 2011)). However, there is a general lack of CIMS for emergency

managers. This should include not just emergency managers and first responders, but also the public, victims, volunteers, non-governmental organizations, businesses, and elected officials. A more integrated, holistic approach to the design of crisis information management systems is needed.

Design Principle 7: CIMS Should Be Designed for Use throughout the Entire Emergency Response Lifecycle

Experts generally agree that there are four main phases of emergency response: mitigation, preparedness, response, and recovery (FEMA, 1996; Waugh & Streib, 2006). Mitigation and preparedness occur on a day-to-day basis. Response occurs during a crisis and recovery occurs following a crisis. Mitigation involves taking actions to reduce potential loss from disasters. For example, this involves reinforcing buildings to ensure that they will not collapse from the winds of the hurricanes or the shaking of the ground during an earthquake. Preparedness involves establishing procedures and the roles and responsibilities of emergency personnel and jurisdictions that will be involved during an emergency. It also involves training personnel. In the response phase, emergency personnel assist the victims and try to reduce the possibility of further loss of life and property (IS-1, n.d.). Recovery involves efforts to restore the community to normal operations. In the short term, emergency workers restore vital systems to an acceptable minimum operation. Once this is accomplished, long term recovery can begin. In the long term, recovery may go on for months or even years until the affected community returns to its previous or an improved condition (FEMA, 1996; IS-1, n.d.). CIMS should integrate the activities from each phase of the emergency response lifecycle.

Design Principle 8: CIMS Need to Integrate Advanced Geographic Information Systems (GIS) Into the Common Operating Picture

This is not new (it was advocated by Gheorghe and Vamanu in 2001) but the advances in technology recently have made it more possible to be easily and widely implemented. Additionally, "The support for context awareness is crucial […] [A] given user, particularly in larger events, is likely to work in a variety of contexts, either because of physical relocation or because of changes in the context itself. […] Therefore, users cannot be assumed to have local knowledge of the geography and resources of the area. Consequently, [CIMS for first responders] should be integrated with Geographic Information Systems, which allow users to gain a deep knowledge of the area." (Catarci et al., 2011) While this is especially true for first responders, it applies to emergency managers as well. During the Super Bowl and the Pro Bowl activation at the Miami-Dade EOC in 2010, for instance, federal and state emergency managers came to the EOC to coordinate actions and to be present in case of an emergency. These emergency managers were not necessarily familiar with the area before coming to Miami. For the public, GIS can be used to locate relatives and victims of the disaster and to mark the locations of shelters. During the Haiti earthquake, for example, victims used a GIS aware website to request help. Through the GPS and GIS, first responders and relief workers were able to find them. For emergency managers, GIS is used to maintain a common operating picture and gain a better understanding of the situation, to coordinate actions, and to aid in better situational awareness and decision-making. GIS also enables information filtering and visualization of the area in need. For example, with an overview map, users can click on an event and get more details about the event (see Figure 1).

Figure 1. A GIS aware application used by the Miami-Dade EOC. Clicking on a particular location marker on the map brings up information and pictures related to the area.

Design Principle 9: CIMS Need to Integrate Social Networking, Mobile-Based GIS, Digital Media and Digital Volunteers

CIMS also will need to learn how to harness and perhaps even direct the self-organizing digital volunteers who mobilize during a disaster. Coinciding with this, emergency managers need to learn how to wade through the massive quantity of information originating from social media outlets while avoiding information overload distractions from various platforms (e.g. smartphones, tablets, computers, websites and other applications) (Howe et al., 2011).

Small-scale collaborations of social networking began during Hurricane Katrina, where wikis were used for collective memory, to located missing persons, to organize volunteers, and to locate emergency housing. One of the first large scale collaborations of social networking and digital media grew out of the humanitarian response to the Haiti earthquake in 2010. Although there were several limitations and technical problems, different digital media technologies, networks and communities were able to overcome their differences and work together to aid in relief efforts to an extent that had not been seen before. (Nelson et al., n.d.).

Examples of the use of digital media were crowdsourcing, the creation and updating of local maps for areas for which maps were out of date, humanitarian media response and local coordination, and coordinating to build a people-finder platform (Nelson et al., n.d.). SMS, or short message service, was used for a variety of applications. One immediate priority was to help victims discover what was happening around them and where they could go for help (Nelson et al., n.d.). Citizens and victims were able to request help by way of text message short code to relief workers. In addition, SMS allowed citizens to send public health alerts to relief workers, for example, concerning water sanitation and food shortages

in relief camps. SMS was also used in a broadcast capacity by the humanitarian relief organizations. Humanitarian relief organizations broadcast public health messages to the population about relief services, general health, hygiene, vaccines, sanitation, malaria, and HIV/AIDS. During the recovery, the Red Cross used SMS in other countries to raise money for the relief efforts (American Red Cross, 2010).

Another problem that digital media was able to help with was in updating outdated maps for the region. In some cases, maps had never been created for particular areas. In others, rural populations had migrated into urban areas so quickly that maps became outdated. Still in other areas, some locations did not appear on any maps. In some situations, relief organizations initially relied on maps based on GPS coordinates which were incorrect (Nelson et al., n.d.). Using a combination of crowdsourcing, geo-tagging, and local personnel on the ground, volunteers were able to create updated maps for the relief workers.

One application that came together during the crisis was Ushahidi, a crisis-mapping platform that was adapted to provide emergency and rescue data. Another application that evolved was OpenStreetMap. OpenStreetMap is built entirely by volunteers who survey with GPS, digitize aerial imagery, and collect existing public sources of geographic data. After supplementing the existing maps with the volunteer inputs and updates from people on the ground with hand-held GPS devices to mark spots, OpenStreetMap became the primary map for responders. A third application that became useful in the aftermath of the Haiti earthquake was Google Earth. Various websites set up and streamed information into the Google Earth database, which then was used to locate missing individuals. Volunteers from around the world translated information and helped write code to create systems for processing data from various websites and forums. Another source of digital media are wikis and RSS feeds. Wiki's were set up to maintain collective memory and to share best practices and lessons learned from the Haiti. Ushahidi developed an RSS feed for the U.S. Coast Guard to help them retrieve emergency information that required immediate assistance. (Heinzelman & Waters, 2010; Nelson et al., n.d.; Zook et al., 2010).

Another example of utilizing digital tools and technologies and social media effectively to manage a disaster was in Exercise24 (X24). X24 and X24 Europe was a two-day and three-day-long simulation that was conducted in September 2010 and March 2011, respectively. Seventy-nine different countries speaking thirty-three different languages located on every continent except Antarctica, participated virtually in the exercise. In X24 Europe, ninety-two nations were involved. The goals of the exercise were to:

1. Demonstrate the use of no/low-cost, off-the-shelf social media, crowdsourcing, and collaboration web tools to gather, coordinate, and share actionable real-time information to build situational awareness to help victims of a natural disaster and help save lives;
2. Establish dialogue and build relationships between European partner nations, international organizations, and public/private partners regarding the use of online tools, make them more effective, and streamline cyber information sharing in preparation for the next real-world crisis;
3. Address the virtual flow of information and activities of international organizations during the first 180 days of a natural disaster;
4. Encourage all formal and informal groups across the globe to actively participate or observe the exercise on–site in San Diego, CA or virtually on the web.

While, this was only an exercise, the results were highly successful, and they show that integrating digital technologies and social media and self-organizing various agencies and the public is valuable in the management of disasters (Howe et al, 2011).

Design Principle 10: There is a Need for a More Integrated Set of CIMS

CIMS need to be able to interact with each other on a local, regional, national and international level. Examples of systems that are able to connect local, regional and national, levels are E-Team and WebEOC (with a WebFusion enhancement). However, there is still much work in terms of CIMS integrating the emergency managers, humanitarian responders, non-governmental organizations, businesses, donors, elected officials, and other types of users. Rather than a closed, local crisis information management system held by disparate emergency operation centers, emergency managers need to be able to integrate diverse systems in sometimes ad hoc or unanticipated ways during a crisis. One of the first examples where this took place was in the Haiti Earthquake disaster in 2010 (Nelson et al., n.d.). With their CIMS, the state of Florida was able to establish situational awareness of resource needs regionally with the various counties that were aiding in the earthquake response.

Another example was in the X24 and X24 Europe simulation. Individuals and agencies from 79 and 92 countries, respectively, were able to come together, albeit to manage a simulated disaster, using integrated tools and technologies (Howe et al, 2011).

Design Principle 11: CIMS Need to Have Backup Solutions

CIMS perform a large variety of functions, and they are critical to managing a disaster. In small-scale or routine crises, power will most likely still be operational. Such was the case with Miami-Dade County as a coordinating EOC during the Haiti Earthquake efforts of 2010. It is also the case with many hurricanes that come through Miami-Dade County. In other cases, such as large-scale crisis that overwhelm the resources of local emergency managers, often electricity and communications infrastructure are damaged (Goodchild & Glennon, 2010). There needs to be a backup system in place. This system can consist of a combination of satellite and radio communications (Jennex 2004). It can also consist of one or two computers with word, excel, access, or some other management software on it. In the worse case, it can even consist of paper and pencil forms, templates, spreadsheets, standard operating procedures, and checklists.

Design Principle 12: CIMS Should Have a Means of Interoperability with Each Other

This can be accomplished with a set of data exchange standards, both for operational use and for training. With respect to data exchange standards for operational CIMS, one method in use is the comma separated values (CSV) format. In WebEOC, for example, one can put data into a CSV format and then import it directly into a status board. One also can export the data in various formats as well. This proved extremely useful to quickly and accurately exchange information during the Haiti earthquake, the Super Bowl of 2010, and Pro Bowl of 2010. As emergency managers were organizing the repatriation efforts, the Miami-Dade EOC has several spreadsheets of information that they had collected on the status and special needs of the individuals being repatriated on the Homestead bound flights from Haiti. They were able to create a status board for the coordination efforts and import this information with perfect accuracy in a matter of minutes. Another option is XML. XML is a markup language that allows users to define a set of rules for encoding documents in a format that is both human readable and machine readable (w3schools.com, n.d.). XML standards for emergency management are just starting to emerge. There are several promising standards that make use of XML. These are outlined below.

- *People Finder Interchange Format (PFIF)* (PFIF 1.0 Specification, 2005);
- *ComCARE Vehicular Emergency Data Set (VEDS) and Automatic Crash Notification (ACN) Initiative* (Vehicular Emergency Data Set, 2004);
- *Common Alerting Protocol (CAP)* (Cover Pages, 2009);
- *Emergency Data Exchange Language (EDXL)* (Emergency Interoperability Consortium, 2005);
- *National Information Exchange Model (NIEM)* (Cover Pages, 2009);
- *SAFE: Tsunami Warning Markup Language (TWML) and Cyclone Warning Markup Language (CWML)* (Cover Pages, 2009);
- *The Homeland Emergency Response Exchange (HERE)* (HERENetwork, n.d.).

IMPLICATIONS AND FUTURE DIRECTIONS OF CIMS

Since Hurricane Katrina, research has focused on improving crisis management through the use of information technology. Yet, there is still a great need for improvements with respect to crisis information management systems, and how they integrate with the web, digital technologies, and the public. Research is providing insights into how we view crisis management itself, how organizations interact, and how communities react. CIMS will continue to advance with technology, particularly with the web and digital technologies. The web enables enhanced interconnectivity among information management systems, digital volunteers, and the public. As the digital technologies evolve, we will see more advanced distributed systems as well as advanced cloud-based systems. Digital technologies also enable enhanced connectivity and collaboration among emergency officials and the public. Some of the biggest improvements will be in social media, smart phones and tablets, and geographic information systems. Additionally, emergency managers will need to learn to harness and possibly direct digital volunteers. Along with crowdsourcing, digital technologies, and larger, more connected systems, we will see more effective interoperability and data exchange standards, both for operational use and for simulations and training.

CONCLUSION

In this paper, we discussed design principles for crisis information management systems. We began by differentiating CIMS from the broader IS community. Next we reviewed trends in the evolution of CIMS, especially with respect to advances in technology and the web. After this, we reviewed seminal papers on the design of effective dynamic emergency management systems and web based emergency management systems. In the subsequent section, we identified additional design characteristics of CIMS. There is still a great need for improvements to CIMS, especially with respect to creating distributed, adaptable CIMS with appropriate access controls. More work also needs to be done to incorporate greater collaboration between emergency managers, humanitarian responders, non-governmental organizations, businesses, donors, elected officials and the public. Emergency managers need to learn how to integrate digital volunteers into the emergency response. There also needs to be improvement with respect to connecting various regions of CIMS together as well as better integration of social media, smart phones and tablets, and geographic information systems. Finally, a key area that needs improvement is data exchange standards for quick and accurate exchange of operational and training data. In the future, CIMS will continue to see large growth and evolution with advancing web and digital technology.

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ENDNOTES

1 The features listed here are broad categories of features for informational and comparison purposes. They are not meant to be an all-inclusive list of features.

2 The features listed here are broad categories of features for informational and comparison purposes. They are not meant to be an all-inclusive list of features.

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Chapter 22
Data Mining-Based CBIR System

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ABSTRACT

Multimedia mining primarily involves information analysis and retrieval based on implicit knowledge. The ever increasing digital image databases on the internet has created a need for using multimedia mining on these databases for effective and efficient retrieval of images. Contents of an image can be expressed in different features such as Shape, Texture and Intensity-distribution (STI). Content Based Image Retrieval (CBIR) is the efficient retrieval of relevant images from large databases based on features extracted from the image. The emergence and proliferation of social network sites such as Facebook, Twitter and LinkedIn and other multimedia networks such as Flickr has further accelerated the need of efficient CBIR systems. Analyzing this huge amount of multimedia data to discover useful knowledge is a challenging task. Most of the existing systems either concentrate on a single representation of all features or linear combination of these features. The need of the day is New Image Mining techniques need to be explored and a self-adaptable CBIR system needs to be developed.

INTRODUCTION

Data mining is the process of extracting useful non-trivial knowledge from huge data repositories. These techniques have gained popularity in various application domains including medicine where a huge amount of data is available in the form of medical images. However, the subjective analysis of these images by radiologists is vulnerable to inter and intra-observer variability. These variations depend upon image quality as well as the expertise of the radiologists. Computer-aided diagnosis (CAD) systems are therefore employed as second readers to improve upon the precision in diagnosis; thereby enhancing the survival rates. Hence, there is a considerable interest among researchers to develop medical image mining techniques to design efficient CAD systems using medical images obtained through various imaging modalities, like X-Ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Ultrasound (US).

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Images are the effective medium for presenting visual data in many applications of industry and academia. With the development of technology, a large amount of images are being generated every day. Therefore, managing and indexing of images become essential in order to retrieve similar images effectively. In conventional systems, images are generally indexed with textual annotation. However, as the database grows larger, the use of keywords based method to retrieve a particular image becomes inefficient. Besides, skilled manual labor is required to annotate every single image with appropriate keywords. As consequences, it becomes a time-consuming and tedious task. Seeing these limitations in the conventional system, content based image retrieval (CBIR) systems came into existence. Content-based image retrieval (CBIR) or Content-base visual information retrieval (CBVIR) is an application of computer vision technique. In CBIR, retrieval of images is based on their visual attributes / features such as color, texture, and shape etc (R.Senthil Kumar et al., 2013). In CBIR, each image that is stored in database has its features extracted and compared to the features of the query image. It involves two steps:

- **Feature Extraction:** The first step in the process is extracting image features to a distinguishable extent.
- **Matching:** The second step involves matching these features to yield a result that is visually similar (Shadma Parveen et al., 2013).

Based on the matching criteria, images can be retrieved from a larger database efficiently. This technique can be used successfully in the following areas:

- **Security Check:** Finger print or retina scanning for access privileges.
- **Medical Diagnosis:** Using CBIR in a medical database of medical images to aid diagnosis by identifying similar past cases.
- **Crime Prevention:** Automatic face recognition system, used by police forces.
- Automated Inspections system for the manufacturing industries.

NEED OF MULTIMEDIA MINING

Recent explosion in the quantity of multimedia data stored in social networks and other multimedia sites has engendered the need for new and better techniques for accessing data specifically images. Indexing and retrieval are at the core of multimedia system design— the knowledge potential of huge quantity of multimedia data may lay unexplored in the absence of effective tools for easy access to the collected information. Once collected, the data must be organized efficiently. The object of the retrieval process is to obtain limited information to meet the needs of a user at a particular time, within particular domain applications. Often it is extremely difficult to achieve this objective in actual practice. A major challenge, therefore, lies in developing techniques that can “interpret” the multimedia contents in large data collections so efficiently as to extract all information items relevant to the user query (Meenakshi Shruti Pal, et al.,2013). Multimedia mining deals with the extraction of implicit knowledge; in other words, it looks for multimedia data relationships or other patterns that are not explicitly stored in multimedia files. Multimedia mining is more than just an extension of data mining; it is an interdisciplinary endeavor that draws upon expertise in computer vision, multimedia processing, multimedia retrieval, data mining, machine learning, database and artificial intelligence. Rapid progress in digital data acquisition and

storage technology has led to enormous and fast-growing volumes of data. Valuable information hidden in this data cannot be extracted without the aid of powerful tools because of the overwhelming size and volume of the data. Multimedia mining systems that can automatically extract semantically meaningful information (knowledge) from multimedia files are increasingly in demand. Generally, multimedia database systems store and manage a large and varied collection of multimedia objects such as image, video, audio and hypertext data. To achieve it, we need tools for discovering relationships between objects or segments within multimedia document components; e.g. classifying images based on their content, extracting patterns in sound, categorizing speech and music, and recognizing and tracking objects in video streams. In general, the multimedia files from a database must be first pre-processed to improve their quality. Thereafter they undergo various transformations and a process of features extraction to generate important features from the multimedia files. With the generated features, mining can be carried out using data mining techniques to discover significant patterns. These resulting patterns are then evaluated and interpreted in order to obtain knowledge for the final application.

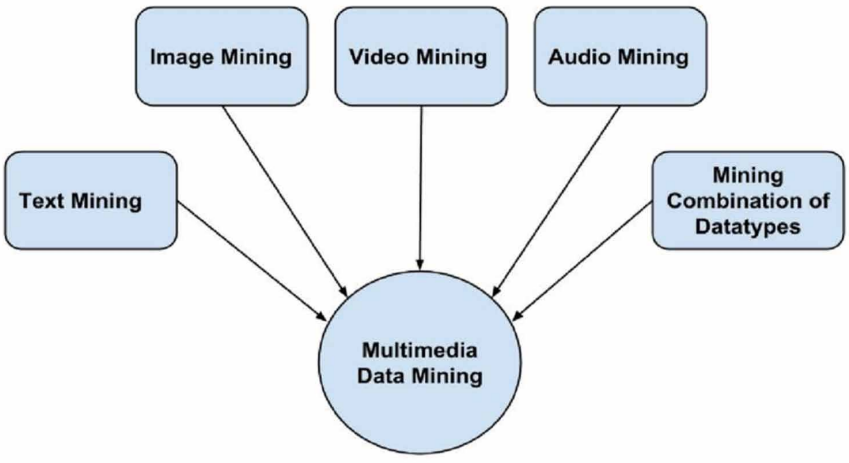
With the recent advances in electronic imaging, video devices, storage, networking and computer power, the amount of multimedia has grown enormously, and data mining has become a popular way of discovering new knowledge from such a large data sets. Note that to mine multimedia data we must mine combination of two or more data types such as text and video, or text, video and audio. One solution is to develop mining tools to operate on the multimedia data directly.

INTRODUCTION TO MULTIMEDIA DATA MINING

Multimedia Data refers to data such as text, numeric, images, video, audio, graphical, temporal, relational and categorical data. Multimedia data mining refers to pattern discovery, rule extraction and knowledge acquisition from multimedia database (Dianhui Wang, et al,2007). Figure 1 illustrates multimedia data mining, in particular, various aspects of multimedia data mining (Bhavani Thuraisingham,et. al, 2001).

Tremendous benefits of traditional data mining are proven for structured data. Now it's time for extending the mining techniques for unstructured & heterogeneous data.

Figure 1. Multimedia data mining



POTENTIAL APPLICATIONS OF MULTIMEDIA MINING

It is well known that multimedia information is ubiquitous and often required, if not essential in, many applications. Consider the application areas of MDM and related industries who are users of technology.

Multimedia Data Mining in Digital Libraries (Sanjeevkumar R. Jadhav,et. al. 2007) — the digital library retrieves collects stores and preserves the digital data. For this purpose, there is a need to convert different formats of information such as text, images, video, audio, etc. The data mining techniques are popular while conversion of the multimedia files in the libraries.

Multimedia data mining for traffic video sequences (Shu-Ching Chen,et. al .2001) -- The analysis & mining of traffic video sequences to discover important but previously unknown knowledge such as vehicle identification, traffic flow, queue detection, incident detection & the spatio temporal relations of the vehicle at intersection, provide an economic approach for daily traffic monitoring operations.

Multimedia data mining approach for automated event analysis of suspicious movements -- Many government organizations, multi-nationals companies, shopping malls, banks and etc are using surveillance system to monitor movements of employees, visitors, machines etc. An ultimate objective of such surveillance system is to detect suspicious person based on their movements to maintain security and avoid any casualty.

- **Application in Medical Analysis:** Application of Data Mining Techniques for Medical Image.
- **Classification Media Production and Broadcasting (Latifur Khan,et. al.,2007):** Proliferation of radio stations and TV channels makes broadcasting companies to search for more efficient approaches for creating programs and monitoring their content.
- **Multimedia Data Mining**: On What Kind of Data Multimedia data mining is being put into use and studied for databases, including multimedia databases and unstructured and semi structured repositories such as the World Wide Web.
- **Multimedia Databases:** Multimedia databases include video, images, and audio and text media. They can be stored on extended object-relational or object-oriented databases, or simply on a file system.
- **World Wide Web:** The multimedia is becoming increasingly available on the World Wide Web which can be viewed as a large, distributed, multimedia database.

However the data is unstructured and heterogeneous. Data in the World Wide Web is organized in inter-connected documents (Manjunath T.N et al. 2010). These documents can be text, audio, video, raw data, and even applications.

IMPORTANCE OF CONTENT BASED IMAGE RETRIEVAL (CBIR)

In late 1990's, Content-based image retrieval was introduced by T. Kato. It has been used as an alternative to text based image retrieval. IBM was the first, who take an initiative by proposing query-by image content (QBIC) (HuiHui Wang,et al,2010).CBIR involves the following four parts in system realization: data collection, build up feature database, search in the database, arrange the order and results of the retrieval.

Image retrieval has been an extremely active research area over the last 10 years, but first review articles on access methods in image database appeared already in the early 1980s. The growing number of digital image acquisition and storage systems in clinical routine raises demands for new access methods. Still, most picture archiving and communication systems (PACS) only use textual information to access a patient's image data, which has been mainly entered manually. Content-based image retrieval (CBIR) depends on automatically extracted content-descriptions for each images as well as their storage and comparison upon a query. The vast majority of users do not want to retrieve images simply on the basis of similarity of appearance. They need to be able to locate picture of a particular type of object, phenomenon or event (Armitage,et.al,1997). He(Gudiva,et.al,1995) have drawn a useful distinction between retrieval by primitive image feature (Such as color, texture or shape) and semantic feature (such as the type of object or even depicted by the image) he (J.P.Eakins,et.al,1998) has taken this distinction further, identifying three distinct levels of image query each of which can be further subdivided.

Level 1: Retrieval by primitive features. Such as color, texture, shape (e.g. "Find all pictures containing yellow or blue stars arranged in a ring").
Level 2: Retrieval by derived attribute or logical feature. (e.g. "Find pictures of a passenger train crossing a bridge").
Level 3: Retrieval by abstract attributes (e.g. "Find pictures illustrating pageantry").

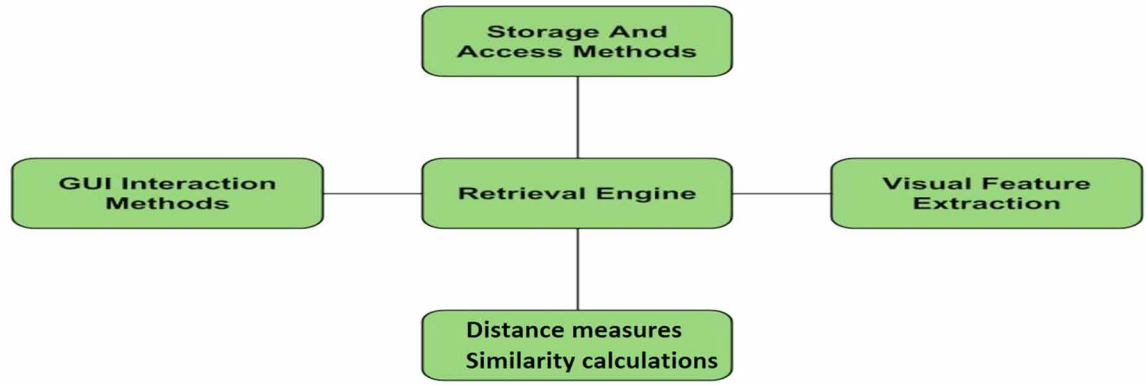
CBIR is important for the features employed by the image retrieval systems include color, texture, shape and spatial are retrieve automatically. Similarities of images are based on the distances between features.

Over the past ten years or so, significant progress has been made in making computers learn to understand, index, and annotate pictures representing a wide range of concepts. Image mining deals with the extraction of implicit knowledge, that is, image data relationship or other /patterns not explicitly stored in the images. Image mining is more than just an extension of data mining to the image domain. The cardinal role of image mining is to discover the means of an effective processing of low-level pixel representations, contained in a raw image or image sequence, to arrive at high-level spatial objects and relationships. (Amol P Bhagat et al.,2013) (R.Senthil Kumar,et al.,2013) The focus of image mining is on the extraction of patterns from a large collection of images. While there seems to be some overlap between image mining and content-based retrieval (since both deal with large collections of images), image mining goes beyond the problem of retrieving relevant images. In image mining, the goal is to discover image patterns that are significant in a given collection of images and the related alphanumeric data (Amol P Bhagat,et al.,2013) . The fundamental challenge in image mining is to reveal out how low-level pixel representation enclosed in a raw image or image sequence can be processed to recognize high-level image objects and relationships (Shadma Parveen et al.,2013).

Most of these systems have a very similar architecture for browsing and archiving/indexing images comprising tools for the extraction of visual features, for the storage and efficient retrieval of these features, for distance measurements or similarity calculations and a type of graphical user interface (GUI). This general system setup is shown in Figure 2.

Although early systems existed already in the beginning of the 1980s (N.S.Chang,et.al,1980) the majority would recall systems such as IBM's Query By Image Content (QBIC) as the start of content-based image retrieval (M.Flickner,et.al.,1995),(W.Niblack,et.al,1993). The commercial QBIC system is definitely the most well known system. Another commercial system for image (J.R.Bach,et.al,1996) and

Figure 2. The principal components of all content-based image retrieval systems



video (A.Hampapur,et.al,1997) retrieval is virage that has been well known commercial customers such as CNN. CBIR is an image search systems that search for image by image content (ie) Keyword-based Image/Video Retieval (eg) Google image search, YouTube.

TYPES OF CBIR BASED IMAGE RETRIEVAL

The need for the CBIR has extremely increased in many application areas such as medical, crime prevention, biomedicine, military, culture, commerce, education, entertainment, and also in web image classification and searching. Existing general purpose content based image retrieval systems roughly comes under these categories:

1. **Region-Based:** The Netra and Blobworld are two earlier region based image retrieval systems (P.Jayaprabha,et.al, 2012). During retrieval, a user is provided with segmented regions of the query image, and is required to assign several properties, such as the regions to be matched, the features of the regions, and even the weights of different features (Feng Jing,et.al, 2005).
2. **Object-Based:** Object-based image retrieval systems retrieve images from a database based on the appearance of physical objects in those images. These objects can be elephants, stop signs, helicopters, buildings, faces, or any other object that the user wishes to find. One common way to search for objects in images is to first segment the image in the database and then compares each segmented region against a region in some query image presented by the user (Derek Hoiem,et. al. 2004). Such image retrieval systems are generally successful for objects that can be easily separated from the background and that have distinctive colors or textures.
3. **Example-Based:** Users give a sample image, or portion of an image, that the system uses as a base for the search. The system then finds images that are similar to the base image.
4. **Feedback-Based:** System shows user a sample of pictures and asks for rating from the user. Using these ratings, system re-queries and repeats until the right image is found (Masashi,et.al, 2009).

CBIR METHODOLOGIES

CBIR system can be used in one of two ways. First, exact image matching, that is matching two images, one an example image and the other, image in image database. Secondly is approximate image matching, that is finding most closely match images to a query image provided. CBIR involves the following four parts in system realization: **Data Collection**, **Build up Feature Database, Search the Database, arrange the order** and deal with the results of the retrieval (NidhiSinghai,et.al,2010).

- **Data Collection:** Using the Internet spider program that can collect webs automatically to interview Internet and do the collection of the images on the web site, then it will go over all the other webs through the URL, repeating this process and collecting all the images it has reviewed into the server.
- **Build up Feature Database:** This system is based on indexing. Firstly we analysis the collected images, then extract the feature information. Currently, the features that use widely involve low level features such as color, texture and so on, the middle level features such as shape etc.
- **Search the Database:** The search engine will search the suited feature from the database and calculate the similar distance, then find several related webs and images with the minimum similar distance.
- **Process and Index the Results Index**: The image obtained from searching due to the similarity of features, then return the retrieval images to the user and let the user select. If the user is not satisfied with the searching result, he can re-retrieval the image again, and searches database again.

METHODS FOR FEATURE EXTRACTION

The different methods based on features are used to extract the images. The main features based methods are described as following:

1. **Color:** Color is the feature of content based image retrieval systems for retrieve the image. First a color space is used to represent color images. The RGB space where the gray level intensity is represented as the sum of red, green and blue gray level intensities (AmitKaul,et.al,2009). Variety of color spaces include, RGB, LUV, HSV (HSL), YCrCb and the huemin-max-difference (HMMD) (MicheleSaad,et.al,2008).Common color features or descriptors in CBIR systems include, color-covariance matrix, color histogram, color moments and color coherence vector . The Color Structure Descriptor (CSD) represents an image by both the local structure of the color and the color distribution of the image or image region.
2. **Texture:** The ntion of texture generally refers to the presence of a spatial pattern the has some properties of homogeneity (AmandeepKhokher,et.al,2011). Directional features are extracted to capture image texture information. The six visual texture properties were coarseness, contrast, directionality, line likeness, regularity and roughness.

Two classes of texture representation method can be distinguished:

- *Structural methods* including morphological operator and adjacency graph, describe texture by identifying structural primitives and their placement rules. They deal with the arrangement of image primitives, presence of parallel or regularly spaced objects.
- *Statistical methods* include the popular co-occurrence matrix, Fourier power spectra, Shift invariant principal component analysis (SPCA), Tamura feature, Multi-resolution filtering technique such as Gabor and wavelet transform, characterize the texture by statistical distribution of the image intensity.

Spectral approach is done by Fourier transform of an image then group the transformed data in a way that it gives some set of measurements.

3. **Shape:** Shape is also one of the important features of an image. Generally we can divided the shape into two categories, region-based and boundary-based. In the late years we just uses only the outer boundary of the shape while the current uses the entire shape region (AmitKaul,et. al,2009),(YongRui,et.al,99).

The most successful representatives for these two categories are Fourier descriptor and moment invariants.

1. **Fourier Descriptor:** The fourier descriptor is to use the Fourier transformed boundary as the shape feature. Some early work can be found. To take into account the digitization noise in the image domain, Rui et al. proposed a modified Fourier descriptor which is both invariant to geometric transformations and strong to noise.
2. **Moment Invariants:** The main motive of moment invariants is to use region-based moments which are invariant to transformations, as the shape feature. The Hu identified seven such moments based on his work. Many improved versions emerged in this method. Based on the discrete version of Green's theorem, Yang and Albregtsen proposed a fast method of computing moments in binary images. Some facts that motivated the most useful invariants were found by extensive experience and trial-and-error, Kapur et al. developed algorithms to systematically search and generate for a given geometry's invariants (Meenakshi Shruti Pal, et al.,2013).

APPLICATION OF CBIR IN MEDICAL

It is important to explain the needs and to discuss possible technical and methodological improvements and the resulting clinical benefits. The goal of medical information systems have often been defined to deliver the needed information at the right time, the right place to the right person. In order to improve the quality and efficiency of care processes, such a goal will most likely need more than a query by patient name, series ID or study ID for images. For the clinical decision-making process it can be beneficial or even important to find other images of the same modality, the same anatomic region of the same disease. DICOM headers have proven to contain a fairly high rate of errors. Take example as the field anatomical region, error rates of 16% have been reported. This can hinder the correct retrieval

of all wanted images. Clinical decision support techniques such as case-based reasoning or evidence-based medicine can even produce a stronger need to retrieve images that can be valuable for supporting certain diagnoses. It could even be imagined to have image-based reasoning (IBR) as a new discipline for diagnostic aid. Besides diagnostics, teaching and research especially are expected to improve through the use of visual access methods as visually interesting images can be chosen and can actually be found in the existing large repositories.

R.Senthil Kumar et al. (2013) shows how CBIR can be helpful in the Medical Application due to ever increasing image database. Digital images are produced in a huge amount by the Radiology, Cardiology, and by the Pathology departments. A need has been arisen to build a system which can handle such a huge number of digital images.

For the medical purpose, the system should deliver the right information to the right person in the right time. So, an efficient and accurate system is required to fulfill the need. According to this, CBIR can be successfully implemented in diagnosis of disease by retrieving similar images of the past cases. Also, CBIR is useful in other field like Teaching can be augmented with the CBIR. In research work the researchers have more options. The low level features (color, texture & shape) have been used for retrieval of the images.

There are also several other departments where CBIRs have been implemented. A categorization of images from various departments has been described. A classification of dermatologic images, cytological specimens have already been described. Pathology images have often been proposed for content-based access as the color and texture properties can relatively easy be identified. Within the radiology departments, mammographics are one of the most frequent application areas with respect to classification and content based search. The negative psychological effects of removing tissue for false positive patients have been described of one of the principal goals to be reduced. Ultrasound images of the breast are used. Another active area is the classification of high resolution computed tomography (HRCT) scans the lung as done by the Assert project. Magnetic resonance images (MRI) of the brain are used to demonstrate the image search algorithm. CT brain scans the search for medical tumors by their shape properties (after segmentation) have been described. Functional photon emission tomography (PET) images and spine X-ray are used for retrieval. Table 1 provides the brief view of various image and the systems that are using these images.

Table 1. Various image types and the systems that are using these images

Images Used	Names of the System
HRCTs of the lung	ASSERT
Functional	PET FICBOS
Spine X-rays	CBIR2
CTS of the head	MIMS
Mammographics	APKS

CURRENT ISSUES WITH CBIR SYSTEMS

The central problems regarding the retrieval task are concerned with "interpreting" the contents of the images in a collection and ranking these according to the degree of relevance to the user query. This 'interpretation' of image content involves extracting content information from the image and using this information to match the user's needs. Knowing how to extract this information is not the only difficulty; another is knowing how to use it to decide relevance.

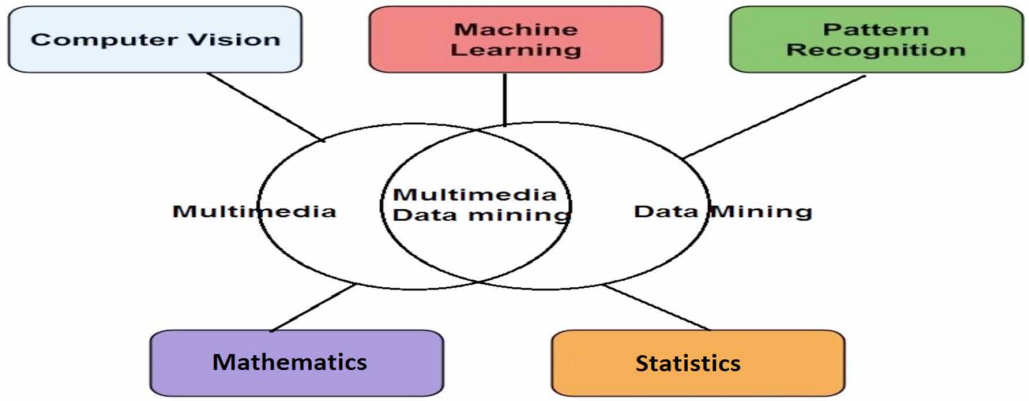
The decision of relevance characterizing user information need is a complex problem. To be effective in satisfying user information need, a retrieval system must view the retrieval problem as 'human-centered', rather than 'computer-centered'. In a number of recent papers, (Shadma Parveen, et al., 2013), (R.Senthil Kumar et al., 2013), (Ramadass, 2013), (Meenakshi Shruti Pal et al.,2013) an alternative to the computer centred predicate was proposed. This new approach is based on a human-computer interface which enhances the system to perform retrieval tasks in line with human capabilities. The main activities in this approach consist in analyzing a user's goals from feedback information on the desired images, and adjusting the search strategy accordingly. Here, the user manages the retrieval system, via the interface, through the selections of information gathered during each interactive session, to address information needs which are not satisfied by a single retrieved set of images.

The human-computer interface has been less understood than other aspects of image retrieval, partly because humans are more complex than computer systems, since motivations and behaviors are more difficult to measure and characterize. Recently, studies have been conducted to simulate human perception of visual contents via the use of the supervised analysis method. "Themes" are derived from similarity functions through the assignment of numerical weights.

DATA MINING IN CBIR

Multimedia database systems store and manage large quantities of multimedia data sets such as audio, video, images, graphics, sounds, text, documents and hypertext data. This multi-media information does not have a uniform structure and a unified approach. Multimedia data is usually multi-dimensional and unstructured or semi- structured, with each medium having its own characteristics, its own way of presentation of information (Nandish Chauhan,et al. 2013) . Apart from presenting information independently, each medium can also express a different characteristic of the same event, so that the media taken together describe the existence, development and result of an event in its entirety. So, there have to be features of information, attributes and the relationships in multimedia data sets that are not within our intuitive grasp. Multimedia data mining (Figure 3) involves intelligent data analysis, aimed at finding these features, attributes and relationships in order to construct models for making decisions, taking countermeasures and achieving fusion analysis. "Based on the data stored in them, multimedia databases are used in content-based image retrieval, sound delivery system, video on demand system, World Wide Web and identifying the password command voice based user interface, etc. Multimedia Mining focuses on the following five fronts: Image Mining, Video Mining, Audio Mining, Web Mining and Multi-Media Integrated Mining. Image mining involves the introduction of data mining technology into the image field of study, to discover the information and knowledge hidden in a large quantity of image data. It is the process of identifying hidden, valid, novel, potentially useful, and ultimately understandable semantics of information and knowledge from extensive image data"(Nandish Chauhan et al.,2013).

Figure 3. Multimedia data mining



The typical data mining process consists of several stages and the overall process is inherently interactive and iterative. The main stages of the data mining process are (1) Domain \understanding; (2) Data selection; (3) Data pre-processing, cleaning and transformation; (4) Discovering patterns; (5) Interpretation; and (6) Reporting and using discovered knowledge (Amol P Bhagat et al,2013).

DATA MINING

Data mining, the extraction of hidden predictive information from large databases, is a powerful new technology with great potential to help companies focus on the most important information in their data warehouses. Data mining tools predict future trends and behaviors, allowing businesses to make proactive, knowledge-driven decisions (Gaurav et al.,2014). The automated, prospective analyses offered by data mining move beyond the analyses of past events provided by retrospective tools typical of decision support systems. Data mining tools can answer business questions that traditionally were too time consuming to resolve. They scour databases for hidden patterns, finding predictive information that experts may miss because it lies outside their expectations.

Most companies already collect and refine massive quantities of data. Data mining techniques can be implemented rapidly on existing software and hardware platforms to enhance the value of existing information resources, and can be integrated with new products and systems as they are brought online (Gaurav et al.,2014). When implemented on high performance client/server or parallel processing computers, data mining tools can analyze massive databases to deliver answers to questions such as, "Which clients are most likely to respond to my next promotional mailing, and why?"

Data mining techniques are the result of a long process of research and product development. This evolution began when business data was first stored on computers, continued with improvements in data access, and more recently, generated technologies that allow users to navigate through their data in real time. Data mining takes this evolutionary process beyond retrospective data access and navigation to prospective and proactive information delivery. Data mining is ready for application in the business community because it is supported by three technologies that are now sufficiently mature:

- Massive data collection.
- Powerful multiprocessor computers.
- Data mining algorithms.

Commercial databases are growing at unprecedented rates. A recent META Group survey of data warehouse projects found that 19% of respondents are beyond the 50 gigabyte level, while 59% expect to be there by second quarter of 1996.1 In some industries, such as retail, these numbers can be much larger. The accompanying need for improved computational engines can now be met in a cost-effective manner with parallel multiprocessor computer technology. Data mining algorithms embody techniques that have existed for at least 10 years, but have only recently been implemented as mature, reliable, understandable tools that consistently outperform older statistical methods.

In the evolution from business data to business information, each new step has built upon the previous one. For example, dynamic data access is critical for drill-through in data navigation applications, and the ability to store large databases is critical to data mining (Gaurav et al.,2014). The core components of data mining technology have been under development for decades, in research areas such as statistics, artificial intelligence, and machine learning (Gaurav et al.,2014). Today, the maturity of these techniques, coupled with high-performance relational database engines and broad data integration efforts, make these technologies practical for current data warehouse environments.

DATA MINING TECHNIQUES

The most commonly used techniques in data mining are:

- **Artificial Neural Networks**: Non-linear predictive models that learn through training and resemble biological neural networks in structure.
- **Decision Trees**: Tree-shaped structures that represent sets of decisions. These decisions generate rules for the classification of a dataset. Specific decision tree methods include Classification and Regression Trees (CART) and Chi Square Automatic Interaction Detection (CHAID).
- **Genetic Algorithms**: Optimization techniques that use processes such as genetic combination, mutation, and natural selection in a design based on the concepts of evolution.
- **Nearest Neighbour Method**: A technique that classifies each record in a dataset based on a combination of the classes of the k record(s) most similar to it in a historical dataset. Sometime called the k-nearest neighbour technique.
- **Rule Induction**: The extraction of useful if-then rules from data based on statistical significance.

Many of these technologies have been in use for more than a decade in specialized analysis tools that work with relatively small volumes of data. These capabilities are now evolving to integrate directly with industry-standard data warehouse and OLAP platforms.

USAGE OF DATA MINING TECHNIQUES TO DEVELOP CBIR

Researchers have worked on developing such CBIR systems. (Nishchol,et.al,2011) He proposed a CBIR System named STIRF (Shape, Texture, and Intensity-distribution with Relevance Feedback) that uses a neural network for nonlinear combination of the heterogeneous STI features. Further for the different applications and users based upon relevance feedback. Prior to retrieval of relevant images, each feature is first clustered independent of the other in its own space and this helps in matching of similar images. Testing the system on a database of images with varied contents and intensive backgrounds showed good results with most relevant images being retrieved for a image query. The system showed better and more robust performance compared to existing CBIR systems. Keywords: Multimedia Data Mining, Image Mining, Content Based Image Retrieval, Multimedia Information retrieval.

In Enhanced Multistage Content-based Image Retrieval (Nandish Chauhan,et al. 2013) explained that Search criteria is based on three-layer feed forward architecture. First layer consists of comparison of color feature, the second layer consists of comparison of texture feature and the last is comparing of shape feature.

In Web Based Image Retrieval System Using Color, Texture and Shape Analysis Comparative Analysis (Amol.P.Bhagat et al,2013) research work shows the client-server functionality, searching images without any compatibility issue. For the retrieval of images, primitive features images have been used. The working principle of various systems like QBIC, Netra Image Management System, and Kingfisher has been explained. In Sketch4Match - Content-based Image Retrieval System using sketches, it is explained that Human is a visual type (Shadma Parveen et al.,2013). The human can recall the visual information more quickly than the textual information since the text is the human abstraction of image. In this paper a user interface is proposed with some drawing area in which the user draws a color sketch or a blob. Features of the color sketch are extracted. The extracted features are matched with the features of stored image and on the bases of similarity matching the images are retrieved. A further refinement process can be employed until get the desired result.

The Content Based Image Retrieval System (CBIR) (H. R. Kang,et.al,1997) is based on the visual content of the Image. Desirable features can extracted based on the visual content of the Image. The development of the Image Mining technique is based on the Content Based Image Retrieval system. Colour, texture, pattern, image topology, shape of objects and their layouts and locations within the image, etc are the basis of the Visual Content of the Image and they indexed. The Several features that are used in the Image Retrieval system are the following. The popular amongst them are colour of the Image, What is the Texture, The Contours i.e. (shape), image topology, on which layout or the Background is Image depicted, region of interest etc.

Colour Features: One of the features that are used is the colour of the Image, since it has very strong co-relation with the underlying objects of the Image. The colour of an Image is very robust to background, orientation, scaling and texture of the Image. In the terms of Digital Imagery the Colour Pixels is the Combination of (RED, BLUE and GREEN). It is well known fact that any colour combination of these three colours can produce any colour. The HSV colour space is depicted below, because that is widely used in the CBIR community. The Red, Blue and Green pixels can be considered as r, g, b and holds in the range of closed intervals [0, 1] and these normalized values r, g, and b are used to transform into the HSV space. Transformation of RGB to HSV colour space can be accomplished by the following set of equations [1]: $V = \max(r, b, g)$

Colour Histogram: The overall distribution of colours can be done with the help of Colour Histogram which is the basis of characterization of the Image. Color histogram is a representation of the distribution of colors in an image. For digital images, a color histogram represents the number of pixels that have colors in each of a fixed list of color ranges that span the image's color space, the set of all possible colors. The color histogram can be built for any kind of color space, although the term is more often used for three-dimensional spaces like RGB or HSV

Colour Coherence Vector: The colour coherence vector-based (G. Pass, et.al, 1996) approach was designed to accommodate the information of spatial colour into the colour histogram. Here we can classify each pixel in an image, based on whether it belongs to a large uniform region or not. For example, we can consider a region to be uniformly coloured if it consists of the same colour and the area of the region is above a certain threshold (say, 2%) of the whole image area. We refer to the pixels in these regions as coherent pixels.

Texture Features: Texture is a very interesting image feature that has been used for characterization of images, with application in content based image retrieval. A major characteristic of texture is the repetition of a pattern or patterns over a region in an image. The elements of patterns are sometimes called textons. The size, shape, colour, and orientation of the textures can vary over the region. The difference between two textures can be in the degree of variation of the textures. It can also be due to spatial statistical distribution of the textons in the image. Texture is an innate property of virtually all surfaces, such as bricks, fabrics, woods, papers, carpets, clouds, trees, lands, skin, etc. It contains important information regarding underlying structural arrangement of the surfaces in an image. When a small area in an image has wide variation of discrete tonal features, the dominant property of that area is texture. In this method the co-occurrence matrix is constructed based on the orientation and distance between image pixels. Meaningful statistics are extracted from this co-occurrence matrix, as the representation of texture. Since basic texture patterns are governed by periodic occurrence of certain Gray levels, co-occurrence of Gray levels at predefined relative positions can be a reasonable measure of the presence of texture and periodicity of the patterns. Using this co-occurrence matrix, the texture features metrics are computed as follows (R. Jain,et.al,1995).

TECHNIQUES USED IN MEDICAL IMAGE RETRIEVAL

The various techniques that are currently – used or that have been proposed for the use in medical image retrieval applications.

Query Formulation: Most systems in CBIR use the query by example (s) QBE paradigm which needs an appropriate starting image for querying. This problem of a sometimes missing starting image is known as the page zero problems. If text is attached to the images then the text can be used as a starting point. The starting point does not need to be further defined but the images of the case can be used directly. The use of sketches has already been proposed in generic image retrieval and it has also been proposed for the use in medical applications. Consisting the difficulty in exact drawing and the need for some artistic skills and time, this method will only be applicable for a very small subset of queries, such a tumor shapes or spine X-rays where outline are possible directly in the images (R.Senthil Kumar et al., 2013). For general image retrieval sketches are too time consuming and the retrieval results often not exact enough.

Text: Many systems propose to use text from the patient record or studies to search by content. The use of text for queries is undeniable efficient. The combination of textual with visual features or content and context of the images does have the most potential to lead to good results. Besides the free text that is frequently used for retrieval, medical patient records also contain very valuable structured information. Such as age, sex and profession of the patient. This information is just as important as free text to put the images into content (R.Senthil Kumar et al., 2013).

CONCLUSION

In recent years there has been tremendous growth in the quality (resolution and color depth), nature (dimensionality) and throughput (rate of generation) of the images acquired and this trend of upward growth is likely to continue. This poses ever changing challenges to image retrieval research. With the advent of very large-scale images (e.g., Google and Yahoo!, Facebook, LinkedIn, Flicker), and high resolution, high dimension biomedical and astronomical imagery, often captured at high throughput, image retrieval research faces an immediate challenge of incorporating the ability to make high resolution, high-dimension, and high-throughput images searchable by content. Meanwhile, we do hope that the quest for a robust and reliable image understanding technology will continue. Together these will constitute the agenda for future research. The future of CBIR will depend on the progress made in each aspect of image retrieval, and the extent to which the individual user benefits by it.

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Chapter 23
Serendipity on a Plate

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ABSTRACT

This article will present and discuss the design thinking, methods, processes and some examples of work that demonstrates how, together with different co-creators, one sets up a work practice using digital 3d objects and images. That in different ways and formats helps us to explore how a database, a set of rules can be used in a dialogue with artistic work practice and how such a process can be used to create images and animation in a variety of design and art projects. The main example is a project called Conversation China that still is in its making, here one works with rather complex processes, involving several digital analogue techniques as the basis for creating the images for a 150 pieces porcelain dinner set. The author's interest in this work is how the intention of the artist or designer is transferred and later embedded in the procedural or algorithmic process and how this intent is organized and set up to secure an desired outcome, mixing the possibilities of the digital media object with manual editing and artistic craftsmanship. What this article tries to put forward is how we designed and set up environments for working with non linear and procedural media, their different expressions and forms by using explorable prototypes and design thinking?

FOUR PROJECTS

Already in early 90's when I worked with a Swedish company Advisors to improve visual representations in a virtual reality setting for cognitive therapy using advanced computer graphics system provided by Silicon Graphics and Softimage. I became familiar with the visual qualities and rendering techniques of virtual objects and 3d worlds. During these experiments I became interested in how to put together different 3d objects from a database into complex spatial configuration to improve the overall immersion and of the virtual world itself. In this process, errors in compiling the different objects created stunning visual results and led me into creating a system for randomly explore a limited database of 3d objects. The project was called VET, Vacuum Extropia Theory. The project was supported by the Swedish art council and presented at an exhibition. In VET the idea was by animation, cluster different 3d objects and use a virtual camera to automatically explore 3d environments and worlds (see Figure 1), in theory,

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Figure 1. Image vsfär 197 from VET

algorithms are repeatable and should produce identical results every time, but by stressing implementation and limitations of software and the computer itself I intentionally caused and looked out for errors and flaws that produce interested visual expressions.

Boom

At that time the tools still where very simple and the different outputs from the computer where limited. I could clearly see that the software I used, and still do could produce good visual results, but to achieve the kind of complexity I was looking for I knew I had to be patient and to spend time to build all the models I needed. So in parallel I started to write scenarios and simulate various computer programs never written, as a ground for visual exploration in a series of paintings

Here you can manufacture a world for its future inhabitants in a couple of hours, since it will not take you any longer to enter BOOM into your computer. In the years to come the program will undoubtedly have a great influence, especially upon the thinking and lifestyle of man. The principal reason for this is the fact that the concepts and methods of the program are so tantalizing and accessible. What you do is that you provide a data memory with a set of facts, and then you load this memory with mathematical data. There are an infinite number of parameters to set for the user. Everything from the way in which the cholesterol level of a certain president will develop during a certain period of time to the background radiation of the universe.

Abadyl

The city of Abadyl has been described and written about in several articles and papers before, and is today my main art project where I conduct most of my work. The city of Abadyl is created and constantly re-generated by using the lack of information as a resource for worldmaking. By providing ambigu-

ous fragments as a starting point, it serves as a vital part in the creation of a space where we can be in a constant dialogue with, a large database of material that is interlinked through the architecture of a city, regardless of its incompatibilities. That space is a continuously evolving platform for staging both immediate and long-term projects. The method establish a multidisciplinary common ground for a art practice, interaction design and technology development, through an investigation of philosophy and criticism in a dynamic material. The approach is to create an environment which facilitates artistic work practice in complex production environments such as those of digital media, supporting invited artists, researchers, companies, and students. We establish a ready-made, fictitious gravity well that others can easily transfer their knowledge into. Abadyl is all about using a generative logic that both limits and expands creativity (Boden, 1997). The fundamental parameters of this logic guide what can and cannot be included in a fictional but plausible universe. Our concern is not so much with a consistent, watertight universe, but rather what can be generated inside a framework of a large number of predetermined real and fictitious parameters.

Endgame

Endgame is a storytelling game using the 100 different objects that is included in the framework of the city of Abadyl (see Figure 2). Establishing a game setting similar to fragmented storytelling, often used in games such as Bioshock. Here the players must find fragments during the progression of the game and piece them together by writing short stories. In End Game the objects become constraints and the foundation for the players to fill in the gaps. Endgame attempts to as pointed out before to understand and redefine our world in a situation where information is lacking. This lack of information is used as a

Figure 2. Endgame

resource. To help our co-creators in End game and later in Conversation China we borrowed the dramatical model from Joseph Cambell and Christoffer Vogler to secure a narrative progression. (Campbell, 2004; Vogler, 2007)

The human dilemmas in that Campbell's captures in his hero's journey structure are conditions that always will have relevance. So if one instead look on the hero's journey as a series of dilemmas that we through our human condition constantly face, we have a series of situated action that can be represented over and over again and still be relevant to us, in understanding our human endeavours. Each part has one of the objects name written on one side and a coloured patterns on the other. With one word of an object written on top of it, and a coloured pattern on the back side. It also contains 100 notes card where the story fragments are written during play, and 100 action card which have the players exchange/steal/loose story fragments. In the end each player tell their gathered story and the best story is chosen by voting amongst the players, that story is put into the log book of the game itself. Afterwards all of the story fragments created will used to create a new collective story based on the story fragments of choice.

Design Thinking

One of the central question in all of the past project described is:

What if you know all of the facts and parameters used in a project, how can they still help producing unforeseen and surprising outcomes?

To be able to answer this and at the same time take full advantage of the digital media object there are some important ingredients that must work and play together. First we have to ask ourselves how do we use digital media object as a "design material"? Digital materials are usually more complex and flexible, less transparent and tangible. But above all, it is more cumbersome to learn and produce than most realize. So I believe that increased complexity in creative development calls for both disciplinary depth and integrative skills. Secondly I adopt the mindset that the primary result of a design process is not only a design concept, but the knowledge acquired during the process, knowledge which can in turn be applied to produce a concept.

The design process can thus be viewed as a process of learning. Knowledge acquisition in the space of the unknown entails a design process based on knowledge acquired through phenomena such as luck, uncertainty and chaos, ambiguity and surprise. Our strategy that we already developed in 2008 was to create new perspectives that put traditional roles of production and research in the area of digital media objects aside to better bridge and mix the different professions in new ways. (Lundh, 2008) The overall goal with this set-up or approach was to look at how we can build a narrative and interactive framework, and create a testing and production environment for the different projects we are working on. We also saw a need to develop a format for creating and sharing knowledge in-between different professions and stakeholders in this process – from tests through rehearsals and prototypes into the finished productions, so the co-creators and participants could work closer together exchanging knowledge and experiences between a broad range of discipline, to support the quest for a surprise somewhere in between databases, artistic intentions, algorithms and narratives.

Design Fiction

The past two years I have in different constellations tried to map out a model that helped us reached the fold of the known and into unknown territory, not only as a theory but as a design practice, and also make a contribution to the area of Design Fiction. As artists and designers in particular we have the nature and nurturing to explore, create, and tell stories about possible worlds. Design has its roots in the application of artistic discipline to the engineering of technology, in the form of pattern making for mass production, and as styling for product marketing. Later, design has come into its own as a creative discipline and an origin of innovations rather than only something slapped onto existing ones. Design is one activity of creating the future, not solving old problems as much as inventing new opportunities, still with strong ties to empirical science and engineering but also with the story telling of branding and marketing. In parallel, industries and design have evolved from producing products, to services, and recently to experiences, expressing basic human tenets to create and tell stories. This of course is at the core of fiction, helping us make sense of what it means to be human, how to plan and live our lives, and to find some purpose behind our journey. Science fiction expands on this in a speculative and perhaps ultimate manner, leaving our known world to verge into the fringes of the unknown and beyond.

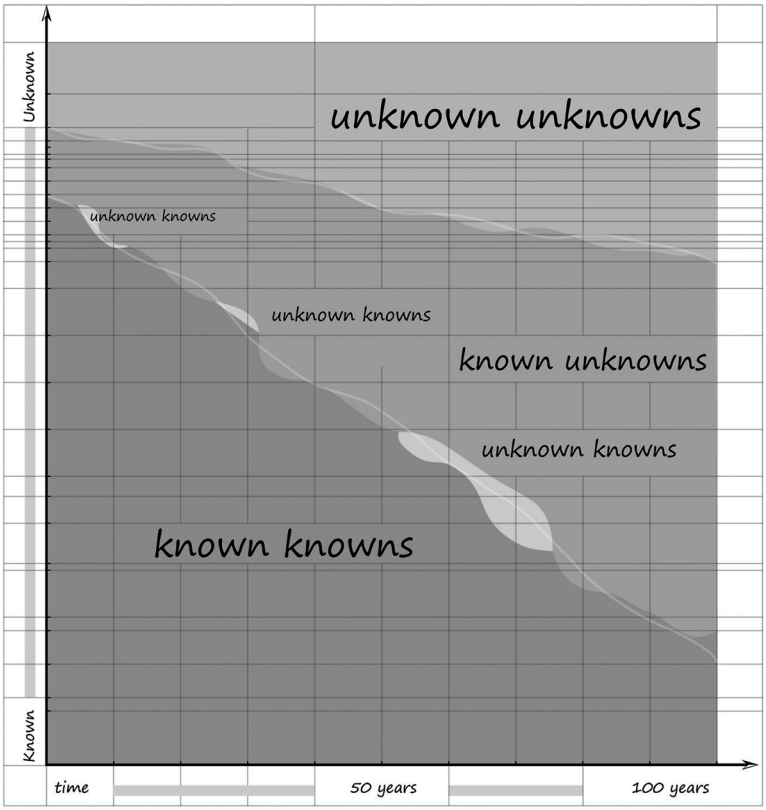
Design fiction as the notion of the "conflation of design, science fiction, and science fact" (Bleeker, 2009) is interesting then as a space of tension and entanglement between what is and what could be. In design fiction we have the space to apply design to science fiction, or science fiction to design. For example, methods like scenario planning used by futurologists have been borrowed by science fiction writers to extrapolate from the present into the future. Industrial designers working in the Detroit automotive industry have not seldom ended up designing spaceships for Hollywood, while researchers in aerospace technologies or ubiquitous computing have also consulted for science fiction movie productions. And there is a long history of science fiction influencing innovations, attitudes and values in our own, real worlds. The emergence of design fiction is one sign of this interplay being acknowledged and appreciated as having a potential for experience design in general. One question is then how to actually work in practice in this space of tension and entanglement between science fact and science fiction, and especially how to encourage the use of science fiction in design, away from derivative, predictable output and towards speculation and tinkering based on the opportunities afforded by the unknown (see Figure 3).

The Database as Material

With all of the above described project it is clear that by trying to combine different digital media objects, mostly 3d objects in the computer and then translated them into physical objects in a constant feedback loop of production, the use of technology is not only that of the tool. Because electronic and digital media have also raised consciousness of an incidental flux in our culture where cultural production combines fragments, dislocates them and re-combines again. The concept of sampling takes its older relative the montage some giant steps further. Montage is a kind of juxtaposition where you disrupt elements to put them in new combinations, the sampling technique works on a more genetic level (Johansson & Linde, 2004). Since all media objects share the same foundation (Manovich, 2001) it is therefore possible to mix them on many different levels.

Here the digital media object can challenge ideas from the physical way of working with qualities that is very hard to achieve in the physical world with physical tools, and in that conflict new expressions can be developed. Hybrid creations have become a method for working with cultural production

Figure 3. Epistemological model of the universe. Copyright Michael Johansson and Kristoffer Åberg, progression over time borrowed from Stross, C. (2013).



not only with different elements of form and how these are generated, but also blending the identities of the creators as well. So there is a demand that challenge their differences and incompatibilities rather than merging them together into one. And by letting them evolve in different media and materials the final hybrid will host an interesting comprehension of different perspectives. Lev Manovich idea of the database as something that "represents the world as a list of items and it refuses to order this list", is an intriguing challenge. Digital media objects just dwelling around waiting to be accessed and ordered, when someone wants to use the databases for making a statement, demonstrate a perspective or telling a story.

Is there a conflict between database and narrative? Or is it the different representations used when a user by interface and interaction extract the bits and pieces from a database by constantly link them together into sequences that are fundamental different, that are more spatial than narrative in its execution?

The "user" of a narrative is traversing a database, following links between its records as established by the database's creator. An interactive narrative can then be understood as the sum of multiple trajectories through a database. A traditional linear narrative is one, among many other possible trajectories; i.e. a particular choice made within a hyper-narrative. (Manovich, 2001)

For an artist or designer to work with databases the question to ask is how to design the trajectories through a database and what kind of representation to use to make them present and by doing so create user engagement playing with the parameters. What kind of Interaction Gestalt (Lim, Stolterman, Jung, & Donaldson, 2008) is needed. "In this regard, the challenge here is to create a language that helps a designer understand which attributes are to be considered in order to create a certain gestalt that in turn will result in desired user experiences." Artist working with digital media should take this into account when they plan and execute the order of the elements when inviting someone to co-create an image, a sequence of movie-clips in a film or how 3d models are explored and/or compiled into a navigable and interactive space for further explorations. Similar to (Certeau, 1984) idea about Spacial Stories, Our approach is to by representation facilitate possible trajectories through our database, and let the co-creators and participants move and interact with our framework and maps of Abadyl and have them create different outputs as performative acts in which they can become the storymaker.

For a single artist or even for a small group of people this is a demanding and time consuming activity that needs both experience and planning. Our strategy has always been to develop our content in open and generic file formats so it won't be captured in a certain generation of technology, and to secure that the developed material is not restricted in use of a single software. The content also has to be manually or machine wise analysed and then meta tagged in order to call for their attributes and fit them into a specific sequences and/or formations that match the intended use and at the same time host something surprising both in relation to form and content. So every time a search in the database is done and an artwork recreated it will be different because the underlying model, it´s objects and the characters have changed and will be recreated, expressed and re-represented again.

By trying to establish a friction between the personal and dynamic way in which people experience moving and interact through space in a daily life, and how our framework, maps and scenarios support a similar act, and at the same time have the co-creators develop and alter the parameters of the maps and scenarios themselves. The framework of Abadyl can be looked upon as a place of static objects where each co-creators have each their subjective input that create a flux and friction in which the lifeless and abstract place can come alive and become an animated, changeable and concrete space. Which literary scholar Mieke Bal defines as follows: it should contain both an actor and a narrator; it also should contain three distinct levels consisting of the text, the story, and the fabula; and its "contents" should be "a series of connected events caused or experienced by actors or the procedural compiling it." (Bal, 1997). Since Abadyl in itself is not a text based project, that like hypertext try to establish different possible trajectories through a database of text by hyper-links. We have instead borrowed a generative logic, a logic that both limiting and expanding creativity amongst the co-creators. We have chosen to focus more on the generative itself in this logic; using 3d objects stored in a database, rules and procedural models to put together the different 3d objects into new assemblages/hybrids and interaction procedures to let co-creators and audiences interact with the construction of the Abadyl framework and at the same time explore and experience its parameters that we made present for the co-creators. It is not about these parameters resulting in a watertight consistent universe, but the main interest is in what can be generated from a number of predetermined accessible parameters. To be able to fully make us of a database it must first host relevant content that also needs to be created and adjust to fit a certain project ideas and intentions.

Walk Your Talk

An examination of the functions of intention in the making of art begins with the contrast between inspirationist and rationalist perspectives on artistic creativity. Intentions are necessary to art-making and are linked to the assumption that a work of art is always evaluable in terms of one kind of potential artistic value—artistry or virtuosity. Intentions are linked to artists' projects, to the distinction between complete and incomplete works of art, as well as to the several senses of 'fragment' in critical discourse. (Livingstone, 2005)

Creativity is often looked upon as a value separate from process or method. But creativity detached from the rendering of an intentional outcome is meaningless. For the artist as well as the designer, creativity is a 'tool' with a purpose. It is therefore subordinated the artist's intentions and ideas. One tends to forget that the actual realization of the artwork in a specific material often is a very monotone and demanding process, and also context specific. Therefore, the artist soon learns how to handle the time frame between idea and completion – as well as the importance to spend time there. The finished artwork will then signal creativity precisely because it has managed to bridge the uncertain space between idea and completion, and because of that, has not given up the artworks intentions, and established the necessary friction that makes creativity spark.

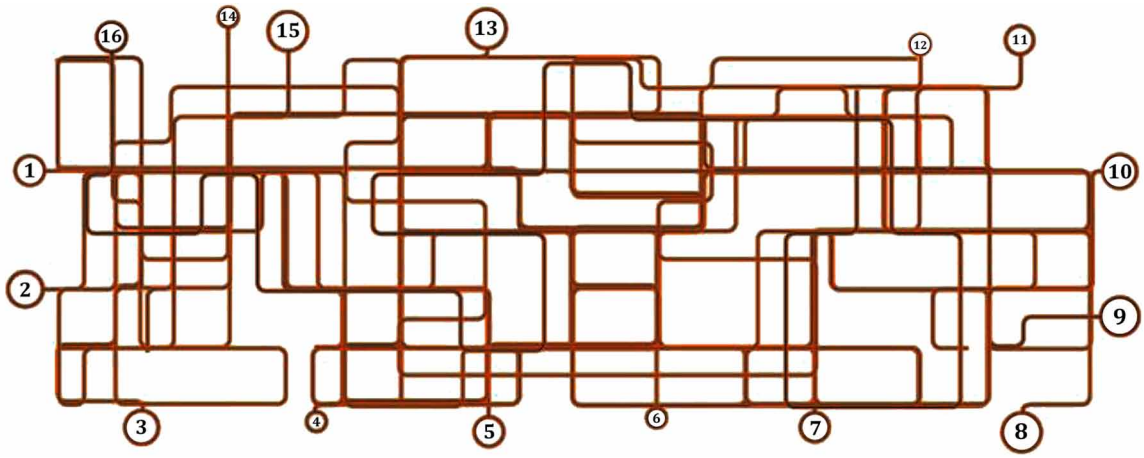
Conversation China

In 2008, I started collaborating with my friend and colleague Gertrud Alfredsson around sixteen stories based on everyday heroes in the City of Abadyl. The purpose was to use them as the basis for creating the images for the porcelain dinner set, that all in all will be 150 pieces, and later explore them in a series of dinner events to evaluate their ability to spark conversation around a dinner table with invited guests. Using the Abadyl Partitur we sent in sixteen fictitious heroes into it. The rules was that each character had to "hit" 23 objects and that the objects should be hit and crossed by at least one hero and that each object never would be used more than five times. We also made a rule that during the process informed us which objects the heroes could use, based on the characters movement, into something we called story routes. All of these story routes was developed into a specific dilemma for each hero and scenarios written based on the journey that each hero managed their way through. The story routes established a kind of mental map that enable us (me and the co-creators) to explore and transform Abadyls and our own conceptual spaces in imaginative and new ways, and in the end a series of stories about sixteen characters life's and dilemmas in the city of Abadyl. So for the first time we had someone walking the streets of Abadyl (see Figure 4).

Game the Rules of Play

Conversation China was the first project in Abadyl that fully challenged and used that framework, influenced by the artists and Architects that will be mentioned later in this part. By doing so, also affected how this framework could be further developed and redesigned. If one look at Abadyl as a sort of conceptual space (Boden, 1997), a latent unprecedented space, that by exploring it through different methods and processes in cooperation with others in a constant feedback loop it changes its way of working as well as its presence. It is important that our framework is so open that we can influence it and use it in different

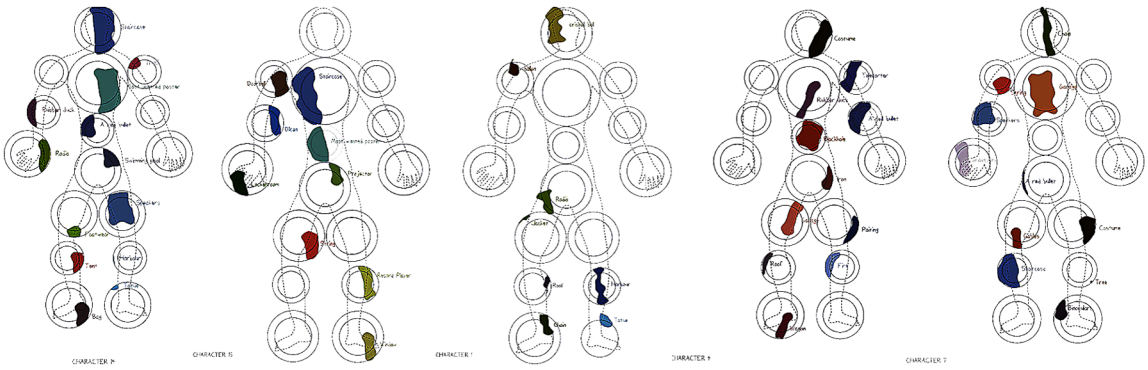
Figure 4. The final sixteen storyroutes created in collaboration with Gertrud Alfredsson



ways again and again by the use of the generic file formats of the content in our database. By constantly be able to change and manipulate our underlying model, game the rules of play, we can better define our final and intended outcome of the project itself. In conversation china most of the initial work were carried out on printed paper, following a set of instructions. Each session let the co-creator connect the city of Abadyl's objects into story routes. By playing with Abadyls framework in the conversation china project it will sometimes expose itself inconsistent, the conceptual constraints captured in the three numbers 7, 16 and 100 become elastic and therefore cannot serve as absolute constraints any more. So by consequence they have to be pinpointed back in new position where they can continue and maintain their autonomy and still be backward compatible.

Something that also have a significant influence on each plate in the dinner set is that each plate is a part in an overall structure, Figure 5. So by combining the plates one could actually create several different characters, this was achieved by introducing a combination of thin lines and an array of distortions of the patterns and main images, but also to break up the traditional structure of patterns and main images, as they were under influence of something else.

Figure 5. Lines and distortion layout on characters



This process also made help us specify the sixteen heroes on a very specific parameter, the length of them.

To be able to both set up and play with the rules at the same time adds an additional level of design thinking. Similar to the parametric and procedural playfulness described in Pamphlet Architecture 27 Tooling (Aranda & Lasch, 2005).

A complex global pattern arises as a result of many individual entities acting independently of one another, and according to a very simple set of local rules…

Changes the underlying model of the world, and add new objects and methods without having to completely rewrite the code…

Be able to run multiple scenarios, based on different assumptions and focusing different aspects of the underlying simulation…

Change parameters within a scenario, and to replay a scenario with a clear indication of what factors are held constant across runs…

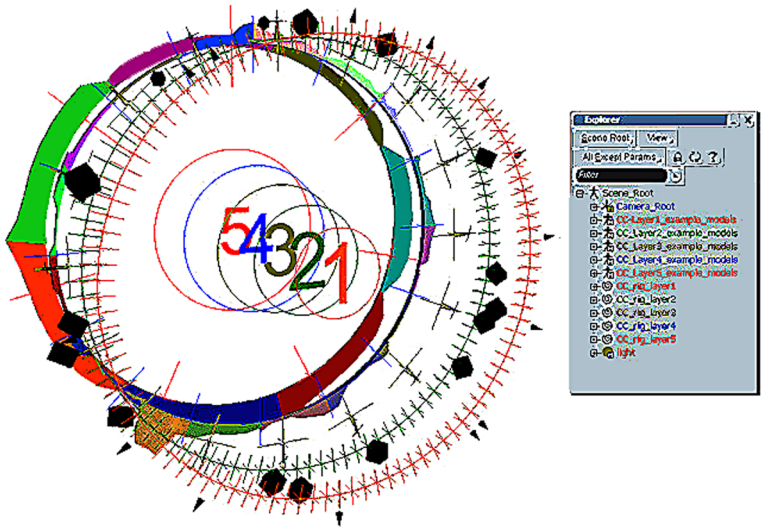
This flux should be seen as a possibility because if some of the parameters are changed so it will not be backward compatible there is an opportunity to run some scenarios of the former projects again and find out new things in relation to both that scenario, project and Abadyl itself. Abadyl should be seen as something that is constantly regenerated and that constantly incorporate it owns memories, findings and experiences and therefore never will be exactly the same. It is a constant dialogue between Abadyls framework, its constraints and the findings in this environment that also shapes itself through this work over time:

Furthermore if worlds are as much made as found so also knowing is as much remaking as reporting. All the processes of worldmaking I have discussed enter into knowing. Perceiving motion, we have seen, often consists in producing it. Discovering laws involving drafting them. Recognizing patterns is very much a matter of inventing and imposing them. Comprehension and creation go on together

We made up and found our world in the conversation China project as a work practice by using ideas and concepts from art and architecture. So on the conceptual and programmatic level Sol Lewitts' statement "The idea becomes a machine that makes art." was central for us and many others as a way to generate art and capture its execution in a concept, a scenario or a script. In the conversation China the "machine" was the 3d rig we built that layout the sevens scales of the objects accordingly of décor on the different porcelain plates and objects (see Figure 6):

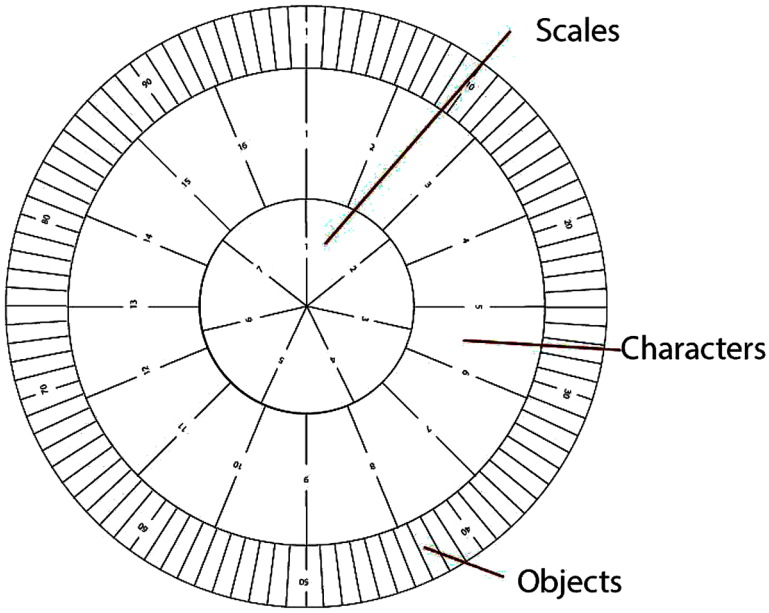
1. Environment.
2. Building.
3. Room.
4. Furniture.
5. Tool.
6. Interface.
7. Idea.

Figure 6. 3d rigg built in Softimage and link to databse using ICE and Python script



To strengthen qualities in the digital media object we borrowed a programming idea from Berhard Tschumi that formalized an aspect of generative logic to enhance new combinations or other relationships (see Figure 7) (Tschumi, 1991). A description how the different layers of 3d objects should be treated as 3d and also as rendered images, in a combination of Boolean operands and virtual camera filtering

Figure 7. By turning the different part of the rig based on the numbers 7, 16 and 100 the rig can produce many different expression for each character's dilemma



and post-production techniques. His work outlines a method which operands we have used before for multiple combinations and substitutions that exist simultaneously, including the following three concepts:

- **Cross-Programming:** The use of a space not as intended;
- **Trans-Programming:** The combination of disparate programs;
- **Dis-Programming:** Disparate programs that contaminate each other. These operations offer possibilities of combinations and permutation of existing programs as well new programs.

As the artist Mark Tansey we are not interested in "doing pictures of things that actually exist in the world. The narratives never actually occurred." (Danto, 1992). We are instead interested in visually combining disparate 3d models from our database into monochrome decors and images that will be rather complex, mystic or surprising in its presence. Similar to Tanseys term "technophor" a metaphorical technique for connecting subject matter and ideas. But going from static 3d models into action also needs to be addressed in a project like this. Therefore we built a underlying structure based on motifs, oppositions and problem that by combination of the different 3d model could create and pose the main characters on the plates and objects, that involves establishing trajectories and points of collision in the database between a variety of its content.

For the décor we used a much more simple and mechanical approach with some underlying matchingmaking. The method we mostly employ here refers to what Claude Levi-Strauss was calling *bricolage*: a thinking-experimenting which rather than devising something brand new, is solving problems by re-organising what is available, at hand. An approach by which objects are not expressly defined and reduced to a sole function, but continually can be made to generate something else, develop hidden potential. A method which applicability in no way is confined to resolute, practical problems, but which can well be used visually.

To summarize this, Sol Lewitt idea of "That irrational thought should be followed absolutely and logically. The process is mechanical and should not be tampered with." Was used to build the 3d rig (see Figure 8). Bernhard Tschumis operands to describe methods how overlapping objects generated by the rig could be transformed and distorted. Mark Tanseys term "technofore" is used for by meta tagging the objects create associations on the pictorial level, and also pose the different characters into action and finally a montage technique inspired by "bricolage" that in manually editing and compose the décor and central images of each porcelain object.

CONCLUSION

Through the years I have worked together with several different co-creators with 3d worlds and artefacts as our surface of communicating and testing our ideas and concepts that are generative rather that produced. Generative in the sense that they have nor original nor final form from the beginning. They are sprung out of a chain of association through our work process and methods that generates new forms, which in its turn recombines into new stories. My idea is not intended to fully automate the process of novel image making, instead I propose an dialogue that takes into account all new possibilities using digital material, that in the end help us to put forward (if we succeed) interesting images which parameters we can tweak and change in order to get the intended result on a level where the artist themselves in the end can complete the work an address its intent in the final form. One cannot underestimate the

Figure 8. Example of the seven layers put together from the 3d rig

impotence of facilitating forms and ways to interact that creates relevant dialogues with all aspects of the digital material and its creators.

The friction created by letting artefacts evolve in specific materials and media specified by us in a project like Conversation China, help the co-creator capture interesting and comprehensive perspectives, that through artefact creation incorporates surprising visual and technical proposals and expand and influence the framework of Abadyl. Working with the imagery or artefact generated as a source of communication let co-creators explore this area by complex connections through iterating between artistic intentions/screen writing, digital generated expressions, physical objects and script/code writing. The key here for the co-creator is the ability to work in ambiguity – to explore different possibilities without too early jumping to conclusions. This negative capability as Keats defines it, "is when man is capable of being in uncertainties, mysteries and doubts without any irritable reaching after fact and reason." The artefacts also act as generators while they generate new and unforeseen processes, which extend into new and likewise unforeseen contexts. Where the co-creators disseminate their knowledge into the artefact and framework, also extracting something which can inform their own future practice.

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APPENDIX

Spill

With the idea of design fiction, we continue to ask and explore how intent can be critical to the design process as well as the final result that is rendered between the procedural techniques and the artistic intention.

Chapter 24
Quality of Experience Factors for Mobile TV Users

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ABSTRACT

This chapter helps the professionals involved in the Mobile TV industry to methodically engineer the Quality of Experience (QoE) of Mobile TV users. Its objective is to investigate the factors that influence the QoE of Mobile TV users. It also discusses the issues for strategic implications for the Mobile TV industry. We retrieved and categorized the majority of the critical works focusing on QoE for Mobile TV users. Then, we considered them and proposed a comprehensive road-map for improving the QoE of Mobile TV users. We present an approach to produce improvements to the Mobile TV customer experiences. This chapter proposes a seven-stage "road-map" to improvement, which develops the existing models. This study remains to be seen how the presented QoE factors– both amongst technologies and Mobile TV actors – will affect the potential for Mobile TV amongst various types of users. The proposed road-map can help to bridge gaps between other studies that have either focused on QoE for mobile TV or have addressed frameworks for mobile TV.

INTRODUCTION

Nowadays sophisticated devices such as smart phones are available in the telecommunication markets. Users can access telecom services at any Universal Personal Telecommunications (UPT) terminal on the basis of a personal identifier (user mobility). For this reason, networks supporting user mobility provide suitable services according to the user's service profile. In the context of mobility, consumers use their mobile applications for fun, games, music, at work etc. and distribute these applications to their community. Some consumers also use their cell phones for invoking various mobile multimedia applications such as Mobile TV. Mobile TV provides television-like content through a mobile device and holds a limelight as the next killer application of wireless technologies. Mobile TV brings together two contemporary social developments:

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(1) Enhanced end-user mobility, and
(2) Novel forms of access to media content.

In the business landscape of mobile TV, there are several actors already involved (Marilly et al., 2007):

- *Broadcasters* who provide TV channels.
- *Aggregators* who bundle TV channels into clusters.
- *Broadcast network operators* who provide access to their own broadcast networks (terrestrial, satellite or cable) to deliver the TV channels or clusters to end-users.
- *Mobile operators* (operating a cellular network).
- *Mobile service providers* (operating a mobile portal) who are now offering Mobile TV programmes in a unicast mode.
- *Content providers*, advertisers or even access service providers (ASPs)/Internet service providers (ISPs) who directly offer content to be delivered through the network.

Mobile TV is mainly consumed in leisure time. As a consequence, users do not want to spend much time to find out how to use it. Therefore, usability issues are major concerns of mobile TV users. So, much research focuses on results clarifying the users' needs and motivations regarding Mobile TV. According to Repo et al. (2004) the commercial success of a TV product depends on the users' requirements and its viability. Schuurman et al. (2009) summarized the literature regarding Mobile TV. In particular, they conducted a meta-analysis on user-studies from mobile TV-trials, surveyed a panel of 35 trial as well as non-trial mobile TV-experts and conducted a user study with 405 respondents. They compared the views from these four sources regarding context (possible mobile peak times, usage duration and usage goals) and content for Mobile TV. This comparison left them with a better understanding of different views regarding Mobile TV, which paves the way for a more user-centric approach. According to Buchinger et al. (2011) a *User Centered Design* (UCD) must be applied to any Mobile TV product. UCD involves users in the design and development process for a better understanding of their needs, tasks and expectations (Hanington, 2003; Eronen, 2003). Eronen (2003) states that for new devices and applications, the focus of Human Computer Interaction (HCI) research has to shift more to user experiences, which are relevant for the use of the product according to user's needs.

The aspects of UCD correlate with the understanding of User Experience. According to Hassenzahl and Tractinsky (2006) *User Experience* is a "*consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.)*". Jumisko- Pyykkö et al. (2008) state that for mobile phones, the user interface and its usability often depend on the usage model and its layout "*and the context (or the environment) within the interaction occurs*". Consequently, based on these factors improved design solutions for Mobile TV can be developed and then evaluated by their usability, and the level they satisfy user needs.

Quality of Experience (QoE) is a subjective measure of a customer's experiences with a service such as TV broadcast. QoE systems try to measure metrics that customer directly perceives as a quality parameter. For example, a potential metric for Mobile TV is the time for a new channel to be played when changing channel on Mobile TV. QoE takes into account the effective *Quality of Service* (QoS), but also considers every factor that contributes to overall user value such as suitability, mobility, flexibility,

security, cost, personalization and choice. QoE differs from QoS which attempts to objectively measure the service delivered by the vendor, while QoS measurement is most of the time not related to customer, but to media. QoS allows the measurement of network parameters, and the detection of changing network conditions such as congestion or availability of bandwidth. This information is utilized in resource management by prioritizing traffic. Nevertheless, QoS processes are not always sufficient, since they do not consider the user's actual perception of both network performance and service quality. Efforts of standardization to define QoE are still at an early stage. The ITU-T Recommendation G.1080 defines user requirements for Quality of Experience for Internet Protocol Television (IPTV) services (ITU-T Study Group 12, 2008). The recommendation contains the following definition: ''*Quality of experience (QoE) is the overall acceptability of an application or service, as perceived subjectively by the end user. QoE includes the complete end-to-end system effects (client, terminal, network, services infrastructure, etc). Overall acceptability may be influenced by user expectations and context*''.

Various studies (Harper et al., 2006; Chipchase et al., 2007; Petrovic et al., 2006) have considered the factors that define the success of mobile multimedia services. The common finding of these studies is that content is one of the basic critical aspects for the success of Mobile TV. End-user acceptance and success of Mobile TV are highly dependent on content, as the end-user can be considered rather technology-agnostic. However, which are the other QoE key factors for Mobile TV? Based on the UCD approach, we must focus on various issues concerning Mobile TV. Such issues are:

- What kind of Mobile TV service and content should be made?
- Where and when will Mobile TV be consumed?
- How should it look like and how it will be consumed?

The aim of this Chapter is to consider the above issues and the impact of QoE factors on the success of Mobile TV. This Chapter aims to help the professionals involved in the Mobile TV industry to methodically engineer the QoE of Mobile TV users. Its objective is to investigate the factors that influence the QoE of Mobile TV users. These factors are involved in the design of customer experience improvement programmes of Mobile TV industry. The Chapter describes the ways in which customers/users can be directly engaged in the design and improvement process. Moreover, it provides a road-map that professionals (e.g., content providers, advertisers) of the Mobile TV industry can use as base for improving their customers' experiences.

QoE FRAMEWORKS

Agboma and Liotta (2012) developed a QoE-based management framework for the construction of QoE models for different types of multimedia contents delivered onto three typical mobile terminals—a mobile phone, PDA and a laptop. A statistical modelling technique was employed which correlates QoS parameters with estimates of QoE perceptions. These correlations were found to be dependent on terminals and multimedia content types. They demonstrated the application of their framework and prediction models in QoE management strategies using examples. Fiedler et al. (2010) provide a theoretical view on QoE and propose mathematical mapping functions between QoE and QoS. From another perspective, Moller et al. (2009) propose a taxonomy of QoS and QoE aspects that consists of three layers:

- QoS-influencing factors.
- QoS interaction performance.
- QoE aspects of pragmatic nature.

To the best of our knowledge, no method for assessing QoE has been standardized yet. However, some QoE frameworks have been proposed recently. In particular, Geerts et al. (2010) have built a framework that is linked with appropriate QoE measurement methods. In their proposed scheme, different layers of context and user expectations are taken into account. Furthermore, changes in use over time are integrated in their model. This aspect appears to be very helpful for describing the existing developments in Mobile TV. De Moor et al. (2010) provide a comprehensive examination on the QoE in combination with a real procedure for measurements. In their framework, software agents measure single quality aspects and overall results are based on users' feedback. Wu et al. (2009) presented a detailed framework focusing on the relation between QoE and QoS parameters in distributed interactive multimedia environments. In particular, they defined three QoE terms:

- *Flow*: This term defines the psychology in which a person has the feeling of full involvement in the process of the activity under the assumption that the request is high enough to require the full concentration of the person. This dimension of cognitive perception influences the exploratory behavior of a user. For example, users may explore unexpectedly the Mobile TV applications without having any goals at all.
- *Telepresence*: It allows users to have the feeling as if they are present or even visually present (e.g. video conferencing). For this purpose, performance gains should be achieved. In other words, users' performance for solving tasks must be increased. Telepresence depends on the environment of the mobile application and the task requirements define the performance gains.
- *Acceptance:* It is "*the degree to which a person believes that using a particular system would be free of effort*'' (Wu et al., 2009). It depends on the factors perceived ease of use and usefulness (e.g. if the navigation of Mobile TV is easy to use and includes useful features). Technology adoption is the adoption or acceptance of a new mobile multimedia application or feature (e.g., to navigate the Mobile TV channels with the use of speech and the acceptance of this feature by users). If we study early consumers' adoption of Mobile TV, valuable information for its survival can be offered. Jung et al. (2009) examined the influences of cognitive concentration (or flow experience) and media content on consumers' acceptance of Mobile TV. In particular, Jung et al. were based on the theoretical assumptions of the technology acceptance model (TAM) and their results are threefold. First, their results suggest that cognitive concentration (or flow experience) and content have a significant role in consumers' intention to use hedonic information technology. Second, their results show that content has a critical impact on cognitive concentration. Finally, their results support the use of the extended TAM as an explainer to the context of hedonic information technology.

Based on the framework of Wu et al. (2009), Buchinger et al. (2011) present a novel framework that represents the influences on performance gains of mobile multimedia applications together with exploratory behaviors and technology adoption.

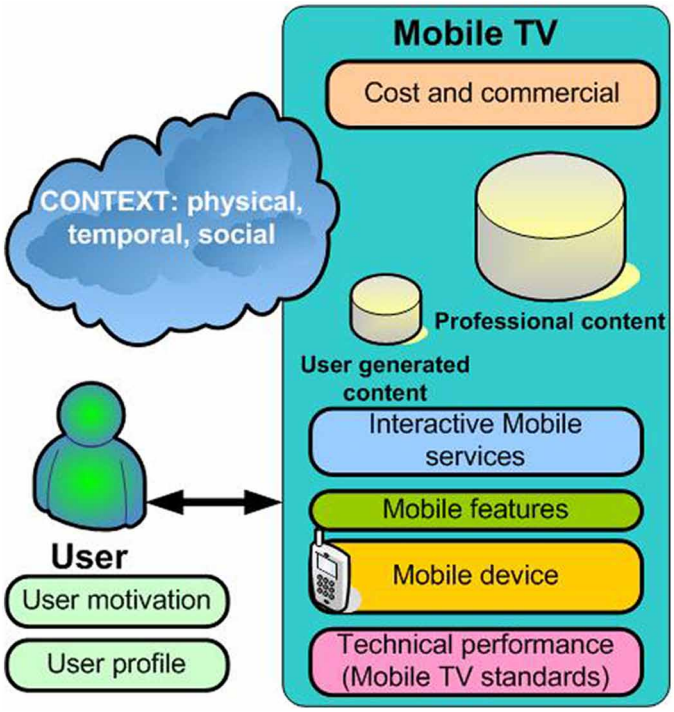
QoE KEY FACTORS FOR MOBILE TV

Previous studies (Buchinger et al., 2011; Knoche and Sasse, 2009; Chipchase et al., 2007) have identified QoE key factors of Mobile TV. These factors are often involved in any *User Centered Design* (UCD) approach of Mobile TV. In such UCD approaches, user plays an essential role and influences other key factors (Figure 1). The QoE key factors of Mobile TV are:

- *User*: The profile of typical users and their motivation to consume Mobile TV.
- *Mobile device*: The desired features of mobile devices for watching Mobile TV.
- *Context*: Where, when, and for how long we consume Mobile TV.
- *Interactive Mobile TV services* and their features: Which interactive Mobile TV services are feasible?
- *Content*: Can we distinguish the content types requested by consumers?
- *Technical performance*: What technical parameters (Mobile TV standards etc) affect the quality of Mobile TV?
- *Costs and commercials*: How can we finance Mobile TV? Are users willing to pay certain fee types and amounts of money?

The provided content, the cost model and the context of Mobile TV influence the behavior of user. For example, if a user wants to watch sports, it is required that the desired content is available. His acceptance to watch the sports channel can depend on the cost model (e.g., "pay per view"). Moreover,

Figure 1. QoE key factors for Mobile TV



the context (e.g. in the morning, day light, environmental noise) in which user wants to watch the sports must be considered. On the other hand, the mobile user behavior is also influenced by:

- *The design model of the mobile device*.
- *The interactive mobile services* and features that are developed for mobile TV applications.
- *Technical performances.* For example, if users do not watch a Mobile TV channel because interactivity is not supported (viz. adaptation and personalization are not feasible), a possible solution would be to design a new interactive Mobile TV service. Additionally, the content, the context, the design model and the cost model influence indirectly the development of the mobile services as well as the technical performances and vice versa.

User

The user is the most significant factor for the achievement of a mobile TV service. Therefore, it is imperative to analyze the user's needs and expectations. In particular, we must consider user profiles of Mobile TV as well as specific issues concerning user motivation.

User Profiles

A user profile includes information about the typical users' gender, age, work, culture, leisure time activities and their relationship to ICTs. Actually, consumers of Mobile TV can be divided by age, occupation, technological-orientation, and even by type of hardware owners (e.g., smartphone, MP3, laptop or cell phone owners) (Frank, 2009). Menon *et al.* (2005) argue that Mobile TV is attractive to one sixth of the users and in particular to users between 18 and 44 years of age in Latin America, Asia and Eastern Europe. Mobile TV attracts early adopters globally. Although young consumers (ages 18–29) are mainly interested in mobile multimedia applications, therefore also 50% of users aged between 30 and 39 (Frank, 2009). In another study, Svoen (2007) remarked that mobile phones are widespread among young people (ages 8–15). Jumisko- Pyykkö *et al.* (2008) revealed that users can consume 3D movies on mobile devices in order to shorten waiting times, be up to date with the daily news while get entertained or being on the move. They showed that the typical Mobile TV user is a well-educated male, aged 23–35 years. Three main user profiles for interactive television are defined in (Eronen, 2001):

- *Comfort-Lovers*. These users prefer to use easy-to-handle services and their median age is 36 years.
- *High-Fliers.* Such users want to read personal content on their own screen and they are strongly technological-oriented. Their median age is 29 years.
- *Pioneers.* This type of users wants to have the newest electronic entertainment possible. The median age of pioneers is 21 years.

Rice and Alm (2008) focused on the requirements of older adults in order to propose an interactive TV interface for older adults. They pointed out that older users (average age 71 years) prefer larger buttons, voice-activated devices and a simple interface with limited functions. This is due to the fact that older users frequently have difficulties in understanding the technical language. According to Simmons (2010) consumers can be divided into five types:

- The *basic planners* who use their cell phone only in case of emergencies.
- The *pragmatic adopters* who use their phone mainly for calling.
- The *mobile professionals* who are attracted by the extra features and retrieve information in several ways.
- The *social connectors* who use the phone to stay connected with their friends.
- The *mobirati* who use their phone for every day life tasks.

Dominant aspects of users' profiles of Mobile TV are consumers' affinity and their motivation to use it. For example, Svoen (2007) showed that the quality of the device (e.g. size and sound), the number of channels, as well as the user's comfort (e.g., sofa) are crucial factors. Additionally, Svoen (2007) revealed that young people use a broad variety of mobile services, while girls use mobile phones as their favorite medium additionally to computers.

Lee *et al.* (2010) examined the nature of four categories of Mobile TV adopters: current, potential, continuous non-, and discontinuous user groups (sample size $N = 214$). They incorporated the users' profile attributes such as demographic characteristics, perceived general adoption attributes, perceived value-based adoption attributes, motivational needs, mass media use, and content interest. The non-adoption rate of Mobile TV of the continuous non-, and discontinuous user groups is higher than the adoption rate of the current and potential user groups. Less than half of the respondents ($N = 34$) who had used TV on a mobile device were unwilling to use it again in the next twelve months, and almost half of those ($N = 102$) did not have the intention of using it within the coming year. The results suggest that the discontinuous group seems to have been dissatisfied with the actual Mobile TV use when compared with their expectations and evaluations, while the potential user group is more likely to have high expectations and positive evaluations before the adoption and use of Mobile TV. All user groups were unwilling to pay the fee, despite the current and potential user groups perceiving the exceptional values. No differences were found in the personality trait of innovativeness and mass media use behaviors among the four groups.

User Motivation

For what reasons do people want to use Mobile TV? The main motivations are the following:

- To kill time while waiting, i.e. for a public transport.
- To kill time during extended waiting periods, i.e. waiting for friends in bars, or in a car.
- To be entertained.
- To be always up to date, i.e. with popular events or news.
- To relax, i.e. at home in the bedroom or in the bath.
- To create a private sphere or to feel less lonely, i.e., lunch break at work.
- To own, share and exchange content.
- Novelty, the desire to be the first, or create and consume personalized content.

Several studies (Chipchase *et al.*, 2007; O'Hara *et al*., 2007; Carlsson and Walden, 2007; Oksman *et al*., 2007; Repo *et al.*, 2004) show that the main motivation for younger people to use Mobile TV is to kill time during waiting periods. According to Lievens *et al.* (2000) users prefer to use their mobile phone to watch videos during a short period (e.g. waiting for a bus) instead of watching it on a laptop,

because it takes more time to start it. From another viewpoint, Menon *et al.* (2005) state that persons, who possess a multimedia or Mobile TV device will mostly use it as such. This means that the motivation for a Mobile TV device use is just the fact of having such an opportunity. Svoen (2007) pointed out that the main motivations for younger people to use television on the whole is to relax, watch their favorite shows/movies or use it as background medium. Bernhaupt *et al.* (2008) showed that watching TV is often a background activity at home, while Chipchase *et al.* (2007) noticed that people use Mobile TV to relax. From another perspective, Zillman (2000) believes that the trend of media entertainment tend to personalized content. The possibility to personalize contents represents one reason for the increasing reputation of Mobile TV. Sodergard (2003) showed that Mobile TV is attractive because people like to use their own personal TV at home. Consumers use Mobile TV to get a closer interaction with television content.

Mobile Device

There are four technical aspects of a mobile device, which are very important for a Mobile TV user.

- *TV buttons.* A study conducted by Knoche and Sasse (2009) pointed out that users prefer to use special TV buttons on the phone, and they are not willing to navigate through menus. The involved subjects also expressed their need to have a quick and simple sound management.
- *Sound controls and headphones.* Mobile TV users often have to turn down or mute the sound rapidly. The common outcome of two studies (Miyauchi *et al*., 2008; Vangenck *et al*., 2008) conducted in different countries is that "*the involved subjects did not want to use headphones when consuming Mobile TV."* The main reason is that some people do not prefer to carry more than the mobile device with them; others may want to remain in contact with their surrounding. However, some users accept headphones. For example, almost all Finland Mobile TV users use headphones in transport and public places (Oksman *et al*., 2007). It is noteworthy that the majority of Finish mobile customers are already used to wearing headphones when listening to music on the way. The enthusiasm to wear headphones actually represents an open issue that must be further explored. The implications of such studies are quite significant as they may concern a variety of issues. For example, content for a major user group must be produced in an entirely different approach, when headphones are preferred. If consumers use their headphones, the sound perception still represents a problem. If a user commutes, the loudness and shape of environmental noise always changes and it is possible to mask the sound of accessible content.
- *Screen and phone size*. According to Knoche and Sasse (2009) users want the screen to be as large as possible, but their phones not to be too big. Petrovic *et al.* (2006) state that users prefer larger image sizes and landscape-oriented use of the display. From another viewpoint, users (mostly female) do not want the weight and size of the handset to be increased (Knoche and McCarthy, 2004).
- *Battery and memory.* Several studies (Knoche and Sasse, 2009; Petrovic *et al*., 2006; O'Hara *et al*., 2007) have pointed out that the limited battery life is the main barrier. Actually, high battery consumption of Mobile TV compromises mobile phone functionality. The receiver part of the device can be put into a low-power sleeping mode, when it receives not interesting transmission slices. In the light of this evidence, special time slicing schemes for DVB-H transmission have been developed that result to power savings of up to 90% (Nokia, 2008). Time-slicing means that

the data representing a particular service are delivered to the handheld device in bursts at given intervals of time. Concerning memory, a lot of space is required for Mobile TV applications and limited memory may have a negative influence on the usage behavior (Kaasinen *et al*., 2009).

Context

In this section, we shed light on which Mobile TV services should be used when, how and where. Mobile TV providers should explore such issues carefully as well as the cultural background of the users they want to reach their product.

Physical context: Studies performed in Austria, Germany, and Japan reveal that Mobile TV is primarily consumed on the go or during waiting time. On the contrary, other studies performed in the UK, Belgium and South Korea point out that consumers want to watch Mobile TV at home. In the studies performed in the UK, USA and Belgium, the most likely location of Mobile TV use is at home. According to Chipchase *et al.* (2007) in South Korea, Mobile TV is mainly consumed at home and while commuting. Such an observation is highly culture depending, and thus it does not reflect a general trend. It is noteworthy that Mobile TV consumption occurs mainly during waiting time and in public transportation in studies performed in countries having some common characteristics. These common characteristics are:

- Public transport is used a lot; and
- The education to behave in a polite way is not so strong as in the UK and Belgium.

Context awareness: Context-awareness is an important topic in mobile multimedia services as such services are consumed in different places differing in their environmental background conditions. Contemporary mobile phones are equipped with special sensors that can detect motion, current viewing conditions or even loudness changes of environmental noise. For example, a light sensor can collect data representing the current viewing conditions. When users watch Mobile TV content in dark conditions, the brightness can be increased. In another case, when users commute, changes from silent to noise areas may occur. Therefore, it is important to switch to a higher loudness level. On the contrary, when returning to more silent places, the selected loudness must be readjusted. Sack *et al.* (2010) proposed a compensation method for loudness and auditory masking. Their method improves the quality of experience drastically. Chen and Kotz (2000) stated that many other parameters could be collected to improve the knowledge on the users' context. Kanellopoulos (2009) proposed an ontology-based context model that supports context reasoning and context management for adaptive multimedia applications. His model is flexible as it provides a general framework that can be applied to any multimedia application. Moreover, his model is extensible as it provides mechanisms to add new multimedia domain specifications such as Mobile TV specifications. Hummel *et al.* (2008) presented a procedure on integrating environmental information in usability evaluation. Finally, Gossa *et al.* (2008) considered performance improvement due to intelligent systems such as *Proactive Replica Placement* based on *Mobility Prediction*.

Temporal context: Almost all recent studies agree about Mobile TV usage durations and prime times. If we know when Mobile TV is expected to be watched and for how long, we can create satisfactory programmes and be prepared for high bandwidth peaks. According to Petrovic *et al.* (2006) Mobile TV content must be short, initially starting by approximately 10 minutes. In addition, Orgad (2006) estimates that the total amount of consumption per day ranges between 5 and 40 minutes. The waiting time differs from traditional TV peak hours (Carlsson and Walden, 2007). Kaasinen *et al.* (2009) explain that this

happens as consumers watch Mobile TV, while travelling or at work to catch up with the latest news. According to Carlsson and Walden (2007) the most popular prime time to watch Mobile TV is early in the evening, before supper. Finally, Kaasinen *et al.* (2009) show that the consumption of Mobile TV does not impact the usage of other media, and that it is often used as an extension to the traditional TV.

Social context: Viewing mobile videos can be divided into *individual* and *collaborative viewing*, which are influenced by various social factors (Sørensen and Nicolajsen, 2010). The possibility of users to create their own videos with mobile phones and sharing them can encourage social activities for collaborative viewing. Users may be motivated to create videos for their own purpose or to use them as communication medium (Reponen *et al.*, 2010). In order to support social activities between users in collaborative viewing new interfaces and technologies are required. For example, sensing technology, computer vision, and artificial intelligence techniques can open new ways to design new interfaces for controlling TV sets (e.g. with the help of the use of speech, gesture, tangible objects) (Vatavu, 2010). Introducing new interfaces will change the behaviour of mobile user and the usage of mobile multimedia applications. To enable content exchange between mobile devices and allow more storage capacity, we must improve the design of mobile devices in various aspects (docking solutions with speakers/large displays, integrated technologies) (Mitchell *et al*., 2010).

Interactive Mobile TV Services

Betting, voting, advertising and shopping services are some examples of interactive Mobile TV services, which are based on the concept of personalization. Lets' assume a personalized shopping service proposed to the end-users for different products to buy according to the end user's profile, localisation or context (e.g. mood, noise, activities, place). In another example, during an advertising campaign of a certain product, personalized links can be suggested to special product information that best fits the end-user profile. From another perspective, it can be offered to end-users voting services that include only those votes/questions that best fit the end-user's profile. The attributes of user's profile and the localisation can be used to succeed personalization and adaptation. Such attributes could be the age, gender, area of interest, social category, TV programmes watched, most frequently service used, terminal characteristics etc.

The EU projects *Daidalos*, *ePerSpace*, *Wireless World Initiative* (WWI), *Mobilife*, and *Eures*com project P1308 (*Frapesa*) have focused on the personalization of the interactive Mobile TV services. For example, the *IST Mobilife* project considers profile management, context, presence and availability, security and privacy issues. The Mobilife project also brings advances in mobile applications and services within the reach of users in their everyday life. Marilly *et al.* (2007) present use cases, technologies and a functional architecture supporting the adaptation and personalization of interactive Mobile TV services.

Rich media technologies are required in order Mobile TV become interactive for advertising, shopping and betting services as well as for content access to a wide range of terminals. The rich media format technologies allow the interactivity to be provided with appropriate personalization and adaptation. The most promising rich media technologies are: (1) MPEG LASeR; (2) MPEG4/BIFS; and (3) Windows media.

Blanco-Fernandez et al. (2011) propose a system that broadcasts user-generated audiovisual contents for handheld devices in a mobile network based on the DVB-H broadcasting standard. Their system offers diverse added-value services to new active users, such as:

- Multi modal access (via Web or by client applications running locally in handheld devices) to digital contents;
- Exploitation of return channels to transmit interactive contents that enhance the user's experience, and
- Annotation, sharing and personalized distribution of audiovisual contents.

In particular, their system adopts well-known technologies for broadcasting and semantic annotation of audiovisual contents, as well as emergent technology from the so-called Web 2.0. A prototype of their system has been experimentally evaluated with a group of students from the University of Vigo, who were enthusiastic about the personalization capabilities offered by their TV system for a mobile setting.

Shin (2006) investigated the prospect of *Digital Multimedia Broadcasting* (DMB) from the technical, economic and regulatory issues and whether the market is evolving an equitable, open, and competitive environment. Especially, Shin (2006) explains how DMB will evolve and stabilize in next generation network environments by applying concepts of open access policy to the emerging technology of DMB.

Mobile network operators are facing significant barriers to access premium content creating bottlenecks in the construction of business models. Therefore, content regulation is essential for the development of mobile television platforms. Evens *et al.* (2011) outline the strategic importance of content in the development of sustainable business models for mobile broadcasting services and discuss the implications of bundling strategies and regulations for the viability of these emerging platforms.

Content

Mobile TV users consume content that can be categorized as professional or user-oriented.

Professional content: Many studies found out that the most interesting genres are news, music, sport, and live broadcasts (Petrovic *et al.,* 2006). On the other hand, it must be mentioned that the selection of channels on Mobile TV is regularly too limited (Kaasinen *et al*., 2009). There is also a relationship between users' age and the content they consume. Younger people prefer sports and Music TV, while users older than 25 years prefer news (Carlsson and Walden, 2007). From another viewpoint, Kaasinen *et al.* (2009) showed that users do not often watch new-piloted channels and they prefer the mainstream broadcast channels. That means that if they have a preferred channel for watching a specific sports channel, they would also like to have it on Mobile TV. The content of Mobile TV must be specifically transcoded. For example, it needs to be adapted to the small screen and opposed viewing conditions. In addition, content must be adapted and fully personalized to the needs of users. According to Chorianopoulos (2008), personalization of the content can be achieved by adopting two possible approaches:

- *The content-based filtering approach*. In this approach, predictions concerning the interested items are based on the user's previous preferences. The user gets a selection of items, which may be of interest to him.
- *The collaborative filtering approach*, in which predictions are based on ratings from ("similar") users who share the same rating patterns with the active user.

User generated content: Roibás and Johnson (2006) state that users would like to create their own content and to share it with other users in mobile communities. Actually, mobile phones can be used as tools for creating and editing personal multimedia content. In addition to that, users can contribute their

applications to the community via tools such as *App Store* or *Market*. Juhlin *et al.* (2010) state that the trend to allow users to broadcast video from mobile devices to a web page as social medium has grown in popularity since 2005. A novel architecture for media content selection and organization has been presented (Cesar *et al.,* 2008). In this architecture, users can personally enrich the content by adding drawing or text comments.

TECHNICAL PERFORMANCE OF MOBILE TV SERVICE

Mobile TV Standards

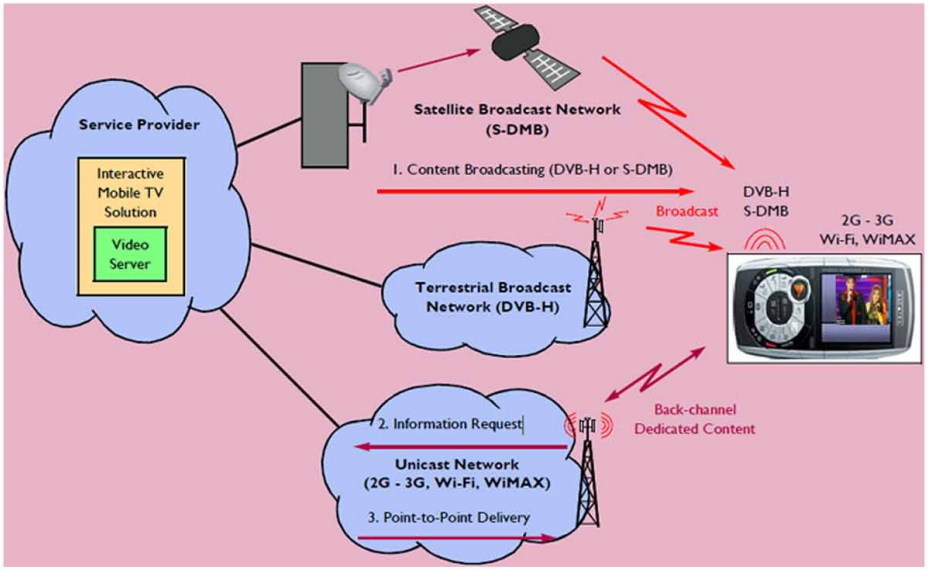
In Europe, the most frequent format to deliver Mobile TV is the *Digital Video Broadcasting for Handheld* (DVB-H) as it offers high downstream data rates (ETSI, 2004). DVB-H is an international standard, which offers broadcast data services to mobile handheld devices. Its main enhancements to conventional *Digital Video Broadcast-Terrestrial* (DVB-T) systems include the addition of time-slicing and an extra stage of error correction, referred to as *Multi-Protocol Encapsulation-Forward Error Correction (*MPE-FEC) at the link layer. ETSI (2008) has also specified the satellite-based DVB version. In DVB-H, time slicing is implemented to reduce power consumption of small handhelds. In Asia, Mobile TV is delivered mainly by using the *Digital Multimedia Broadcasting* (DMB) format. ETSI (2005) has specified the satellite-based DMB (S-DMB) and the terrestrial mode DMB (T-DMB). In the United States, the Qualcomm company has developed the *MediaFLO* format that represents a competitive alternative to DVB-H. It is noteworthy that FLO stands for *Forward Link Only*, and thus the transmission path is one way (Qualcomm, 2008). Finally, the 3GPP(2008) has specified the *Multimedia Broadcast/Multicast Service*.

In the technology landscape of Mobile TV, several aspects have to be considered:

- Mobile broadcast technologies could be terrestrial (DVB-H, T-DMB, MBMS), satellite (S-DMB) or hybrid satellite/terrestrial (DVB-SH);
- The frequencies that can be allocated to Mobile TV channels depend on the regulation rules of each country – available frequencies are a critical resource that may have a strong impact on the selection of the broadcast technologies;
- The unicast network, used for the back channel to get the requested content once the interactivity is triggered, can be a GPRS/EDGE, 3G or an upcoming WiMAX network (Figure 2);
- Some other critical technologies, such as DRM, are mandatory for content providers to deliver their added value content safely in the network.

At the network level, the mobile broadcast landscape is still shifting as the technical, regulatory and business options have not yet been made and could also be country dependent. Therefore, to decrease the integration costs of the solution by avoiding specific assimilations for each business model, an ideal Mobile TV architecture must be flexible and based on standardized interfaces. Since mobile TV services mostly consist of real-time video data, very stringent demands in terms of quality of service (QoS) are imposed on the broadcast operator's primary distribution network.

Figure 2. Co-operation between unicast and broadcast networks (adapted from Marilly et al., 2007)



Other Functional Parameters

- *Channel switching and response time.* Channel switching delays are caused by time slicing techniques applied to save power consumption. Such delays are annoying to the users of Mobile TV. Chipchase *et al.* (2007) confirmed that mobile users do not want to wait to long for the appearance of the new channel. To solve this problem, Robitza *et al.* (2010) propose an interesting scheme: *pre-loading of content such as commercials and playing them locally while waiting for a response*. Having transmissions over satellite (DVB-SH and S-DMB) the response time becomes higher (50 seconds) and thus the delayed presentation is likely to be severely annoyed.
- *Text quality.* Mobile TV quality depends on text quality. When transcoding a video from standard TV to Mobile TV, the text size from news tickers usually becomes too small. If we just increase the text size of a news ticker, the perceived quality can be significantly improved (Knoche *et al*., 2006).
- *Frame-rate.* If bandwidth is limited, video encoding must satisfy the bandwidth restrictions, and also to optimize the perceived quality of the video. This compromise often depends on the content to be encoded. Buchinger and Hlavacs (2006) found out that good picture quality with a low frame rate returns generally better results than high frame rate with lower picture quality. For news and comic contents containing little motion, the frame rate should be reduced to 5 frames per second (fps), while for a typical advertisement and soccer game, a value of 10 fps should be used.
- *Viewing distance.* Knoche and Sasse (2008) evaluated that preferred viewing distances are between 25 and 50 cm. The posture of people within a given environment determines to a certain degree the Mobile TV distance. From another perspective, the size of the mobile device must be combined with appropriate resolution. For example, preferred size for 120x90 for device with 116-ppi display is 32.6 mm.

- *Region of interest.* The *regions of interest* (ROI) of a video are important aspects of subjectively perceived quality estimation. The quality of the ROI has a large impact on the quality perception of Mobile TV content. On the contrary, background quality has low impact on the quality perception of Mobile TV. Therefore, it has been proposed to automatically detect the foreground and background of the video. Then, it is advised to treat them differently by allocating more encoding bitrate to the foreground (FG) and less to the background (BG). For example, we can apply a "blur function" with lower saturation to the BG, and the "blur function" with higher saturation values to the foreground (Buchinger *et al.*, 2009).

Costs and Commercials

Commercials finance mainly the Mobile TV services. However, users often skip commercials, if interactivity is provided instead of simple broadcasting. Vangenck *et al.* (2008) state that people are not willing to pay much for Mobile TV. Users would accept to pay for an average 9.7 euros monthly and they would prefer "pay per view" payment instead of paying for packages of channels (Kaasinen *et al*., 2009). The model of flat fees is acceptable by Mobile TV users for flat fee ≤ 5 euros per month. Frank (2009) reveals that even early adopters would reject to pay for content (42%), and they would prefer to watch adds (71%). Miyauchi *et al.* (2008) point out that reduction of noise and interruptions for advertisements are important aspects to consider, if users have to pay for Mobile TV. This happens because users would not pay for it, if the TV reception conditions are not good enough.

Implications of Mobile TV Use

The development of Mobile TV changes the concepts of space and time in media use. The implications of Mobile TV are not the same for all kinds of users and in all countries. In order to understand the social and technological implications of Mobile TV in its early stage, we must investigate whether there is a demand for the service in the target country and a business model to support it. In particular, we must examine the situations in which the use of Mobile TV is profitable for the user in each country. For this reason, various user studies should be consulted in each country. The technological and social implications of Mobile TV depend mainly on the exploratory behavior of Mobile TV user, which in turn forms various Mobile TV scenarios. For example, we can study if Mobile TV users can adopt olfaction-enhanced Mobile TV and whether such kind of Mobile TV is feasible. Kumar (2007) states "*the Mobile TV scenario can change overnight for technology providers, chip and handset manufacturers, and service providers based on decisions about technology, regulation, and spectrum and of industry bodies such as the Open Mobile Alliance or 3GPP and 3GPP2*". Mobile TV scenarios generate many business models of Mobile TV (DigiTAG, 2007). The four major business models are (DigiTAG, 2007):

- Model 1: Broadcaster-led approach with mobile telecom operator.
- Model 2: Mobile telecom operator-led approach with broadcaster.
- Model 3: Independent DVB-H service provider approach.
- Model 4: Mobile telecom operator-led approach.

According to Buchinger *et al*. (2011) the exploratory behavior of Mobile TV user is strongly dependent on technology adoption and performance gain issues.

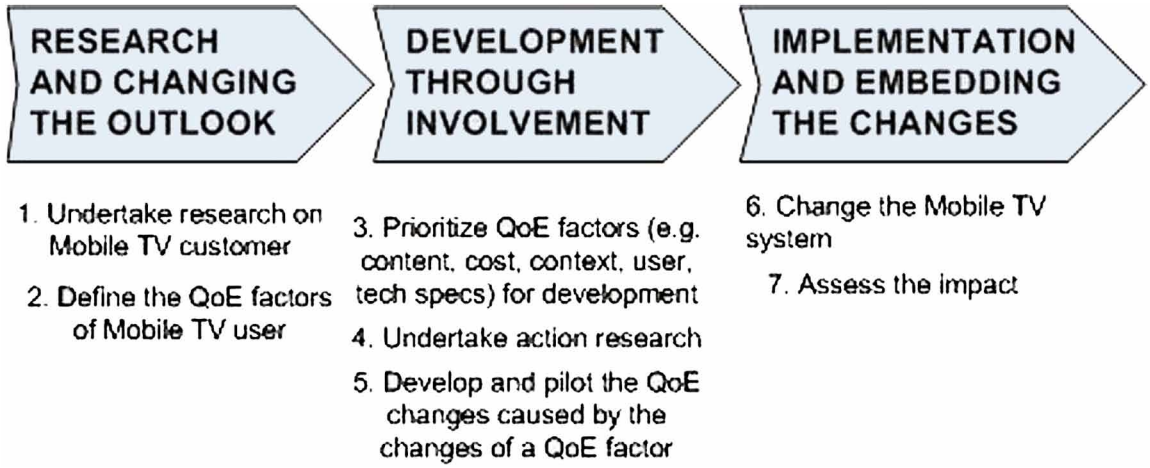
Technology Adoption. Choi and Totten (2012) investigate the effects of cultural differences (individualism vs. collectivism) on the acceptance of Mobile TV by identifying self-construal (independent vs. interdependent) as a possible antecedent of the *Technology Acceptance Model* (TAM). Surveying 817 university students in Korea and the United States, the study found that TAM is consistently stable across countries, and that individual-level cultural orientation had significant effects on the model as a direct antecedent of TAM. However, the relationships between self-construal and TAM variables were rather mixed. As hypothesized, interdependence was more important for Koreans' subjective norms and perceived usefulness, whereas independence was more important for Americans' subjective norms. Unexpectedly, however, the direction was reversed in the case of perceived ease of use. Moderating effects of country culture also appeared in the relative effects of perceived ease of use and usefulness on attitude. Perceived ease of use was more important than attitude in the US, while perceived usefulness mattered more in Korea. By adding self-construal as an antecedent variable, the study effectively explains how users' individual value orientation shapes TAM. This approach can provide deeper understanding for the adoption of new technology and suggest marketers better strategies for directly dealing with consumer characteristics in promoting mobile TV technology.

Performance Gains. As we mentioned before, the technical performance of a Mobile TV service depends mainly on the adoption of Mobile TV standards and various other aspects such as: (1) the frequencies that can be allocated to the Mobile TV channels; (2) the unicast network used for the back channel to get the requested content once interactivity is triggered; and (3) DRM issues. It is noteworthy that frequencies for allocating Mobile TV channels depend on the regulation rules of each country – available frequencies are a critical resource that may have a strong impact on the selection of the broadcast technologies. *Channel switching and response time; text quality; frame rate; viewing distance* and *region of interest* are some of the technical parameters that determine the wide-scale implementation of Mobile TV.

A ROAD-MAP FOR IMPROVING THE MOBILE TV CUSTOMER EXPERIENCE

This Chapter provides a road-map, which actors of Mobile TV industry can use as a base for improving their customer experiences. In this road-map (Figure 3), we have clear objectives in seven areas (customer-user, mobile device features, interactive Mobile TV services, content, context, costs and commercial, technical performance specifications) and use them to assess the benefits of improving the customer experience. There are several contributions for practitioners. First, it has identified the critical importance of outlook change in Mobile TV customer experience design. Second, it has highlighted the importance of involving Mobile TV users in the improvement programmes of Mobile TV industry, not simply as providers of information but through direct involvement as part of the Experience Teams. Johnston and Kong (2011) have investigated how organizations actually go about designing and improving their customer experiences. In particular, they proposed a ten-stage general road-map for improving the customer experience. The road map proposed by Johnston and Kong (2011) is general, and thus we adopted and specialized this road-map in order to finalize our seven-stage road map for the Mobile TV domain. We suggest a seven steps approach for improving the QoE of Mobile TV users.

Figure 3. Seven-stage road-map for improving the Mobile TV customer experience



(1) *Undertake research on Mobile TV customer*. At this stage, the received and desired QoE of Mobile customer-user is understood.
(2) *Define the QoE factors of Mobile TV user*. The experience team using facilitated sessions achieves this action.
(3) *Prioritize QoE factors* (e.g., content, cost, context, user, technological specifications) for development. At this stage, QoE factors for change are indentified.
(4) *Undertake action research*. Here, we have bottom-up mindset change and ideas for improvement. Key-tools that can be used are: observation, emotion mapping and walk-through audits. External "benchmarking" can also be implemented.
(5) *Develop and pilot the QoE changes caused by the changes of a QoE factor*. At this stage, we have idea generation, pilot testing, assessment and implementation.
(6) *Change the Mobile TV system*. The experience team is responsible for changes (e.g. measures, training, re-design of the system).
(7) *Assess the impact of the changes*. The greatest outcome is an increase in understanding of the Mobile TV service from a customer's point of view.

CONCLUSION

Mobile TV services must take into account user's needs, tasks and expectations. The user interface of mobile phones and its usability for Mobile TV often depend on the usage model and its layout as well as the context (or the environment) within the interaction occurs (Jumisko-Pyykko *et al*., 2008). In addition, the *Quality of Experience* approach adopted by the Mobile TV can explain how overall acceptability may be influenced by user expectations and context. In this Chapter, we presented the following aspects that should be considered to create a successful Mobile TV service:

- The profile of user watching Mobile TV.
- The acceptance of a mobile phone in order the user consumes multimedia content.

- How Mobile TV service can be improved by context awareness?
- What Mobile TV services are preferred and which are their features?
- What content users want to share and modify on their mobile devices?
- Which are the factors that influence the technical performance of the Mobile TV service?
- Cost and commercials. Users can skip commercials when interactivity is provided on Mobile TV. However, commercials are necessary for financing the service. The problems of fee types and the interplay of commercials are not solved yet.

FUTURE RESEARCH DIRECTIONS

The literature review shows that further investigation is required to answer the above questions adequately. We believe that the '*Living Lab*' concept is very promising for further research. The '*Living Lab*' concept is emerging in a user-centered (UCD) approach adopted recently for information and communication technologies (ICTs) innovation research. Schuurman *et al.* (2011) present a concrete application of Living Lab-research into the possibilities of Mobile TV, a notable example of ICT-innovations that incorporates the convergence of mobile phones and television. Their research was carried out within Flanders' mobile TV trial 'MADUF' and echoes a long tradition of interactive and digital TV trials. They proposed an analysis of the strong points, weaknesses, opportunities and threats of Living Lab-research based on this case study. This way, they contend that a Living Lab-approach seems proper for innovation research into Mobile TV in particular, but that certain issues remain to be tackled in order to optimize this kind of research.

The advent of olfaction-enhanced Mobile TV. Ghinea and Ademoye (2011) first coined the term "Olfaction-enhanced multimedia applications", which defined it as "*combining computer-generated smell with other media to enrich the users' experience and perception of a multimedia presentation or application*". In particular, they focused on investigating the user perceived experience of olfaction-enhanced multimedia applications, with the aim of discovering the quality evaluation factors that are important from a user's perspective of these applications. Enhancing Mobile TV with olfactory stimuli can create a more complex—and richer—user multimedia experience, by heightening the sense of reality and diversifying user interaction modalities. Nevertheless, olfaction-enhanced Mobile TV still remains in infantile stages. A few olfactory-enhanced multimedia applications have been presented, with olfaction being used towards a variety of goals, including notification alerts, enhancing the sense of reality in immersive applications, and branding. Kim *et al.* (2006) designed an olfactory display system called "*FragrantMemories*" that enables users to easily create fragranced home movies. In addition, they conducted an evaluation experiment to verify the need for olfaction enhanced broadcasting in TV using their "*FragrantMemories*" system. The results of their evaluation experiment verified that there is an increasing demand for TV broadcasting to include the transmission of olfactory data signals. An interesting olfaction-enhanced display system has been implemented in (Matsukura *et al*., 2009a; Matsukura *et al*., 2009b). This display system focuses on the technical aspects of olfaction-enhanced displays and uses computational fluid dynamics (CFD) to calculate odour distribution and subsequently use an *odor blender* (Nakamoto *et al.*, 2008) to generate the odor with the concentration determined by the calculations. Finally, Pornpanomchai *et al.* (2009) implemented a simple olfaction-enhanced multimedia display system and investigated the usability and efficiency of their system.

Achieving quality of olfaction-enhanced Mobile TV from the users' perspective will be crucial to the success and continuity of Mobile TV. Specific attention needs to be given when synchronizing other media content with olfactory data. Ghinea and Ademoye (2010) present the results of an experimental study carried out to explore and investigate the temporal boundaries within which olfactory-data output in an olfaction-enhanced multimedia application can be successfully synchronized with other media objects from an end-user perspective. Results show the presence of two main synchronization regions, and that olfaction ahead of audiovisual content is more tolerable than olfaction behind content.

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KEY TERMS AND DEFINITIONS

Context Awareness: It is a term that is used for devices that have information about the circumstances under which they operate and can react accordingly. Context aware devices may also try to make assumptions about the user's current situation.

Context: A central concept in ubiquitous computing literature that can be understood as the background and specific circumstances of a subject.

Device Interactivity: Facilitation of one-way and two-way communication through applications.

Digital Multimedia Broadcasting: (**DMB**): It is a digital radio transmission technology developed in South Korea for sending multimedia such as TV, radio and data-casting to mobile devices such as mobile phones, laptops and GPS navigation systems. Some times, DMB technology is known as mobile TV.

DVB-H: (**Digital Video Broadcasting - Handheld**): It is one of three prevalent mobile TV formats. It is a technical specification for bringing broadcast services to mobile handsets. DVB-H was formally adopted as ETSI standard EN 302 304 in November 2004.

Mobile TV: Watching TV on a mobile phone. There are several mobile TV air interfaces competing for prime time. Digital multimedia broadcasting (DMB) is based on the digital audio broadcasting radio standard; digital video broadcast-Handheld (DVB-H) is the mobile version of the international digital TV standard, and forward link only (FLO) is based on QUALCOMM's popular CDMA technology.

Quality of Experience: (**QoE**): It is a measure of a customer's experiences with a service (mobile TV, web browsing, phone call, TV broadcast etc.). QoE focuses on the entire service experience, and is a more holistic evaluation than the more narrowly focused user experience (focused on a software interface) and customer-support experience (support focused).

Ubiquitous Media Environment: A future media environment supporting device independent, anytime, anywhere publishing.

User Experience (UX): It is a term used to describe the overall experience and satisfaction a user has when using a product or system. It most commonly refers to a combination of software and business topics, such as selling over the web, but it applies to any result of interaction design.

User-Centered Design (UCD): It is a design philosophy and a process in which the needs, wants, and limitations of the end-user of an interface are given extensive attention at each stage of the design process. UCD is a multi-stage problem solving process that not only requires designers to analyze and foresee how users are likely to use an interface, but to test the validity of their assumptions with regards to user behavior in real world tests with actual users. Such testing is essential as it is often very difficult for the designers of an interface to understand intuitively what a first-time user of their design experiences, and what each user's learning curve may look like.

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Chapter 25
Digital Transformation in the Public Sector:
Electronic Procurement in Portugal

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ABSTRACT

Digital transformation in the public sector is an inevitable requirement for governments due to the growing complexity and interconnections of information systems, and to the demands of citizens, who are becoming better informed and are increasingly looking to more agile and innovative services. However, despite the willingness of many governments and public institutions, the results do not always tally with the original objectives. In the case of public procurement in Portugal, it could be said that digital transformation experience had an unexpected success in the European context, through a business model that is still quite unique in Europe. This result is much owed to the strong political determination, the experience gained from pilot projects, and to the involvement of many stakeholders, who contributed, in a consistent and innovative way, to the definition of the system. The system is not perfect: there are many challenges that need to be addressed in the coming years. Yet, it has enabled the Portuguese public administration to significantly grow in the digital era, so that today the State has a database containing structure information about public procurement, which is a unique case in many countries.

INTRODUCTION

Digital transformation (DT) – the use of technology to radically improve performance or reach of enterprises – is becoming a hot topic for companies across the globe. (MIT Center for Digital Business and Capgemini Consulting, 2013)

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The era of digital transformation is here to stay. It is happening in our lives in ways we have not even begun to grasp, but it is there. One need only think about the proliferation of social networks, and in particular on how they influence relationships, impact on electoral results, etc. But, if this is a very obvious example, many others are not so obvious, albeit equally relevant.

While the public sector is no exception to this avalanche of transformations the world has witnessed, it is not always agile enough to successfully drive this transformation process. Moreover, the confidence of citizens in the public administration ability to reinvent and modernize itself today seems more lost than ever, as the result of the austerity measures and economic instability that has already dealt a cruel hand on some countries and had its repercussions on many others, through globalization and the interdependencies that have been established.

According to a survey conducted by Accenture, European citizens across five countries were asked how confident they felt about their governments' ability to deliver services that will meet the needs and expectations of citizens in the future. More than 62% said they were not confident. To stay connected to their constituents, public leaders both at Member State and European levels need to usher in a new accountability framework (Masson, 2014).

In the specific case of public procurement, according to an OECD recommendation, public procurement is a crucial pillar of strategic governance and services delivery for governments. Because of the sheer volume of spending it represents, well governed public procurement can and must play a major role in fostering public sector efficiency and establishing citizens' trust. Well-designed public procurement systems also contribute to achieving pressing policy goals such as environmental protection, innovation, job creation and the development of small and medium enterprises (OECD, 2015).

If digital reform is added to an effective reform of public procurement, which today one cannot forgo, then there would be an opportunity for transforming public service. Portugal was, in this field, a surprising and unexpected case study. In fact, without making it explicitly known, the Portuguese government made the bold decision of making e-procurement compulsory on 1 November 2009 through a solution based on Cloud service resources.

The purpose of this article, which as part of studies on digital transformation seeks to explain the reasons why the Portuguese model is so effective, is to understand that decision and put it into context.

With this in mind, the article is divided into the following sections: introduction, background on digital transformation, description of the Portuguese case in respect of the legal reform and the implemented electronic system, analysis of the case in the context of digital transformation, lessons learned and current challenges, and, finally, the conclusions.

BACKGROUND

According to the declaration on the digital transformation of European industry and enterprises stemming from the conference on the digital transformation of European industry and enterprises, held in Brussels in February this year, digital technologies are currently driving the 'fourth industrial revolution' (Conference on Digital Transformation, 2016).

Empowered by digital investments, disruptive business models and improved production processes, European companies are generating international market opportunities with new products and services. In today's globalized world, the transition to a digital economy is essential for Europe's competitive edge

and to deliver much needed economic growth and jobs. This is what drove the analysis of electronic public procurement in this current turmoil.

To this end, and although the topic of digital transformation has exponentially increased in many fields over the last two years, in particular in consultancy and in the academy, this work has focused on the analysis carried out by George Westerman and co-authors in his recent work on the leading role of digital transformation.

The rationale behind this choice is that this analysis is essentially based on the activity of companies worldwide and, on the other hand, because this is a quite diversified business sector. This study explains that successful transformation is a clear, two-fold framework: where to invest in digital capabilities, and how to lead the transformation.

The authors' attention was most captured by the component of how to lead the transformation because in the case of Public Procurement the decision about "what" – to implement electronic public procurement – was a political decision. So, how to implement Electronic Public Procurement is where the challenge lies and is related to the field of leadership. Leadership capabilities are essential to achieving true digital transformation; they turn digital investment into digital advantage.

The four key elements of leadership (Westerman, Bonnet, & Mcaffe, 2014) are:

- **Creating a Digital Vision:** Digital transformation starts when you create a transformative vision of how the organization will be different in the digital world;
- **Engagement of Employees:** Engaging employers means getting everyone moving towards the same direction;
- **Creating Governance System:** Establish the right model digital governance model is critical, since it acts as the rudder to steer digital initiatives in the right direction;
- **Creating IT/Business Synergies:** Building strong relationships between IT and business people and the right digital skills will help to build and continually reap the benefits from a well-designed digital platform.

E-Procurement Concept - e-Procurement refers to the use of Internet-based (integrated) information and communication technologies (ICTs) to carry out individual or all stages of the procurement process, including search, sourcing, negotiation, ordering, receipt, and post-purchase review. While there are various forms of e-Procurement that concentrate on one or many stages of the procurement process, such as e-Tendering, e-Marketplace, e-Auction/Reverse Auction, and e-Catalogue/Purchasing, e-Procurement can be viewed more broadly as an end-to-end solution that integrates and streamlines many procurement processes throughout the organization (Vaidya, Sajeev, & Callender, 2006)

THE 2008 THREE PILLARS PUBLIC PROCUREMENT REFORM

Strongly motivated by the need to conform the Portuguese public procurement system to the EU law, especially Directives 2004/17/EC and 2004/18/EC, the 2008 reform was based on three essential pillars: a new public contracts code as the primary public procurement law, an institutional framework based on the National Public Procurement System and a fully-fledged e-procurement system.

Public Contracts Code

EU regulations on Public Procurement aim to promote transparency, fairness and a competitive public procurement across the EU's single market, fostering business opportunities and generating economic growth and job creation.

In the case of the 2004 EU directives package (Directives 2004/18/EC and 2004/17/EC) that regulated the procurement procedures for major contracts (Bovis, 2006) until 2014, they addressed the creation of an internal market for public procurement and were based on the Treaty provisions related to the single market. The aim of these directives was not to provide a general framework for implementing other objectives, such as ensuring best value for taxpayers' money, preventing corruption, or ensuring transparency and accountability (Arrowsmith, 2005), which, as in other aspects of procurement policy, should still be considered a matter to be dealt with at Member State level. This explains why so many Member States have set their own regulations and requirements applicable to contracts the value of which is below the Directives' thresholds.

Approved by Decree-law 18/2008, the Portuguese Public Contracts Code (PCC) primarily aimed at transposing the above mentioned EU 2004 procurement directives into the national legal system.

Public procurement contracts, including supplies, services, works, and works and services concessions are regulated by the PCC and all entities classified as contracting authorities by the EU directives fall within the scope of and must comply with it. These include the central government, the regional and local authorities and the bodies governed by public law (regardless of their public or private nature).

However, the PCC went further than the minimum mandatory scope of the required transposition by promoting a major shift in the Portuguese public procurement system, as the legislator made use of its relative freedom to regulate contracts below the Directives' thresholds and opted to set out, in many ways, a similar framework for contracts above and below the Directives thresholds (Almeida & Fautino, 2009) and set an innovative and bold public procurement model to foster non-discrimination, competition, transparency and accountability in public procurement contracting (Tavares, A gestão das aquisições públicas: guia de aplicação do Código dos Contratos Públicos, 2009).

Drawing on the external pressure of the EU to transpose the 2004 Directives, it should be emphasized that the Code eventually became the decisive instrument of change towards a new paradigm based on e-procurement in 2008. In tandem with the supplementary legislation described in Table X below, the Code added a new DNA to the Portuguese public procurement system – the use of electronics in the contract preparation phase (until the award of the contract) and the disclosure of procedures and opening of the procurement market to society, guaranteed through the combination of electronic means of data transfer and of e-procurement platforms (transactional system component) with the availability of a single public contracts portal, the BASE Portal.

No other innovation brought in by the 2008 Code can be considered more striking than the transformation into a fully-fledged e-procurement system. While it had been promised for the entire UE since the "Manchester Declaration" (ministerial declaration approved unanimously on 24 November 2005, Manchester, under the auspices of the United Kingdom EU Presidency) with the assumed target of "By 2010 at least 50% of public procurement above the EU public procurement threshold will be carried out electronically", Portugal had already achieved 91% of this target in 2010 (IMPIC, I.P., 2011).

Reality has shown the appropriateness of the legislator. The new legislation has introduced an unparalleled level of transparency, at a time when most Portuguese people believed that contract formation

procedures, even open tenders, were "rigged" and did not satisfy the principle of equal treatment or, at best, the system did not promote competition and prevented or made it hard for new players to enter the system, especially SMEs. While it is true that electronics on its own does not necessarily open doors to an ideal world, there is however a recognition that it removed from contract formation procedures most discriminatory practices and, when supported by a portal such as BASE, it served most of the interests of stakeholders involved in public procurement, either those on the demand and supply side, or the inspection bodies and society in general (the right of scrutiny over the management of taxpayers' money).

The most striking aspects of this reform are that its adoption is mandatory, even though "electronics" and "paper" were allowed to coexist during a transitional period, and the legal enforcement by which contracts are void if formed through non-electronic media.

Even if from a technological viewpoint this profound change posed no major, let alone insurmountable difficulties to any EU Member State, the fact is that only the mandatory nature of its adoption now prescribed in the 2014 Directives was to bring about change and, from the limit dates set at EU-wide level, the following causes were said to have slowed down the process:

- A relative distrust of public powers and economic operators on the degree of openness and increased facilitated access to domestic/national markets by international market players (protectionist tensions), for example, in that e-Procurement enables some context costs associated to the physical location of companies and of target markets of their products and services be close to irrelevant (once language difficulties are sorted out, e-procurement makes it financially feasible, perhaps even interesting, for a Finnish architecture office to bid in a public works tender launched by a municipality in the Portuguese hinterland, or, conversely, for a Portuguese software company to bid in a public tender for the selection of a system to monitor the marine environment around Helsinki. There is no need for teams to travel to the sites, and there are no communication costs involved, for e.g., costs for shipping documents and mock-ups);
- Poor promotion of the e-Procurement system as regards aspects other than contract awarding (up to the e-tendering phase) that deal with the integrated management of public organizations (the interfacing with public finance management and other areas, applications and tools used in the management of public organizations, ERPs, CRMs, etc., with the aim of increasing their efficiency);
- The classical resistance to change, perhaps more noticeable in some sectors of public administration rather than in private economy, which is much more exposed to more demanding global levels of competition and faces the key challenge of innovation as an "approach" to survival.

Against this background, one of the questions most often heard among stakeholders in the early years of the reform was: "What about Portugal? Is the decision to take the lead the right one?

While it is true that the national public market provided (even) easier access to economic agents from other EU countries, nonetheless the pioneering role of Portugal in this area:

- Increased transparency, providing more and better methods of preventing corruption;
- Afforded more competition between economies of scale (better prices and savings);
- Prepared the Portuguese companies, in particular the SMEs, to access electronic public procurement markets, which, in adopting the new 2014 Directives, will become the rule in the Single Market, and

- Enabled the formation of a cluster of service providers linked to e-procurement, from e-platform operators to public procurement consultants (as "e-public procurement" is turning into "public procurement").

By introducing, in 2008, electronics as the new (mandatory) paradigm in the public contracts formation in Portugal (See Table 2), the Code and its supplementary legislation impacted tremendously on the public procurement lifecycle and helped change workflows, processes and working methodologies of both contracting authorities and economic operators. To some extent the Code brought Portugal to a leading position and prepared the country well in advance for what the EU came to set as targets for the use of electronics in 2014, through Directive 2014/24.

National System of Public Procurement

The National Public Procurement System (NPPS) was established in 2007 while the preparatory work on the new Public Contracts Code was already being finalized. Its main aim was the optimization of

Table 1. 2008 reform legislative package

	LEGAL ACT	SUBJECT MATTER
A	Decree-Law 37/2007 (DRE, 2007)	Defines the National System of Public Purchases (NSPP) and creates the National Agency for Public Procurement (NAPP) as the entity responsible for the system's management
	Regulation 330/2009 (DRE, 2009)	Regulates the functioning of the National System of Public Procurement
B	Decree-Law 18/2008 (DRE, 2008)	**PUBLIC CONTRACTS CODE** (PCC) – new primary public procurement law
C	Decree-Law 143-A/2008 (DRE, 2008)	Electronic Platforms and data communication forms
	Order 701-A/2008 (DRE, 2008)	Approves the key standard forms related to contract notices and contract award notices that are published in the "*Diário da República Eletrónico*" (e- Official Journal)
	Order 701-B/2008	Setup of an Advisory Committee in charge of monitoring the application of the Public Contracts Code
	Order 701- D/2008	Defines the model of statistical data to be reported by contracting authorities
	Order 701- E/2008	Defines the model of the data reports to be completed and provided by contracting authorities in/through the Public Procurement Portal www.base.gov.pt
	Order 701- F/2008	Regulates the setup, operation and management of the Public Procurement Portal (www.base.gov.pt)
	Order 701-G/2008	Sets out the requirements and conditions of use of electronic platforms by the contracting authorities and regulates their terms of operation
	Order 701- H/2008	Approves the mandatory content of the execution project of public works and the procedures and standards to be adopted
	Order 701- I/2008	Establishes the "Observatory of Public Works", and approves its operational rules
	Order 701-J /2008	Defines the model of statistical data to be reported by contracting authorities

A – Setup of central purchasing system and body **B** – Code of Public Contracts (transposing the EU 2004 Directives into the national legal system) **C** – Specific e-Procurement and implementing provisions

Table 2. Key deadlines set forth by Directive 2014/247EU

Key deadlines set forth by the Directive 2014/24/EU	
E-Noticing, including all procurement documents,	18 April 2016
Full e-procurement including e-Tendering for Central Purchasing Bodies	18 April 2017
Full e-procurement including e-Tendering for other public contracting authorities	18 October 2018

purchases of categories of goods and services likely to be centralized, led by the National Agency for Public Procurement (ANCP), the nature and policy instruments of which are those typical of a Central Purchasing Body (CPB), in addition to some policy-making and coordination powers besides those relating to centralized purchases. The NPPS, led by the ANCP until 2012 and based on a network of Ministerial Purchasing Units, comprised the affiliated entities (direct administration services and public institutions) and voluntary entities, who joined the system through accession agreements for purchasing purposes under framework agreements provided by the CPB (Municipalities and Municipality-Owned Companies, Regional Authorities, State Owned Companies).

More recently, through Decree-Law 117-A/2012, of 14 June, the ANCP merged with other two entities (GERAP, set up to deal with some shared services in the field of human resources and public finance management, and the IT Centre for Public Administration, which had been until then a unit within the Ministry of Finance) into a new body of public law, the Agency for Shared Services in the Public Administration (eSPap).

So, the institutional framework has significantly evolved within the last 10 years (2007-2016) as the key competences and responsibilities of the public procurement system have been assigned to seven different public bodies throughout this period. Figure 2 shows the evolution of actors and distribution of key functions:

- **National Public Procurement System (NPPS):**
  - **ESPAP**: Former ANCP (Ministry of Finance) – Manages the National System of Public Procurement and acts as a generalist central purchasing body.
  - **UMC**: Ministerial Purchasing Units (one per Ministry).
  - **SPMS**: Central purchasing body for the Health Sector.
- **National Information System and Regulation:**
  - **IMPIC** (**Ministry of Planning and Infrastructures):** Public Contracts Portal (BASE) and Electronic Platforms Regulation.
  - **GNS (National Security Office):** Accreditation of Security Auditors.
- **Private Electronic Platforms Operators:**
  - 6 licensed to operate in the Market (May, 2016).
- **National Auditing Authorities:**
  - Court of Auditors.
  - Inspectorate-General of Finance, Ministerial Inspectorates (Sectoral).
  - Competition Authority.

The key entities who contribute to the strategy and policy making, implementation, monitoring and control of public procurement in Portugal can be grouped under the following four functions as shown in Figure 1.

The Portuguese institutional framework does not comprise an independent Review Body as in other countries. In case the request for review is rejected by the Contracting Authority (CA), the Economic Operator (EO) has to make use of the judicial system through the Administrative Courts.

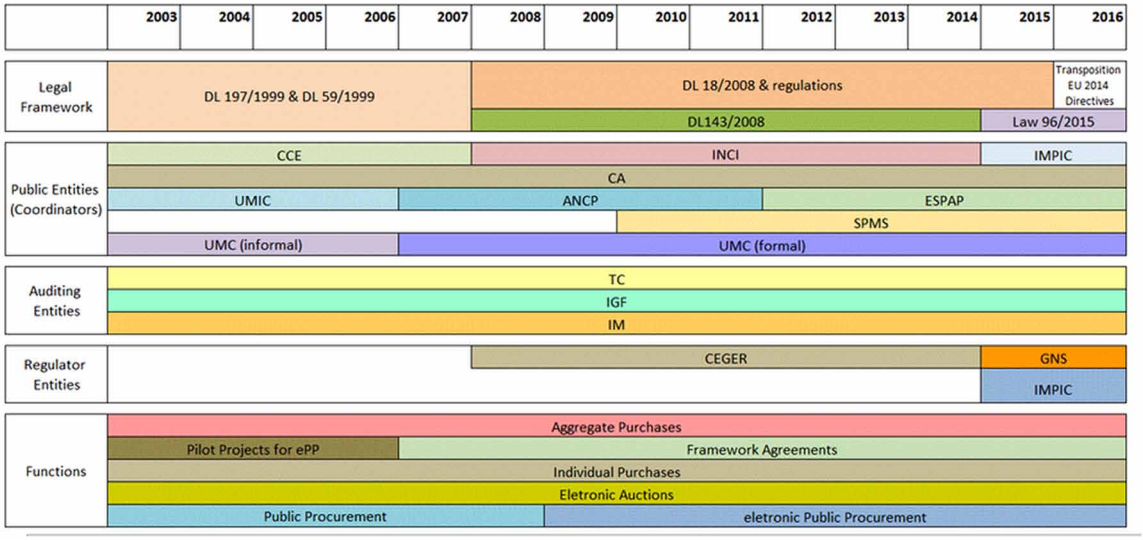
The Star of the Reform: E-Procurement System

It must nevertheless be noted that the most remarkable aspect – and incidentally more lasting – of the 2008 reform was precisely the setup of a fully-fledged e-procurement system which proved to be the "star of the reform" and the reason why it was referred to as the "Portuguese case" at international level. In fact, from a substantive viewpoint of the legal reform, in addition to some creative solutions (for example, the swapping of the sequential order of eligibility and awarding, the harbinger of the EU solution adopted by Directive 2014/24/EC), most of the legislator's solutions were circumscribed by the European directives. Where the legislator surprised the most was precisely in respect of e-procurement – due to the change in strategy, anchored within a short transitional period during which paper and electronics coexisted, followed by the imposition of electronics in the formation process of almost all public contracts.

It comes as no surprise that the more skeptical prophesized the deadlock of the public administration, claiming that it was not prepared for such a revolution, and alerting to the possibility of the breakdown in the supplies of essential utilities to schools, security forces, prisons, etc. None of those catastrophist scenarios have materialized.

Although the great turning point in the public procurement national system occurred in 2008, with the adoption of the new PCC, the fact is that the profound changes that became visible in that year had been in the pipeline since 2002.

Figure 1. 2016 KEY public entities in public procurement governance



The Roadmap

In fact, it all started with the setup of the Knowledge Society Agency (UMIC) by Resolution of the Council of Ministers No. 135/2002, of 20 November, and the assignment to this new body of the task to devise and propose a strategy for development of information society and electronic government in Portugal, as well as an implementation plan covering the period from 2003 to 2006.

In June 2003, the Council of Ministers approved, among a set of strategic documents aiming at stimulating the changeover towards an information society, the National Plan of Electronic Procurement, the first roadmap towards the adoption of a fully-fledged e-procurement system in Portugal. Until 2007, this national plan encompassed the implementation of 8 (eight) pilot projects completed in 8 (eight) ministries through the use of the 4 (four) B2B platforms (Business to Business) that existed in the private market at the time. It should be stressed that the scope of the pilot projects was limited to internal preparatory tasks, e.g. the collection and aggregation of needs for joint procurement or conduction of e-auctions as an allowed method under the negotiated procedure at the time.

By showcasing the potential benefits of a broader e-procurement system, the implementation of these pilots has been critical to induce a structural change both at the level of procedures and working methodologies and, more importantly, the attitudes towards public procurement management which was calling for a new mind-set to be adopted by the key stakeholders.

The positive impact of pilot projects went well beyond the sole "electronic perspective" of matters and solutions - where the conduct of e-auctions deserves to be highlighted - and has significantly contributed to initiate a broader transformation. It was, indeed, within the pilot projects that a number of contracting authorities experienced, for the first time ever, a different collaborative atmosphere enabling them to share and aggregate needs, to setup the first specialized units within ministries and other contracting authorities in charge of managing the procurement and setting the minimum standards for the public consumption of some pre-selected cross-cutting categories of goods and services.

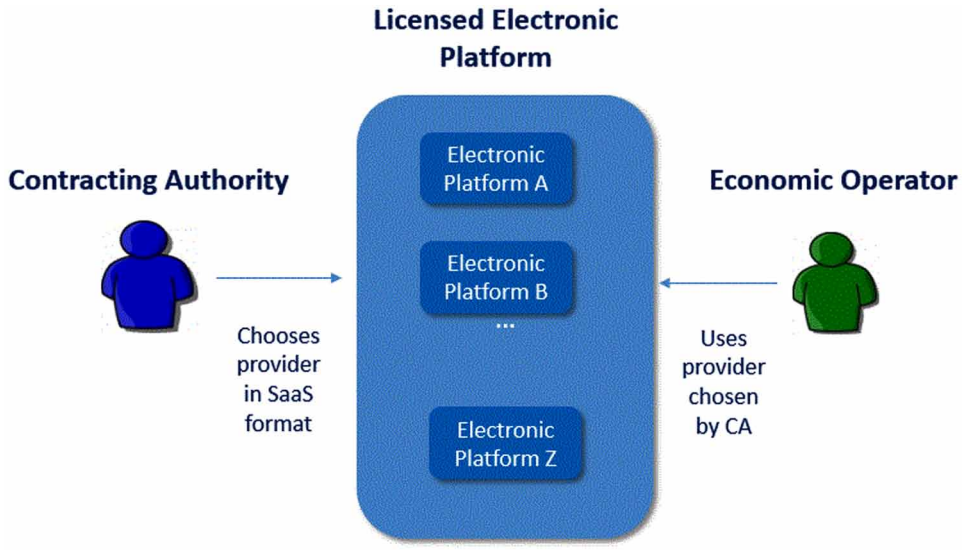
Key Features of the System

In clear contrast with a much less ambitious attitude adopted by the majority of Member States, and following a transitional period of one year, the electronic procurement became mandatory in Portugal as of 1 November 2009.

The PCC made, itself, a bold and comprehensive commitment to electronic procurement (Tavares, 2010) and translated into the legal provisions a solid, determined and ambitious political decision about a new public procurement system highly anchored in the use of electronic communications as a means to make it more transparent and efficient.

The rule is, in fact, that all public procurement procedures in Portugal must be performed electronically, from the publication of the contract notice to the publication of the contract award notice and the contract itself: all tender documents must be produced, published, notified and stored electronically; all economic operators must submit their applications, tenders, documents, requests for clarification, claims, etc., electronically; all communications between these two parties must be done electronically. Additionally, for all procedures encompassing the publication of notices, the contract formation phase must run on a certified electronic platform, i.e., the contracting authority documents must be published, notified and stored on an electronic platform; all economic operators must submit their applications, tenders, documents, requests for clarification, claims, etc., through an electronic platform.

Figure 2. The Portuguese e-public procurement framework



The implementation of this model required the availability of electronic platforms and the Portuguese legislator opted to rely on a market of electronic platform operators (instead of a model based on a single public platform). Decree-Law 143-A/2008, of 25 July, and Ordinance 701-G/2008, of 29 July, were adopted with the aim of regulating the activities of platform operators, and the key features and functionalities these platforms should be ready to offer in order to be granted the licence to operate.

The Law 96/2015, of 17 August 2015, (DRE, 2015) repealed DL 143-A/2008 and introduced the legal definition of electronic platform as "a technological infra-structure that consists of a number of computer applications, resources and services required for the operation of electronic procedures relating to national public procurement, and through which these procedures are carried out" (Article 2(e)).

The National Security Office (NSO) is the organisation under the Presidency of the Council of Ministers responsible for certifying electronic platforms in terms of electronic security. In May 2016, six certified electronic platforms were allowed to operate in Portugal.

The second pillar of the Portuguese e-public procurement model is the public contracts portal: portal BASE. This portal is a centralised database that contains extensive information about all public contracts and is automatically fed by the DRE - electronic official journal (www.dre.pt), the electronic platforms and by contracting authorities, depending on the type of procedure and the phase within the procurement cycle.

The Business Model

Simultaneous with the decision on mandatory electronic public procurement, Portugal also opted for a decentralised approach to e-procurement platforms, in contrast to several countries across Europe where e-procurement implementation models relied on the mandatory use of a single national platform (Assar & Boughzala, 2008) (European Commission, 2009). The CAs may select the most suitable platform

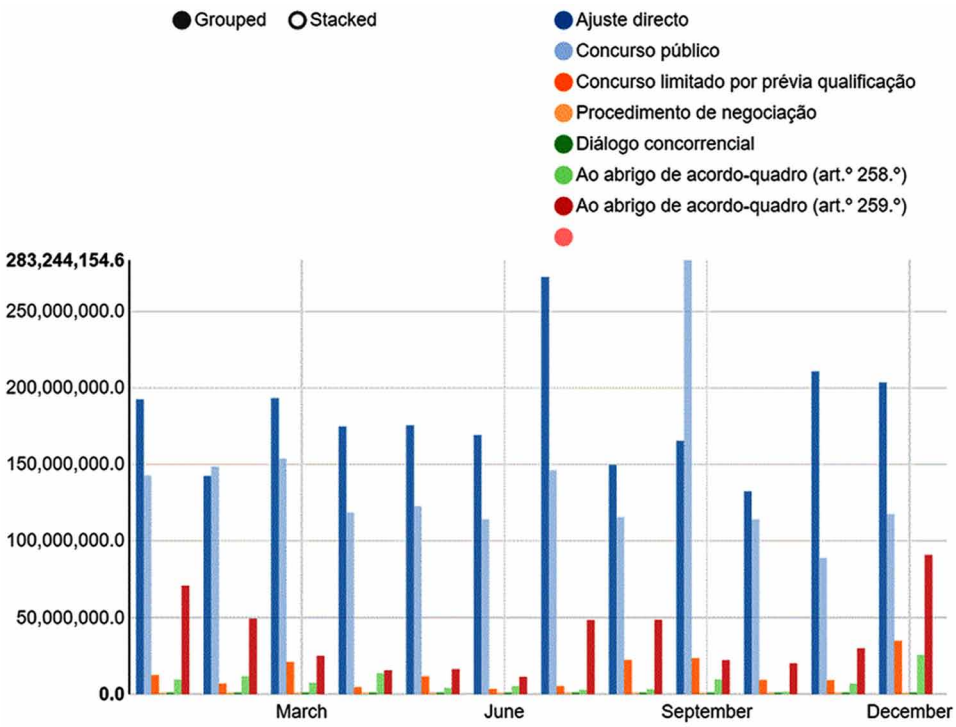
from a set of electronic platforms licensed by a Supervisory Board offering general and differentiated services, whose list is available on the public contracts portal (IMPIC, IP, 2016) and EOs must be registered and use the various platforms at the same time (see Figure 3). In the decentralised approach, the e-procurement platform market is regulated and each member must comply with strict security and safety requirements (Betts, et al., 2006) (Polemi & Papastergiou, 2006). As expected, the existence of several platforms increased competition and stimulated the development of more capable solutions, integrating business processes, promoting green procurement, boosting collaboration and enhancing electronic supply chain management (Arantes, Aguiar Costa, & Valadares, 2013).

As explained further ahead in this paper, this very option may have been among the critical success factors that allowed the public procurement system to overcome the difficulties raised by a slight high political rotation with concrete impacts at the level of the Public Administration and several strategic changes within a slightly short period of time if we consider the structural kind of reforms at stake. Notwithstanding, as in any other alternative, its practical deployment has shown positive and negative aspects that are recognised at both national and international levels.

On the positive side, it is important to stress that the model:

- Allows a very fast "Time to Market";
- Promotes a competitive market among private electronic platform operators;
- Fosters innovation as a result of such competition and as a result of a more demanding public client;

Figure 3. SaaS business model



- Requires a low initial investment and entry cost for public entities;
- The accreditation process regarding the security requirements of the platform and the operational conditions of the provider exempts Contracting Authorities from worrying about this complex task they are not prepared for and have no resources to undertake by themselves.

On the negative side, the following coud be highlighted as weaknesses of the model:

- Each economic operator must use multiple e-platforms;
- Lack of interoperability among e-Platforms;
- Difficulty to prevent some risks of anti-competitive behavior and conduct (both relating to the scope of services to be rendered and prices) from platform operators which was calling for a better regulatory framework. The Law 96/2015, of 17 August 2015 has responded to this challenge and today a proper enforcement scheme is in place.

New Levels of Transparency and Accountability

In its unique view of the electronic model of the information system, the Public Contracts Code provides for the establishment of a Web Portal to register contracts awarded under its legal framework.

One of the main reasons that supported the creation of this type of solution was the fact that direct awards - a fairly frequent type of public procurement procedure where suppliers can participate by invitation - were considered a black box within public expenditure. To avoid that, it became mandatory to disclose these contracts through a Web-based solution. Besides promoting transparency in the conduct of these procedures, which in the past were only known to the participating entities, the legislator wanted also to ensure its effective enforcement by determining that if this type of procedures were not disclosed on the Portal, the corresponding contract would not be paid. This enforcement mechanism significantly contributed to contracting authorities being more careful when complying with the regulations and, as a consequence of a much higher degree of compliance, the accuracy and completeness of information has increased significantly.

It should be noted that this type of information on the internal operations of the Public Administration had never come under the public eye in such a direct manner before. Such a transparency brought into direct awards induced a "silent revolution" in the behavioral culture of people and organizations and prompted a quite exacerbated scrutiny of the data published on the Portal in the early days of its existence.

Also of utmost importance was the need to provide a single information repository regarding all public procurement procedures enabling policy makers and market operators, from both demand and supply sides, to have a 360º view over the system. This aspect was quite visionary at that time, and not all stakeholders understood the implications of this measure, which was the establishment of a centralized repository of the life cycle of public contracts, in addition to the decentralized model of transactions processed through private platforms.

For the first time ever, it became possible to trace public contracts from the pre-award phase up to the post-award phase within an integrated information system.

The Public Contracts Portal: A Contracts Register

The public contracts Portal, called and known as "BASE", is a complex information system that automatically collects data, via the Internet, from various sources and from the electronic forms completed by contracting authorities in the reserved area. The system comprises a database the purpose of which is to centralize in a single repository the information from the entire Portuguese public administration. Accessed at www.base.gov.pt, it has a reserved access area for contracting authorities who, using the same link, can access their data either introduced directly by them or fed into the system by the electronic platforms. Its public component comprises also a specific subsystem for procedures related to works and public works, called the Public Works Observatory. The data entered in the Portal since August 2008 are an extremely valuable asset, enabling the Portuguese public administration to analyze information in many different ways, to profile public expenditure and its evolution across different macroeconomic scenarios and already significant time series, to carry out forecasts and analyses and, last but not least, to monitor compliance with the PCC in quantitative terms. By the end of May 2016, there were around 645 000 contracts registered in the system. Since August 2013, the uploading of the image of the document itself became mandatory.

Several stakeholders play a relevant role in interacting with the system's architecture, especially as regards the forwarding of information concerning the transactions related to the contract formation phase. Once electronic public procurements in the contract formation phase became mandatory, since 1 November 2009, electronic platforms have had to be used for all public procedures. Although electronic platforms are not mandatory in the case of direct awards, electronic means do have to be used. Transactions made on these e-platforms must be automatically forwarded to the BASE Portal through an interoperability system, for which a feasible technological solution had to be found, consisting of a number of *Web services* for the safe transmission of reported data.

One of the relevant stakeholders is the Portuguese printing house and mint (INCM - Imprensa Nacional Casa da Moeda), as it is responsible for the authentication system and the automatic transmission of notices concerning public procurement procedures. Cooperation with that entity is, therefore, particularly relevant. Firstly, because system developments in the user authentication component were no longer necessary, thus reducing efforts and implementing a good practice by reusing existing solutions. Secondly, not only because of the visibility of notices on a portal dedicated to public procurement, but also because integration with INCM has a very strong impact on the database: the integration of public notices automatically generates the procedures. As to the contracting authorities, they are responsible for ensuring the registration and execution of contracts using the forms available in the BASE reserved area. However, plans are in the pipeline to ensure the automatic transmission of this information in the future by developing *Web services* connected to the internal systems of each entity.

The BASE Portal keeps extensive information about most public procurement procedures and contracts, some of which is public and available online in real time, and some is stored and analyzed for reporting and policy purposes.

The model is a very simple one and is shortly described as follows:

For procedures conducted upon invitation, indicated by red arrows on Figure 4, all documents including the invitation to tender, contract specifications/requirements and respective tenders have to be transacted through electronic channels. While the use of electronic platforms is not mandatory for procedures by invitation, indicated by yellow arrows on Figure 4, still many contracting authorities are opting for electronic platform services to manage them. In any case, regardless of the means of communication effec-

Figure 4. Key processes run through the e-platforms, official journal and BASE Portal

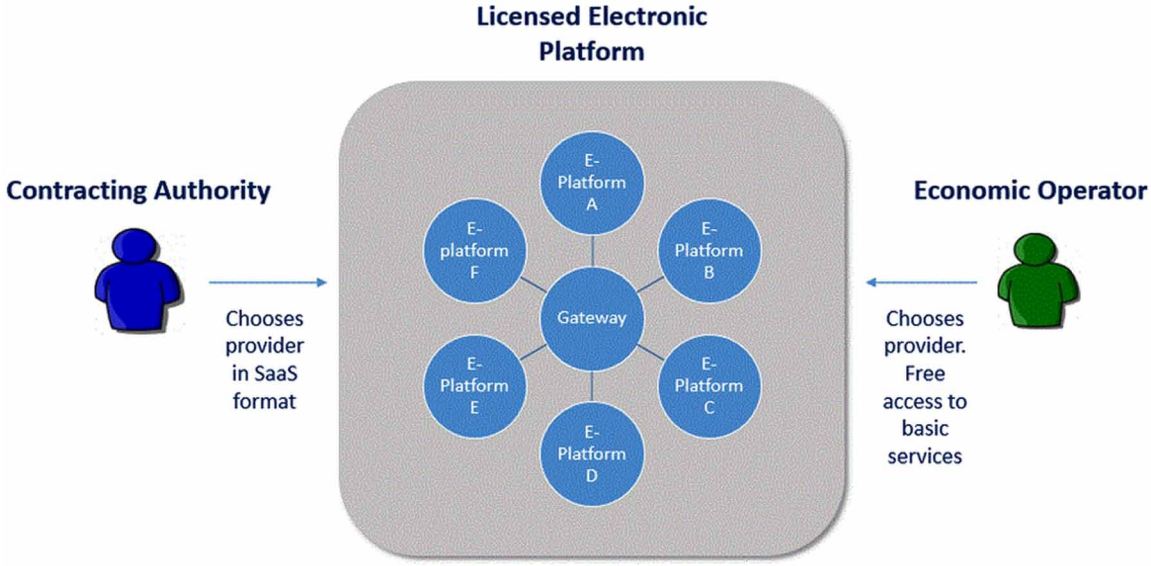
tively used, the publication of the contract information on the BASE Portal by the contracting authority is always mandatory in order to ensure completeness of information. This information includes, among others, details about the contacting authority, the economic operator, as well as the subject matter and the value of the contract. An important aspect of the publication of this information relating to contracts originated by a direct award (red arrows) is that, according to the PCC, the contract is null and void if the information is not published on the BASE Portal.

For procedures open to the competition (yellow arrows), some additional information is to be sent to the Base Portal. As defined in the legal framework, all notices are published in the electronic official journal DRE (www.dre.pt) by registered contracting authorities. The DRE sends a copy of the notice to the BASE Portal, by automatic means, and immediately registers the procedure into the database. From this moment onwards, contracting authorities (using the same login credentials as for accessing the DRE) can manage the procedure and contract related information in BASE Portal. Economic operators can both access notices on the DRE, or on the BASE Portal. In the last case some structured criteria are available for search. As mentioned before, it is mandatory that all published procedures are conducted through/within a certified electronic platform. The electronic platform automatically feeds the BASE Portal, through a *web services* infrastructure, with information about the procedures and contracts of the client contracting authority. The technical and functional documentation for the *web services* is public available on BASE as recommended in the legal regulation (IMPIC, IP, 2016).

In the public interface, it is possible to find a statistic area, in which some graphics and global amounts can be calculated in real time, organized by type of procedure, type of contract and by year.

Figure 5 shows an example of a graphic related to global amount per type of procedure distributed along 2015.

Figure 5. Sample statistical graphic generated by BASE Portal in the public interface



It is possible to find in the media many references to data published on the BASE Portal as well as on other tools such as the DADOS.GOV Portal, which contains the open format files published on the public area of the BASE Portal.

A Special View on Public Works: The Observatory - OOP.INCI.PT

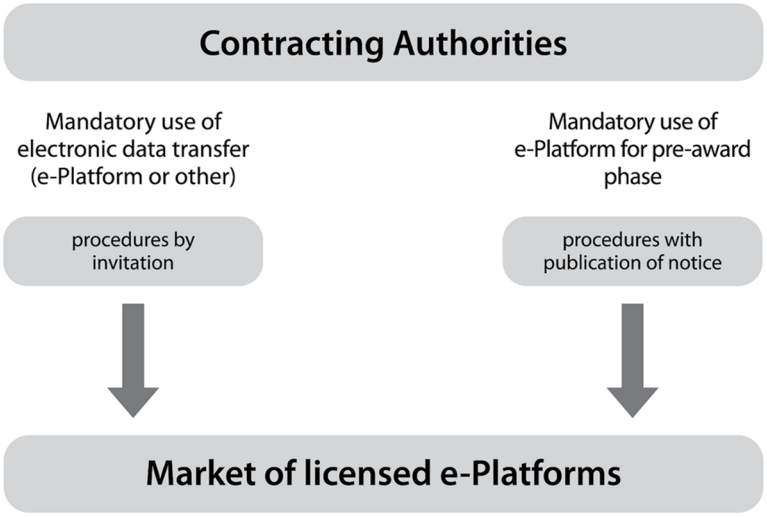
Contracts related to public works have always have always been the subject of special attention from various governments. The Public Contracts Code introduced significant changes in this area and provides for the creation of a Public Works Observatory (PWO) - Ordinance 701-I/2008, of 29 July - with the aim of monitoring the most relevant aspects of the execution of public works contracts.

The PWO is a special information filter within the BASE database that ensures the access and visualization of a set of data, as well as the analysis and dissemination of the corresponding statistical data related to public works contracts. The PWO is a relevant working tool for all entities that develop studies and need various statistical data on the public works market.

It comprises an information search system allowing a quick access to data related to the contract formation phase, including the invited tenderers (where appropriate), the applicants (where appropriate), the tenderers and the contractors. Moreover, during the contract execution phase the current status of each contract and the causes for deviation from its agreed deliverables, deadlines and cost can be traced throughout. All this information builds on the data entered in the BASE Portal by the contracting authorities, either during the contract formation phase, with the transmission of the Contracting Report (an embedded xml form), or during the contract execution phase, through the transmission of the Annual Summary Report (where appropriate) and the Works Completion Report.

The PWO is a valuable instrument for analyzing the public works sector, providing important quantitative inputs to policy-making in this extremely important field of public procurement.

Figure 6. Public works observatory main page



CASE ANALYSIS

As described above, the entire reform of the public procurement system in Portugal took place over several years and assumed a new shape in 2008 as a result of the legal reform that led to the publication of the Public Contracts Code, an integrated legal instrument applicable to the procurement of goods, services, public works and concessions. Although this legal instrument came into force in mid-2008, part of its scope, i.e., e-procurement, was only enforced almost a year later, in November 2009.

An important issue had a significant effect throughout the entire process: phased implementation, on a step-by-step basis.

The prior period that led the government to adopt the measures of the Code, which we know today, was essential to decision-making. For that reason, the study has taken the key success factors of digital transformation – creating a digital vision, engagement of employees, creating a governance system, and creating IT/business synergies – and analyzed the conditions associated with these factors in the Portuguese case that led to the measures that are still in force in Portugal.

As regards creating a digital vision – this vision, defined in 2004, marks the beginning of the system's reform through 4 pilot projects in 8 ministries. At the time, the solution to use tried and tested B2B tools available in the market and to not develop any central solution for the State seemed bold and very risky. The only way to assess whether this vision was feasible or not was to test it in the field. The vision, however, had been delineated and its potential had to be evaluated. These were Cloud service-based solutions for State services with everything that this entails in many aspects, and which are still the topic of lively debates in many areas. This vision was delineated by the UMIC mission unit with good political coverage at the time.

As regards the engagement of employees – this was decisive for the success of the pilot projects and underlined the government's decision to make electronic procurement compulsory. A large number of people from dozens of public institutions participated voluntarily in several specific working groups: legal analysis, product standardization, aggregated purchases, technical definition of specifications for IT

solutions, etc. The heads of services and units were involved and these groups engaged multidisciplinary teams organized throughout a network covering the whole public administration, working intensely for 3 years. While the effect of the involvement of people was felt in different ways, they all agreed that this was a period of thorough team work in which people worked towards the same goal.

As regards the creation of a governance system – the establishment of a new unit (UMIC) and, most importantly, its statute of task-force strongly impacted on how the reform strategy unfolded. First, because it was assigned to a new institution, thus overcoming possible conflicts in previously existing institutions that were dealing with the same matters before and could feel targeted by the changes. Secondly, the fact that the political coverage of this mission unit was quite far-reaching helped to spread the message that this was a high priority issue in the government's agenda. Lastly, because it enabled the strategy to be centrally managed at top level in the government structure, with operationalization being carried out by the institutions under the coordination of UMIC.

As regards creating IT/business strategies – the pilot projects were decisive for the government's decision to make e-procurement compulsory and, above all, for choosing a model based on private providers, a solution hitherto highly innovative in the public sector in this area.

Moreover, besides supporting the implemented model, it also enabled the design of what later became the architecture of the Portuguese electronic system. This experience clarified two major issues:

- The providers must be technically and functionally in line with the legal framework;
- The State needs a solution to safeguard what is most important: data.

The certification of electronic platforms by a public entity solved the first of these issues, while the second issue was resolved through a system implemented to gather the information on public contracts: the Public Contracts Portal.

It is right and proper to say that the digital transformation in public e-procurement was much influenced by the government's strong emphasis on modernizing its processes and services provided to citizens.

LESSONS LEARNED AND CHALLENGES AHEAD

What Made the 2008 Reform a Success

The positive results of the 2008 reform would not have been achieved had the legal, institutional and technological issues not been properly adjusted. The entire strategy behind the reform took into consideration the need to establish and nurture an alliance between the Government and other stakeholders in the public procurement system – an alliance which often had to overcome "counter-reform" tensions which, albeit outnumbered, nevertheless fueled a near-state of anxiety during the originally planned transitional period (Jul 2008 – Jul 2009) and especially during its extended period (Jul 2009 – Nov 2009). The following positively contributed to the situation:

- The political determination to tread the path outlined in the roadmap, with the legal requirement to mandatorily adopt electronic media once the transitional period ended and to report sanctions if "procurement on paper" happened to be used, i.e., resulting in a null contract and possible disciplinary penalties imposed to the heads of the contracting authority);

- The testimonials of organizations that had already fully migrated to the new paradigm (nobody was really experiencing any disruption or catastrophe as anticipated by those more skeptical about the change – on the contrary, the feeling of a "breath of fresh air" in public procurement and the opportunity for public procurers (demand side) to participate in a transformational process and to reposition their badly recognized profession came into play and acted as the "new ally" in the reform. Showcasing has proved to be the last and decisive selling argument to bring more and more entities and professionals to the new system;
- The response of e-platform operators, who, besides their obvious interest in being part of the change led by public stakeholders, offered technically reliable solutions and allocated adequate resources to the "problem-solving front" that is to be expected within such a vast and fast transformation.

Seven years of a mandatory electronic public procurement system have proved that a cloud-based architecture, based on software as a service model, can successfully meet the business needs.

Security accreditation of operators proved to be a key point in the whole process because without this fundamental requirement it would be very difficult for Contracting Authorities to define these criteria in the procurement procedure.

The knowledge required for this purpose is vast and complex and, in Portugal, as in many other countries, knowledge of ICT varies greatly from one public entity to another, being scarce in most organisms, especially the smaller-sized ones.

What's Next for Portugal?

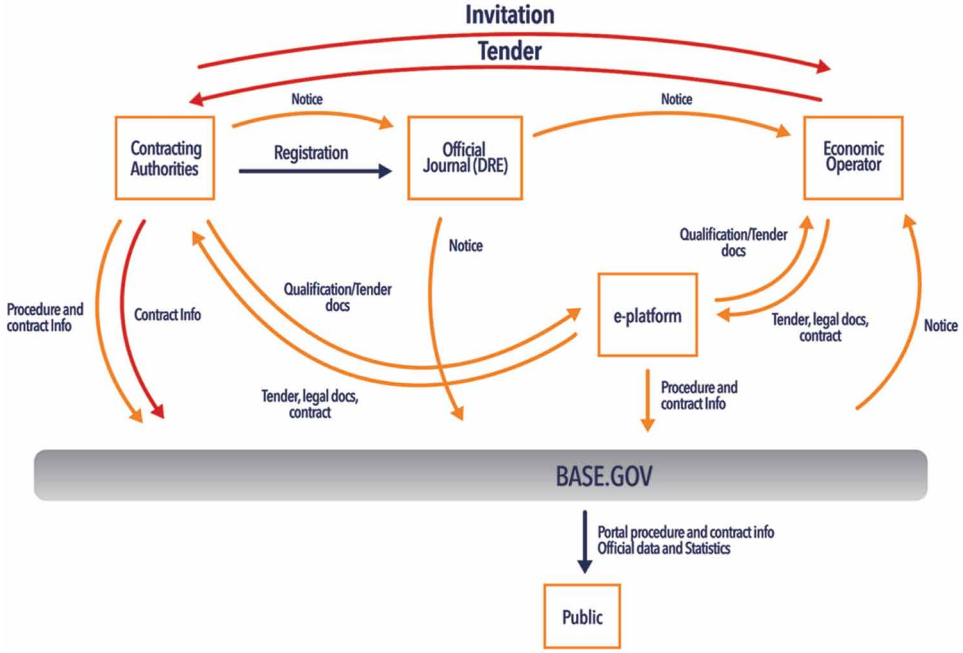
However, soon the Portuguese government realized that technical accreditation was not sufficient as the existing rules do not allow the imposition of sanctions in the event of infringement by the electronic platform operators, so it became crucial to update the legal framework to regulate this market.

Law 96/2015 not only sought to resolve this issue, but also resolved the issue, widely discussed in Europe, of the interoperability between e-Plaforms. The overall purpose here is to grant the economic operators the possibility of choosing the e-Platform they will use in a given procedure or transaction. To some extent, it aims at extending the principle of free choice, which today benefits only the contracting entities, to economic operators (supply side/suppliers).

This component of the legal framework will be further detailed by means of an Order to be published as soon as the ongoing architectural design phase is completed. If Portugal addresses this issue, it will have taken another giant step as leader in the development of public procurement solutions, because this will be a crucial point in the implementation of the European single market. However, it is also obvious that the maturity of this market is still relatively small for sufficient comfort to the solutions that currently foresee.

There is a tendency to increase measures, at European level, towards standardization to further consolidate an interoperability architecture, such as the creation CEN's Project Committee 'Electronic Public Procurement' (CEN/TC 440) which will proceed with the development of technical specifications that are intended to support electronic public procurement processes and their accompanying information flows. The deliverables being drafted in this Project Committee will provide business interoperability specifications and vocabulary in relation to e-Procurement, e-Notification, e-Tendering, e-Ordering and e-Fulfilment (CEN - CENELEC, 2016). Indeed, more than technology, interoperability is subject to the standardization of services and activities, which is still in its very early stages. In addition, the creation

Figure 7. Interoperability model



of a database with information from public contracts proved to be a fundamental part of the system. This piece of the puzzle allows the government to hold on to the information that would otherwise be kept only in private solutions, and hold a set of data analysis tools which can be applied according to the objectives.

It turns out that while there is still much to do in respect of reliability and data integrity, Portugal has reached in this field a fairly high level of development, hardly compared with other countries.

In this area, it has been proved that the system will benefit very much from automation mechanisms for data transfer under development. This is also a huge challenge for the Portuguese public administration because it implies more internal interoperability and the enforcement of the only-once principle.

CONCLUSION

The implementation of e-procurement in Portugal was, without any doubt, unusual within the European Union.

To some extent, it can be said that this was perhaps due to the following reasons:

- First, because it was the first country to adopt compulsory e-procurement for the pre-award phase;
- Because the model was based on solutions in Cloud Services, when few dared to do so at the time;
- Because it set forth in Europe a level of transparency in public contracts unheard of before;
- Because it introduced the certification of e-platforms;
- Because the architecture of the electronic system is based on an interoperability network between private and public systems;

And, finally, because despite the various unusual circumstances, what came out of it was a true and profound digital transformation.

There have already been repercussions from the learning acquired from the implemented model. In 2015, the e-procurement system was reformed and e-platforms became a regulated activity supervised by the State, in addition to the technical accreditation process already implemented.

This diploma makes room for an interoperability solution to cater for the principle of free choice of platform for Awarding Entities, and also for Economic Operators. Its future implementation could represent a major leap forward in interoperability across borders.

Finally, this profound revolution process began and was prepared with the establishment of UMIC in 2003 and with the implementation of pilot processes in 8 Ministries of the Portuguese Public Administration.

The rationale behind the implemented model has its roots in this history of unparalleled strong leadership and vision.

In the light of digital transformation, it can be said that:

- It was essential to define a clear vision of the model to be implemented, and to carry out tests;
- The engagement of people as a team was the driving force behind the strong sense of unity;
- Having a mission unit with clear capacities and power to coordinate the pilot projects led to this governance structure being accepted and coordinated by all stakeholders; and
- The experience of pilot projects enabled the system's architecture to be designed as it is today, by integrating several private and public elements in harmony.

To briefly summarize it, leadership in this case, as in many others, was without a doubt a differentiating and decisive factor in the achieved results.

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Chapter 26
Managerial Orientations and Digital Commerce Adoption in SMEs

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ABSTRACT

This chapter determines the relationships between managerial orientation factors, such as entrepreneurial alertness, learning goal orientation, and digital efficacy, on the adoption and outcomes of digital commerce in Small and Medium-Sized Enterprises (SMEs). A survey of Australian SMEs was conducted, and 109 useable responses were received. The results describe owner/manager views of digital commerce use and business outcomes such as growth and efficiency resulting from adoption. Hierarchical regression analysis reveals that managerial orientations related to entrepreneurial alertness scanning and search as well as learning goal-orientation predict growth outcomes resulting from using digital commerce. Being able to see connections, make associations, and search for new opportunities is significantly related to efficiency stemming from digital commerce adoption. The findings contribute to the knowledge of digital commerce adoption, its outcomes, and how these relate to managerial orientations of entrepreneurial alertness, learning, and digital efficacy.

INTRODUCTION

The digital landscape present many opportunities to alert entrepreneurs, from those that seize opportunities to create new firms in the virtual world to those who use digital technologies and tools to enhance business efficiencies, improve customer service, achieve significant cost savings and improve external network relationships with partners, stakeholders and suppliers (Jones, Simmons, Packham, Beynon-Davies & Pickernell, *in press*; Kaplan & Haenlein, 2010; Simsek, Lubatkin, Veiga & Dino, 2009). While the adoption of digital technologies by small and medium sized enterprises (SMEs) could

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provide numerous business-related benefits (Nguyen, 2009) and is seen as essential for future economic progress in Australia (Department of Broadband, Communication and the Digital Economy 2008), not all SMEs are keen to adopt new technologies. In fact Love, Irani, Standing, Line and Burn (2005) argue that reality is more complex for SMEs, with a myriad of factors influencing adoption, not simply cost-benefit-risk evaluation metrics. Similarly, Fillis, Johannson and Wagner (2004) propose that individual firm and managerial orientations play a key role in seizing digital opportunities. Valliere (*in press*) shed more light on the question as to why some SMEs are more likely to see digital opportunities, take action to exploit, and implement digital commerce than others through his conceptualisation of entrepreneurial alertness, as a managerial orientation.

Entrepreneurially alert owner/managers are more likely to notice environmental changes or internal triggers (Fillis *et al*, 2004) and in making sense of these triggers, may infer an opportunity to adopt digital commerce and seize the benefits it offers (Daniel & Wilson, 2002). Other managerial factors that influence digital commerce adoption include competencies (Nguyen, 2009), attitudes (Fillis et al, 2004) as well as learning and digital efficacy (Yi & Hwang, 2003). Simsek *et al*, (2009) find that an entrepreneurial alert information system enables SMEs to facilitate entrepreneurial action, while Yi and Hwang's study (2003) outlines the importance of learning goal orientation and self-efficacy for digital commerce adoption. While numerous authors have studied the barriers, benefits, costs (Love et al, 2005; Daniel & Wilson, 2002) and managerial competency factors (Fillis et al, 2004; Jones et al, *in press*) of SMEs related to information technology adoption, we're not aware of studies which relate entrepreneurial alertness to the adoption of digital commerce. Examining information technology adoption from a managerial orientation lens, which include entrepreneurial alertness, learning focus and digital efficacy enables us to gain a better understanding into SME owners/managers' behaviour, which is sometimes described as an enigma (Love et al, 2005). Thus the purpose of this paper is to determine the relationship between entrepreneurial alertness, learning goal orientation and digital efficacy as managerial orientations to the adoption and outcomes of digital commerce for SMEs. As such this study contributes to the digital commerce adoption literature, highlighting the role of entrepreneurial alertness, learning and efficacy for SMEs.

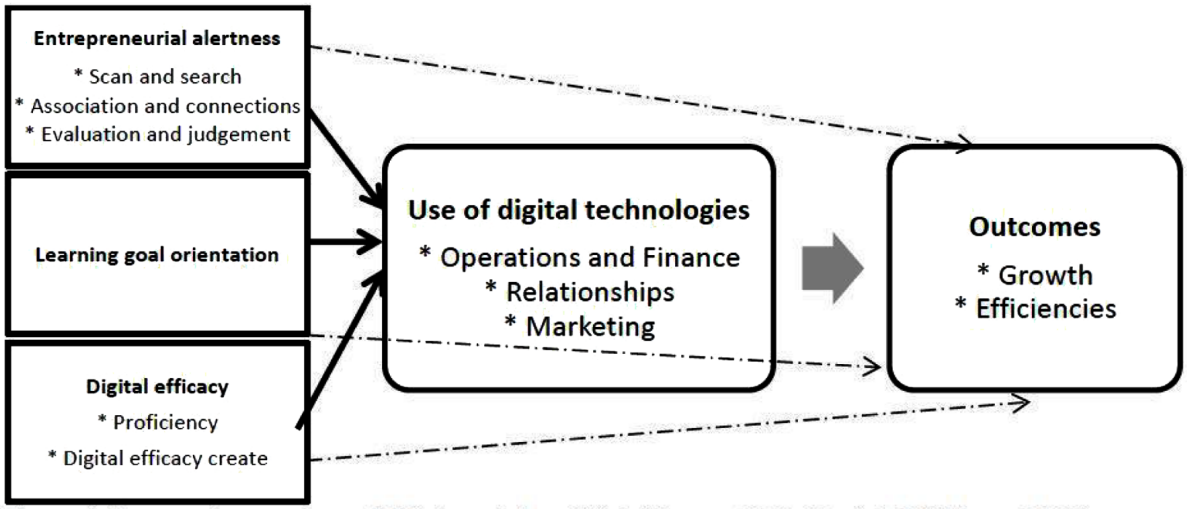
This study proceeds by first reviewing the literature regarding managerial orientations expected to influence digital commerce adoption, in particular entrepreneurial alertness, learning, digital efficacy, and adoption use and outcomes. There-after the method and results of the study is presented and hypotheses assessed, finally the discussion and conclusion highlights the key findings and implications of the study.

THEORETICAL BACKGROUND

Research Model and Hypotheses

Figure 1 presents the proposed research model. This model is based on the e-commerce adoption model (Daniel & Wilson, 2002) which postulates that technology use and outcomes are influenced by learning goal orientation and digital efficacy (Yi & Hwang, 2003). In this study we've added entrepreneurial alertness, since this construct can also be related to the use of digital technologies and outcomes from the use of those technologies. More specifically we take these constructs usually applied at an individual

Figure 1. Proposed research model (adapted from Yi & Hwang 2003; Daniel & Wilson, 2002)



level and extend these to the firm-level. This model in this paper explicitly studies technologies firms are currently using, and not those they are planning to adopt. It is expected that as firms use digital technologies, they should realise certain business outcomes such as growth in sales and customers, as well as increased efficiencies (Daniel & Wilson, 2002).

Adoption Use of Digital Technologies and Outcomes

A number of studies have shown that SMEs can use digital technologies for wide ranging business-related reasons such as customer (Daniel and Storey, 1997; Poon and Swatman, 1999; Wilson, Daniel, Sutherland, McDonald & Ward, 2001); competitors and supplier (Porter, 2001; Daniel & Wilson, 2002) as well as internal efficiency reasons (Poon & Swatman, 1999). This wide ranging number of reasons indicates that digital commerce is not a simple innovation, but rather a cluster of complex innovations which firms can choose to adopt (Daniel & Wilson, 2002). Therefore firms can choose between a number of alternative actions such as not adopting any technologies (Jones et al, *in press*); adopting a number of technologies related to operational and financial systems, internal communication and information sharing, or networking and relationship building, or marketing (Love et al., 2005), or they could integrate all of these technologies (Daniel, 2003). Based on the level of adoption use of digital commerce technologies, varying outcomes may result from this adoption (Nguyen, 2009). It is expected that the higher the level of perceived benefits, the more likely firms would be to continue using digital technologies, since they are aware of changes and may receive updates and learn more about new technologies. Daniel and Wilson (2002) show that the most important benefit SMEs in the UK derived from technology adoption was improved internal knowledge sharing; improved competitive position; enhanced efficient service and the ability to attract new customers. Not all firms decide to adopt these technologies, one of the reasons firms decide not to adopt digital commerce may be linked to the fact that they are not alert to digital opportunities.

Entrepreneurial Alertness

Entrepreneurial alertness plays a critical role in individuals' and firms' discovery and evaluation of opportunities (Kirzner, 2008) and might help explain why some firms are more likely to seize opportunities and act entrepreneurially than others (Simsek et al., 2009). Lack of theoretical clarity and measurement issues stalled research progress of this concept, however Tang, Kacmar and Busenitz (2012) recently proposed a validated measure of entrepreneurial alertness, while Valliere (*in press*) has enriched the theoretical foundations and antecedents of the concept. Therefore the time is ripe to extend the concept of entrepreneurial alertness to a firm-level orientation related to digital opportunity perception and technology adoption; and examine whether some SMEs, who are more entrepreneurially alert than their peers, are more likely to adopt and realise the benefits from available digital opportunities.

Tang *et al* (2012) conceptualise alertness as having three complementary dimensions: scanning and search for new information in the digital realm; connecting previously-disparate information regarding digital changes in the market place; and evaluating whether the new information represents an opportunity. These three dimensions work in a process like fashion where firms first become aware of gaps or shortcomings by actively looking for new bits of information, second creatively associate these disparate bits of information with existing knowledge and schema (Valliere, *in press*) and then finally make evaluations and judgements about the dynamism perceived and decide whether the opportunity is a general one, or one they would like to adopt and exploit (McMullen and Shepherd, 2006).

The first dimension, scanning and search, enable SME owner/managers to look for digital ideas to solve resource problems, improve customer service as well as improving relationships within their networks, with suppliers for example. SME owner/managers develop both tacit knowledge from experience, conversations and digital interactions with stakeholders, and explicit knowledge codified in firm and market reports and other formal documents (Tang *et al*, 2012). Owner/managers might also purposefully look for answers to questions about the value of digital technologies, possible cost savings and efficiency improvements (Jones *et al, in press*). Information gained through this scanning and search process would be added to existing cognitive frameworks and experiences (Valliere, *in press*). Those SME owner/managers who actively scan and search the digital environment are therefore more likely to use new technologies and also more likely to realise the beneficial outcomes these technologies may offer, thus:

H1a: Alert scanning and search is positively related to use of digital technologies.
H1b: Alert scanning and search is positively related to business growth and efficiencies of digital technologies.

The process of connecting and associating new stimuli with existing knowledge and coming to new insights represents the second stage, namely association and connection. In this stage information that supports existing beliefs are more easily incorporated into an existing schema, while negative data may be weighed, considered and either be rejected or the existing schema might be adjusted to accommodate this information (Fiske and Taylor, 1984). This process enables SME owner/managers to see the 'big picture' rather than consider each piece of information separately; therefore pattern-recognition (Baron and Ensley, 2006) plays an important role here. Scanning and search and association will happen continuously as the owner/managers works through the problem or new idea enrichment. As firms use digital technologies new stimuli regarding these technologies would be associated and connected with

existing schema. Furthermore growth and efficiency outcomes realised from digital adoption would further enhance the connection and association process, thus:

H2a: Alert association and connection is positively related to use of digital technologies.
H2b: Alert association and connection is positively related to growth and efficiency outcomes of digital technologies.

In the evaluation and judgement stage owner/managers might perceive the existence of digital opportunities, however they might decide that these are third person opportunities, in other words they believe the opportunity exists for someone else to exploit (McMullen & Shepherd, 2006); or if they decide it is a first person opportunity, they themselves might exploit the opportunity or adopt the digital technology. This evaluation and judgement stage of entrepreneurial alertness seem to be critical in the entrepreneurial alertness process (Tang *et al*, 2012). In the evaluation and judgement stage SMEs would decide through the use of digital technologies, whether to pursue and adopt further technologies. Additionally the outcomes are also expected to influence future evaluation and judgement for further digital adoption, thus:

H3a: Alert evaluation and judgement is related to use of digital technologies.
H3b: Alert evaluation and judgement is related to the outcomes (growth and efficiencies) of digital technology use.

Learning Goal Orientation

Entrepreneurial learning has been shown to promote entrepreneurial behaviour, despite severe time, attention and other resource limitations SMEs face (Ravasi & Turati, 2005). Experiential learning, commonplace in SMEs, is closely linked to all three dimensions of entrepreneurial alertness, from scanning and search, association and idea generation to evaluation and judgement (Corbett, 2007). Specifically owner/managers, who are highly motivated to learn (high learning goal orientation), attempt tasks to investigate the novelty of emerging technologies, find out how things work or to improve their skills. In the case of digital commerce adoption owner/managers with high levels of learning goal orientation would be more driven and energised to master new technologies. Such owner/managers believe digital ability is an incremental competency that can be improved continuously by experimenting with new technologies, thereby acquiring knowledge (Wood and Bandura, 1989). They look for perplexing tasks that provide opportunities to enhance their expertise and skills and are not fazed by mistakes. These they view as a normal part of the learning process.

Learning goals have been related to a number of adaptive outcomes, including higher levels of efficacy, task value, interest, positive affect, effort and persistence, learning strategies, as well as better performance (Printrich, 2000). Individuals with a high learning goal orientation are more likely to stick to a task, persevere and even increase their efforts until they achieve their goals. These are typically the individuals in an organisation who feel compelled to help and solve technological problems, for a challenge or enjoyment. In SMEs it is expected that firms, which support and encourage individuals with high learning goal orientations, will make more use of digital technologies, since these individuals will be encouraged to master new digital tools. Additionally it is expected that individuals with high learning goal orientations will experience benefits from the challenge of the task and develop self confidence in using and mastering new technologies. Therefore, we hypothesize that:

H4a: Learning goal orientation will be positively related to the use of digital technologies;
H4b: Learning goal orientation will be positively associated with the outcomes derived from digital technology use.

Digital Efficacy

Self-efficacy (ESE) refers to the self-confidence owner/managers have that they hold the required abilities to be successful, which plays an important role in determining their level of motivation in pursuing opportunities (Kickul, Wilson & Marlino 2004). Wood and Bandura (1989) noted that "to be successful one not only must possess the required skills, but also a resilient self-belief in one's capability to exercise control over events to accomplish desired goals." Many studies have validated the relationship between self-efficacy and challenging tasks in various contexts such as entrepreneurial intentions (Kickul et al., 2004), images of an opportunity (Mitchell & Shepherd, 2010), complex decision making (Wood and Bandura, 1989), computer skill acquisition (Gist, Schwoerer & Rosen, 1989; Mitchell, Hopper, Daniels, George-Falvy & James, 1994), and user acceptance of technology (Agarwal, Sambamurthy & Stair, 2000; Venkatesh, 2000).

According to Marakas, Yi and Johnson (1998), computer self-efficacy (CSE) is a multi-level construct relevant to application based digital technologies, but also on a general level. This type of efficacy is based on an individual's judgement of their efficacy across specific applications or at the overall domain of general computing (Pavlou & Fygenson, 2006; Yi & Hwang, 2003) and can serve as a proxy for managerial competencies (Bassellier, Reich & Benbasat, 2001). We extend this concept of computer self-efficacy to the more general domain of digital commerce and examine digital efficacy at a firm level by determining the range of individuals within an SME who are confident of their digital technology skills to perform operational tasks as well as those who are confident to create new digital artefacts for the firm using existing digital tools. Depending on the performance of these daily operational tasks (which is seen as digital proficiency) and creating new digital artefacts such as websites or social media pages the efficacy of the firm overall should improve or weaken their overall motivation to adopt digital technologies and solve problems (Wood & Bandura, 1989). Yi and Hwang (2003) find that computer self-efficacy is positively related to increased use of digital technologies. According to social cognitive theory (Bandura, 1982) encouraging experiences and positive incidents tend to enhance efficacy, therefore it is expected that positive outcomes experienced through increased digital use will strengthen digital efficacy.

H5a: Digital proficiency is associated with use of digital technologies.
H6a: Digital efficacy is positively related to the use of digital technologies;
H6b: Digital efficacy is positively associated with the positive outcomes derived from digital technology use.

METHODOLOGY

This studied surveyed SMEs in Australia, using a questionnaire to determine the adoption of digital commerce and the influence of managerial orientations such as entrepreneurial alertness, learning goal orientation and digital efficacy on digital commerce adoption.

Population and Sample

The population of interest for this paper is SMEs using or developing digital commerce technologies. In Australia SMEs are defined as firms employing less than 200 employees aligned to the Australian Bureau of Statistics (ABS) guidelines (Wiesner, McDonald & Banham, 2007). Specific industries of interest were tourism, communications, retail and wholesale and services, since these industries were identified as experiencing significant pressures to adopt digital commerce.

A random sample of 1 000 SMEs was drawn from the Instant Mailing Lists database (commercial database company). Criteria to select these firms were less than 200 employees, from the specified industries, and representative of all Australian states. Each firm was contacted telephonically, informed about the aim of the research and invited to participate. Consenting firms were sent the questionnaire either by post or with a link to the online version. Data collection was undertaken in October to December of 2012. In total 125 responses were recorded (total response rate of 12.5%) Of these 16 were rejected as incomplete, therefore the 109 useable responses (effective response rate of 10.9%) and were used as a basis for the findings of this study.

A little more than half of firms (52.8%) in the sample are micro-enterprises, employing less than five full-time employees, while 15.8% employ between 5 to 20 employees, 8.7% between 20 to 50 employees and the rest 50 to 199 employees. The majority of firms (46.5%) in the sample have been in existence for longer than 15 years, while 5.5% of firms had done business less than 3 years and close to a third (33.8%) indicated that they have been in existence between 3 to 15 years. The majority (37.8%) of firms indicated that their turnover was between $1 to $5 million per annum, while 23% indicated a turnover exceeding $5 million; and 5.5% reported their turnover to be less than $100 000 per annum. The firms in the sample varied between serving mainly business customers (25.9%) on the one hand to serving mainly final consumers (28.3%) at the other, with most concentrating on sales within Australia (55.1%). Only 10.2% of firms in the sample indicated that they sold more than 70% of the products or services outside the country. Firms across all states were targeted for the survey; however most respondents (28.3%) were based in Queensland, followed by 18.1% in Victoria, 15.7% in New South Wales and 10.2% from Western Australia.

The method of determining non-response bias adopted in studies such as Goode and Stevens (2000) was adopted for this study. In this method the earliest responses received were compared with the later responses. The useable responses were split into two equal sets of 54 responses according to the dates on which they were received. No significant differences were found for any of the eight sections of the instrument. It is therefore concluded that the responses received are unlikely to contain non-response bias.

Measurement Instrument

The research was carried out using a questionnaire which firstly explained the aim of the study, eligibility, voluntary nature and a simple definition of digital commerce that we preferred respondents keep in mind when completing the survey. The questionnaire contained seven sections. Section 1 to 4 explored the reasons, use, outcomes and integration of digital commerce adoption, while Sections 5 and 6 focused on entrepreneurial alertness, learning goal orientation and digital efficacy, as managerial orientations. The final section of the questionnaire collected general firm information (size, age, industry). This paper uses data related to adoption use of digital technologies, outcomes, entrepreneurial alertness, learning goal orientation and digital efficacy.

The survey instrument was piloted with 23 SMEs. Ambiguous and repetitive questions were removed or adapted and the layout was also changed to facilitate responses. Despite these changes, the questionnaire proved to be a bit long for some respondents and incomplete responses suggest respondent fatigue.

Digital commerce adoption was measured by actual use of digital technologies, rather than adoption intentions or the technology features or platforms utilised, in accordance with Daniel, Wilson and Myers (2002) in their study of e-commerce adoption of UK SMEs. Respondents were asked to indicate whether they were using, developing or not using a particular digital tool in their firms (Daniel & Grimshaw, 2002). These digital technologies resorted into three main areas: finance and operations; outward relationship-type of activities and marketing activities. Outcomes from adoption of digital technologies was measured on a 4 point Likert scale and resorted into two factors related to growth and efficiency (Daniel, 2003). The dependent variables were measured using existing scales, for example entrepreneurial alertness using a 4 point Likert scale and items proposed by Tang et al (2012), learning goal efficiency on a 4 point Likert scale adapted from Yi and Hwang (2003)'s study and Brett and VandeWalle (1999), and digital efficacy on a 5 point scale adopted from Hsu & Chiu (2004).

Data Analysis

The data were analysed using IBM SPSS V21. Descriptive statistics, reliability coefficients and correlations were calculated for the variables. While descriptive statistics provide a general picture of the data, the Cronbach alpha coefficients provide a measure of the internal consistency of variables, while the correlation analysis allow for an initial test of the hypothesis. Hierarchical regression analysis was used to further test the hypothesised relationships between the constructs, while controlling for industry.

RESULTS

Table 1 shows the mean and standard deviation for the dependant and independent variables. The Cronbach alpha coefficient is shown in italics for each construct. The coefficient scores meet Nunnally's (1978) threshold for internal consistency, with the independent variable entrepreneurial alertness' three dimensions scanning and search (0.77), association and connection (0.88) and evaluation and judgement (0.84) showing acceptable reliability. This was also the case for learning goal orientation (0.78); and proficiency (0.88) and digital efficacy (0.76) as measures of a firm's digital confidence. The dependent variables, use of digital technologies' three dimensions operations and finance (0.79), relationships (0.77) and marketing (0.73); as well as growth (0.74) and efficiency (0.76) outcomes, indicated internal consistency.

The mean scores for the constructs of entrepreneurial alertness showed that most SMEs rated themselves highly on scanning and search (3.02) and then evaluation and judgement (2.99). In terms of firm digital confidence, firms who were using digital commerce showed high levels of proficiency across all staff working for the firm (3.91), while digital efficacy which included items related to creating web sites or social pages, had a lower mean score (2.44) indicating that fewer individuals in firms have this level of confidence. Use of digital commerce was particularly prevalent for marketing (3.59) and operations and financial (3.54) activities, as can be expected since many SMEs make use of financial packages for accounting purposes. Only those firms who used digital commerce answered the questions about

Table 1. Descriptive statistics and correlation analysis

Constructs	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Scan	3.02	0.51	*0.77*										
2. Association	2.69	0.65	0.643**	*0.88*									
3. Evaluation	2.99	0.54	0.365**	0.499**	*0.84*								
4. Learning	2.71	0.58	0.544**	0.393**	0.258**	*0.78*							
5. Proficiency	3.91	0.67	0.212*	0.207*	0.162	0.343**	*0.88*						
6. Digital Efficacy	2.44	0.85	0.254*	0.227*	0.123	0.326**	0.437**	*0.76*					
7. Operation & Finance	3.54	0.52	0.299*	0.326**	0.170	0.133	0.078	0.228	*0.79*				
8. Relationships	3.15	0.66	0.337**	0.255*	0.245*	0.352**	0.049	0.200	0.630**	*0.77*			
9. Marketing	3.59	0.45	0.249*	0.073	0.009	0.148	0.205*	0.273**	0.666**	0.490**	*0.73*		
10. Growth benefits	2.79	0.56	0.623**	0.502**	0.95	0.665**	0.189	0.358**	0.139	0.524**	-0.41	*0.74*	
11. Efficiency benefits	2.63	0.61	0.542**	0.581**	0.303*	0.305*	0.126	0.313*	0.396**	0.428**	0.331*	0.702**	*0.76*

n=109
* Significance
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Explanatory notes:
The constructs in the left hand column are purposefully numbered, these numbers signify the same variables in the columns numbered 1 to 11.
The number in *italics* denote the Cronbach alpha coefficient for each construct.

the resultant outcomes. Generally SMEs indicated more growth (2.79) outcomes realised from digital commerce, than efficiency outcomes (2.63).

Correlation Analysis

The correlation analysis shown in Table 1 provides an indication of the relationships between constructs and the dimensions of the constructs.

The three dimensions of entrepreneurial alertness are significantly associated with one another, with scanning and search and association and connection showing the strongest correlation (0.643; $p<0.01$). The dimensions evaluation and association (0.499; $p<0.01$) also a show significant correlation, as well as scanning and search with evaluation and judgement (0.365; $p<0.01$). This is in line with Tang et al's (2012) measures and supports the argument that entrepreneurial alertness is a conceptual process, starting with scanning and search as a divergent process, converging in evaluation and judgement; as the action orientated dimension of entrepreneurial alertness.

Digital proficiency and efficacy was also significantly correlated (0.437; $p<0.01$), yet distinct from proficiency, meaning the ability and confidence to use a digital application. In contrast digital efficacy was related to the creation of digital artefacts such as creating a website or social pages, indicating advanced knowledge and confidence.

In our study use of digital technologies were divided into three main areas: operations and finance, relationship or outward bound activities and marketing. Operations and finance was strongly and significantly associated with marketing activities (0.666; $p<0.01$) and then with outward relationship activities (0.630; $p<0.01$). Outward relationships and marketing was also significantly correlated (0.490; $p<0.01$),

supporting the notion that firms progressively adopt digital technologies across all the range of business activities. The resulting outcomes from digital commerce, growth and efficiency, were also strongly and significantly related (0.702; $p<0.01$).

An initial assessment of the relationship of entrepreneurial alertness' three dimensions showed significant correlations with learning goal orientation, that is scanning and search (0.544; $p<0.01$), association and connections (0.393; $p<0.01$), and evaluation and judgement (0.258; $p<0.01$), of which scanning and search the strongest. This seems logical since the purpose of scanning and search is to learn more about different opportunities of challenges, in contrast association would be more closely linked to creative, divergent thinking and evaluation and judgement to decisions and actions.

Entrepreneurial alertness was significantly correlated to proficiency and digital efficacy in terms of scanning and search (0.212; $p<0.05$; 0.254; $p<0.05$ respectively) and association and connections (0.207; $p<0.05$; 0.227; $p<0.05$ respectively), however evaluation and judgement was not correlated to proficiency or efficacy. For the use of digital technologies the correlation analysis showed that scanning and search was significantly correlated with operations and finance (0.299; $p<0.05$), relationships (0.337; $p<0.01$) and marketing (0.249; $p<0.05$), while association and connection was correlated to operations and finance (0.326; $p<0.05$) and relationships (0.255; $p<0.05$), but not marketing. Evaluation and judgement was only correlated to relationships (0.245; $p<0.05$). Much stronger associations are shown with the outcomes from digital commerce. For growth outcomes both scanning and search (0.623; $p<0.01$) and association and connection (0.502; $p<0.01$) show significant correlations, however evaluation and judgement do not. For efficiency outcomes all three dimensions show significant associations, scanning and search (0.542; $p<0.01$), association and connection (0.581; $p<0.01$) and evaluation and judgement (0.303; $p<0.05$).

Learning goal orientation which indicates a high level of motivation to master new digital technologies was significantly associated with proficiency (0.343; $p<0.01$) as well as digital efficacy (0.326; $p<0.01$), since it is expected that these two constructs would increase as more employees are willing and energised to learn to use new digital technologies. Learning goal orientation was only correlated to the use of digital technologies to build relationships (0.352; $p<0.01$), but not operations and finance or marketing. This is possibly due to the fact that learning orientation is seen as a preparation step which is associated with relationships, but not with routinized activities such as operations and marketing, already mastered by most employees. Significant relationships were shown with outcomes from digital commerce, especially for growth (0.665; $p<0.01$), but also for efficiency (0.305; $p<0.05$). As Wood and Bandura (1998) suggested positive outcomes realised from these activities strengthen learning goal orientation.

Proficiency was not associated with the adoption of digital commerce for operations and finance or relationship digital activities. Proficiency showed a weak, significant correlation to marketing activities (0.205; $p<0.05$). Digital efficacy was not correlated to operations and finance or relationship adoption activities, however it was significantly correlated to marketing adoption activities (0.273; $p<0.01$). Proficiency was not related to the outcomes from digital commerce, however digital efficacy was significantly correlated to growth (0.385; $p<0.01$) and also efficiency (0.313; $p<0.05$).

The use of operations and finance technologies was significantly related to efficiency (0.396; $p<0.01$), as was also the case for marketing digital technologies (0.331; $p<0.05$). Both growth (0.524; $p<0.01$) and efficiency (0.428; $p<0.01$) outcomes were realised through the use of relationship type technologies.

Hierarchical Regression Analysis

Hierarchical regression analysis was used to assess hypotheses 1 to 6 which proposed that managerial orientations: entrepreneurial alertness, learning goal orientation and digital efficacy (independent variables) would be related to adoption use of digital technologies and outcomes from digital commerce adoption. Hierarchical regression allows us to control for industry, which has been shown to influence investment and outcomes in information technology adoption (Love et al, 2005).

Adoption Activities

When looking at adoption use of digital commerce the following relationships were ascertained using hierarchical regression analysis. Operations and finance activities showed no significant relationships with entrepreneurial alertness, learning goal orientation or digital efficacy. These type of activities are often routinized and digital technologies used here can be related to the advice and support provided by external stakeholders such as accountants, who Berry, Sweeting and Goto (2006) and Mole (2002) find provide business, emergency, and financial management support in addition to statutory advice, and have a significant impact on SME decisions. Therefore the owner/manager's orientation related to entrepreneurial alertness, learning or digital efficacy does not seem to influence the adoption of operational and financial type technologies.

Relationship adoption activities focused on supplier and competitors actions. Hierarchical regression analysis showed that learning goal orientation (β=0.283; $p<0.10$) was marginally significant in relation to relationship adoption activities, explaining an additional 4% of the variance in this variable, after controlling for industry. Therefore H4a which stated that learning goal orientation is positively related to the use of digital technologies is tentatively accepted, since this hypothesis only holds for relationship adoption activities. Entrepreneurial alertness and digital efficacy was not related to relationship adoption activities.

For marketing related activities only the scanning and search dimension of entrepreneurial alertness (β=0.293; $p<0.05$) was a predictor for marketing use, with this construct explaining an additional 6.5% of the variance in marketing adoption activities after controlling for industry. Therefore H1a which stated that alert scanning and search is positively related to the use of digital technologies is partly accepted, particularly for marketing related activities.

Therefore hypotheses 2a and 3a which postulated that the alert association and connection and evaluation and judgement dimensions of entrepreneurial alertness are related to the use of digital technologies is rejected. Hypothesis 5a which suggested that digital proficiency is associated with the use of digital technologies is rejected as well as H6a which claimed that digital efficacy is positively related to the use of digital technologies for marketing related activities. As Love et al (2005) suggested industry influences digital efficacy.

Outcomes from the Use of Digital Commerce

In this study two main types of outcomes resulting from digital commerce use were studied, namely growth and efficiency. The results of the hierarchical regression analysis are shown in Table 2.

To analyse growth outcomes, we first entered industry as a control variable. This base model was marginally significant (R^2 = 7%, $p<0.10$). The addition of the predictor variables made a significant

Table 2. Hierarchical regression analysis for outcomes of digital commerce adoption

Variables	Growth		Efficiency	
Managerial Orientations	**Base Model**	**Full Model**	**Base Model**	**Full Model**
Entrepreneurial alertness				
Alert Scanning and Search		0.344*		0.270^{+}
Alert Association and Connection		0.086		0.419*
Alert Evaluation and Judgement		-0.150		-0.018
Learning Goal Orientation		0.401**		-0.086
Proficiency		-0.038		-0.017
Digital efficacy		0.100		0.163
Control – Industry	-0.265^{+}	-0.166^{+}	-0.121	-0.094
Constant	3.210**	1.293*	12.763**	-0.121
Model				
F statistic	4.00	9.396	0.864	5.226**
R^2	0.070^{+}	0.583**	0.015	0.413**
Adjusted R^2	0.530^{+}	0.521	-0.002	0.334**
Δ R^2	0.700	0.513**	0.864	0.398**
N	55	55	60	60

Standardised regression coefficients are displayed in the table
** p<0.01; * p<0.05; $^{+}$ p<0.10

contribution over and above the base model (ΔR^2=70%; p< 0.01). In the full model, there were significant coefficients for alert scanning and search (β =0.344, p<0.05) and learning goal orientation (β =0.401, p<0.01). These results partial support hypotheses 1b and 4b respectively. The effects for the remaining managerial orientation variables of alert scanning and connection, evaluation and judgement and digital efficacy were not significant and therefore hypotheses 2b, 3b and 6b were not supported.

In the results for efficiency outcomes, the base model was not statistically significant (R^2=1.5%, p>0.10). The addition of predictor variables made a significant contribution over and above the base model (ΔR^2=39.8%; p<0.01). In the full model alert association and connections had a significant coefficient (β =0.419, p<0.05) and alert scanning and search a marginally significant coefficient (β =0.270, p<0.10). The predictor variables explain 33.4% of the variance in efficiency outcomes. These results provide partial support for hypothesis 1b and 2b, where it was suggested that alert scanning and search and alert association and connection would be related to efficiency outcomes. Hypotheses 3b, 4b and 6b were not supported, since alert evaluation and judgement, learning goal orientation and digital efficacy were not significantly related to efficiency outcomes. Therefore the efficiencies realised from the adoption of digital technologies can in part be explained by SME owner/managers making association and connections to see how different technologies are integrated and also by alert scanning and search for new digital opportunities.

DISCUSSION

The findings from our study suggest that the adoption of digital commerce is influenced by a complex number of interrelated factors, as Jones et al (*in press*) and Love et al (2005) also confirm. SMEs do not uniformly adopt digital technologies, citing reasons such as client preferences and resources for non-adoption, while the literature provide a wide-ranging number of reasons categorised into macro factors, industry and sectoral factors, as well as firm and managerial factors (Fillis *et al*, 2004; Love *et al*, 2005).

In our study the adoption of digital technologies was grouped into three main use categories, namely for operations and finance, outward relationship and marketing activities. Operation and finance digital activities was not related to entrepreneurial alertness, learning goal orientation or digital efficacy, possibly due to the fact that business advisors, such as accountants may recommend the use of these systems thus reducing the influence of owner/manager's orientation towards opportunities, learning or digital efficacy. The use of digital technologies for relationship activities was related to learning goal orientation, but not entrepreneurial alertness or digital efficacy. In SMEs where the owner/manager and employees are open to new digital technologies and willing to learn about how to use and realise the benefits there-of, it seems that digital technologies will also be used to enhance relationships with external stakeholders. In these cases SMEs are motivated and driven to improve relationships with suppliers and use technologies to find information on competitor activities, possibly adding value to the firm's competencies. Marketing activities such as advertising and after sales service was partly explained by the scanning and search dimension of entrepreneurial alertness. As marketing activities involve direct relationships with customers, SMEs may often become aware of opportunities through interactions with clients and searching for solutions for client problems, thus clients may partly drive the use of digital commerce for these types of activities, as supported by other studies (Daniel & Wilson, 2002; Love et al, 2005).

Adoption of digital technologies results in various outcomes, such as growth in customers and efficiency improvements from the use of these technologies.

Outcomes related to growth refer to increases in customer numbers, more meaningful customer interactions, growth in customisation of services, identification of business opportunities and more effective advertising. These growth outcomes are explained by entrepreneurial alertness and learning goal orientation. Entrepreneurial alertness, specifically scanning and search explain the variance in growth benefits, after controlling for industry effects. Valliere (*in press*) provide a framework to explain how entrepreneurial alertness, as an opportunity spotting talent starts with entrepreneurial attention focused on a consequential aspect for an individual. Applied to this study, SME owner/managers who are focused on realising growth outcomes from their investments in digital commerce will habitually look for environmental changes and assess whether these changes represent digital opportunities, in other words they lower their activation threshold for these opportunities. Taking this further Valliere (*in press*) suggests such owner/managers incorporate the richness of their experiences from digital adoption, associate these with other emerging opportunities and are primed for action to unlock beneficial outcomes of digital commerce, therefore more entrepreneurially alert owner/managers should realise more beneficial growth outcomes from digital commerce, than others who are not 'tuned into' these outcomes. As for learning goal orientation, the motivation and energy to learn about the productive use of digital technologies hold customer, communication and advertising benefits for firms. Since these firms are aware of these beneficial outcomes, they commit the learning effort to realise these benefits. Thus in essence these two managerial orientation factors suggest deliberate mental and exertion efforts by SMEs to realise these growth outcomes.

Efficiency outcomes are related to working smarter, realising time savings and improving efficiencies in the supply chain for the SME. Our findings show that association and connection and scanning and search, dimensions of entrepreneurial alertness explain a significant portion of the variance in efficiency benefits, after controlling for industry. The association and connection dimension of entrepreneurial alertness allows for divergent thinking, considering multiple options and possibilities to make connections and see a larger picture. This dimension is strongly linked to creativity and generating novel solutions to problems. In the context of our study this suggests that SME owner/managers often struggle with achieving efficiencies, especially in small firms, however connecting various useful 'bits' of digital technologies through association and connection allow them to realise these sought-after efficiencies. To enable SMEs to fully realise these efficiency outcomes, firms also go further to scan their environment and search for further digital opportunities. Supported by social cognitive theory that success from these experiences also enhance efficacy, this seems to be a positive, reinforcing cycle for digital adoption.

This study holds implications for theory and practice. On a practical level despite resource limitations inherent in small firms, SME owner/managers should be aware that they themselves represent an immense resource. The owner/manager has a tremendous influence on the decision to use, actual activities and resultant outcomes that result from the adoption of digital commerce. While technologies are merely tools which if used appropriately can lead to beneficial outcomes such as increases in customers, improved products and better relationships with external stakeholders, this requires significant effort in terms of learning and strategic focus, unfortunately as Jones et al (*in press*) correctly point out small firms focused on survival and a short-term orientation fail to see the benefits from digital commerce, since these have a longer-term payoff. Despite these challenges many micro and small firms are using 'free' or cost-effective technologies such as collaboration sites, file sharing directories, online surveys, network forums and database technologies to realise growth benefits, that fit their own strategic approach and management style in their business. Being alert to and discovering new digital opportunities seem to be contingent on using and experiencing the beneficial outcomes technology adoption brings.

Theoretically this study enriches our understanding of how entrepreneurial alertness relate to the adoption and outcomes of digital commerce, building the theoretical foundation of Valliere's (*in press*) schematic model of influences on entrepreneurial alertness. This study also extends the concept of digital efficacy and examines it from a firm-level perspective and not merely an individual level perspective. While our study have focused on cognitive, motivational factors which influence adoption of digital commerce and the outcomes there-of, a number of other established models such as the technology adoption model (TAM) (Davis, 1989; Pavlou Fygenson, 2006), diffusion of innovation and perceived attributes of innovation (Rogers, 2003) also help to explain SME technology adoption, therefore this study is not without its limitations.

Caution should be exercised when generalising these results, since limitations from the research design may influence the findings. This chapter focuses on a small sample and this should be extended and tested in other contexts. Future research should focus on more qualitative explorations of Valliere's (*in press*) model of entrepreneurial alertness, focusing on the antecedents and digital opportunity exploration. Additionally comparing the motivational processes of adopters and non-adopters would yield valuable insights. This study also suffers from recall bias and self-reporting, inherent in a survey research design. Future research should focus on using experimental and conjoint analysis designs, which could provide more robust results.

CONCLUSION

The purpose of this study was to determine the relationship between entrepreneurial alertness, learning goal orientation and digital efficacy as managerial orientations to the adoption and outcomes of digital commerce for SMEs. The findings show that a high level of learning motivation was significantly related to the use of relationship enhancing digital technologies. Scanning and the search for digital opportunities was significantly related to marketing activities. Entrepreneurial alertness, specifically scanning and search and the motivation to learn how digital technologies deliver value tend to predict the growth outcomes that result from digital commerce adoption. Association and connection as well as scanning and search of entrepreneurial alertness explain the variance in efficiency outcomes, after controlling for industry. These relationships suggest complex interactions between a number of variables, showing that the adoption of digital commerce is a function of numerous factors, as Nguyen (2009) highlighted. For SME owner/managers however this study emphasises the facilitating role digital commerce can play to realise beneficial growth and efficiency outcomes for the firm, provided these firms are entrepreneurially alert can make the commitment to learn and make these technologies work for them.

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KEY TERMS AND DEFINITIONS

Digital Commerce: The electronic buying and/or selling of goods and services.

Digital Efficacy: Is the capacity to produce an effect, in this case some improvement in the digital effectiveness of an organization.

Entrepreneurial Alertness: Is the ability that some people have to recognize competitive advantages in markets.

Hierarchical Regression Analysis: Regression analysis where the researcher determines the order that variables are entered into the regression equation.

Self-Efficacy (ESE): Is the measure of the belief in one's own ability to complete tasks and reach goals.

SME: Small to medium enterprises.

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Chapter 27
Digital Competence:
A Net of Literacies

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ABSTRACT

This chapter presents a proposal for a conceptual framework of digital competence, which is a civil right and need and is vital for appropriate, intelligent study and functioning in the real world, through means that technology and the internet offer the citizen. Digital competence in the 2010s is a multifaceted complex of a net of literacies that have been updated, reformulated and transformed under the influence of technology. The framework of the digital competency includes eight fields of digital literacies. At the top of the net is digital ethics literacy, outlines the moral core for proper use of technology; at the base are technological literacy and digital reading and writing literacy, comprising the foundation and interface for all the digital literacies, and in between are the digital literacies in these fields: information literacy, digital visual literacy, new media literacy, communication and collaboration literacy and social media literacy. These interconnected literacies compose a synergetic complex of the digital competence framework.

INTRODUCTION

Digital competence (hereafter Dcom) is a right and necessity of humans and citizens, which is fundamental for proper, intelligent functioning in the real world in the 2010s with technological means.

ICT, which has become an almost inseparable part of every aspect of our lives, has vastly changed the ways we communicate, use language, information and knowledge, think and solve problems, work, consume, and relate to culture and leisure. As a result, the knowledge and skills required by every citizen, student and graduate of the education system for coping with daily needs, functioning optimally in society and the labor market, and surviving in the competitive world, have changed. Dcom also comprises a key

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to suitable scholastic skills in the K-12 educational system as well as a basis for acquiring an education and for continual learning and developing throughout life.

Dcom is a complex, multifaceted capability of a complex of traditional, familiar literacies that technology has tinted with digital features, reshaping the current character of literacies and adding new skills that were nonexistent in the pre-digital age. These digital literacies include knowledge, performance skills and high-level thinking skills, viewpoints, and values, for which the common denominator is intelligent, efficient application by digital means and on the internet, in accordance with the needs of the student and citizen in the 2010s.

Dcom refers to almost every aspect of modern human functioning, the intrapersonal aspects alongside the interpersonal ones (Pellegrino & Hilton, 2012). In each of the literacies, functioning moves along a continuum of personal and collective-social context, in which one can discern the rising trend of shared-social use on the timeline. The abilities emphasizing more personal functioning are primarily the technological literacies: digital reading and writing, information and visual literacies. The abilities emphasizing more shared-social functioning are the communication and collaboration, new media, and social media literacies.

The importance of digital competence to digital citizenry as an answer to society's contemporary needs, the business world, and the educational realm, raises the need for modernized conceptualization of its framework. Over the years, corresponding to the incorporation of ICT and socialization in routine life, a variety of digital abilities have been characterized and conceptualized that have focused primarily on technological starting-off points; while the essence of abilities required by the student and citizen are based on traditional literacies that have been refashioned in the technological context. Limitations of these former conceptualizations include focusing on narrower aspects rather than the broad, comprehensive complex of required skills, as well as focusing on technology itself without sufficiently dealing with appropriate, astute implementation for the benefit of humanity and society. Because of the rapid development of technological means, these limitations have led to considerable difficulty in updating required skills in accordance with lifestyle in the digital age.

The conceptual framework proposed here has been constructed with the understanding that digital competence and scholastic qualifications have become integrated, interwoven, imminent essences. In effect, there is *no meaning or relevance today* to learning skills that stand alone outside the context of technology. For the past decade many countries have seen the necessity of giving priority to providing their young learners and older citizens with a digital competence. Initiatives for encouraging digital literacy have been increasing, among them government bodies in the United States (National Telecommunications and Information Administration, 2014) and education committee (The European Commission, 2014), Measuring Digital Skills across the EU (2014) and located at aspects of schools, education systems, and teaching associated (Fraillon, 2014). One such outstanding project is Education 2020 (Cross, Hamilton, Plested, & Rez, 2013), an initiative for young learners, which has been adopted by many countries in the belief that educational systems should not only accept necessary changes but should lead as an ecological and synergetic system, in conjunction with communities and study networks.

The goal of constructing a conceptual framework of updated, digital competence for the 2010s is to analyze and present the essence, terms and content of the abilities needed for complex, multifaceted literacy functioning in the digital age. Such a defined, comprehensive framework will aid in raising public and educational awareness of the topic. We can achieve this by using clear anchors, a common, agreed-upon language and better understanding of the fundamental principles to serve the public and educational discourse with all the relevant factors and components of knowledge literacy, which com-

prise a basis for setting out a policy for acquisition and implementation of the digital literacies and their integration in educational work.

Construction of an updated Dcom framework necessitates both a critical attitude and intellectual humility with regard to its components and content, owing to awareness of the uncertainty of innovation, change, and dynamic development of the insights involved therein. We must admit that we do not yet actually know how a young person, born into and growing up in the digital age, experiences reality, both cognitively and emotionally, whether by use of devices attached to his/her body or through the digital glass, as a metaphor for the digital landscape. Nor do we know how an older person or "digital immigrant" (Prensky, 2001), in the digital environment and without human support, will experience transparency, accessibility, loss of privacy, instant communication, use of web applications and software, deciphering of digital messaging and so on. Thus, we must be open to reception of new knowledge and skills and abandonment of less relevant or important ones for today's world.

Acquiring digital competence is a dynamic, developing process lasting a lifetime. The challenge of implementing it for both students and older citizens offers developing, spiraling learning by classification of the target communities into levels and emphasis on what is relevant for them. In the educational system, the definition of a conceptual framework offers merging of the dimensions of digital literacy with innovative pedagogy and technological learning environments as is appropriate for the scholastic range and characteristics of disciplines. Dcom, in the same way that it is implemented in the daily routine of life, is integrated into a synergetic system that makes significant, authentic, scholastic progress possible for all learners. This is done in up-to-date study tracks conducted in a variety of ways throughout the day, wherever the student is to be found, as part of managing his/her life in the digital age.

BACKGROUND: FROM LITERACY TO DIGITAL COMPETENCE

The abilities required for optimal functioning of the individual in society change and evolve, according to the period and culture in which he/she lives. The concept of literacy has changed and developed over the years, and today, in the 2010s, it refers to the complex, multi-dimensional facets of competence required for a lifestyle incorporating digital means.

In order to clarify the framework of digital competences, we will distinguish among these concepts: literacy, digital literacy, and digital competence.

Literacy

In times past, the concept of literacy related to the ability required of a person to receive, decipher, create, and disseminate messages of various types, as was customary in the culture and period in which he or she lived. From this traditional perception of literacy, as the command of basic skills like reading and writing, the concept of literacy has broadened and now refers to an "[…] expanding set of knowledge, skills and strategies that individuals build on through life in various contexts, through interaction with their peers and the wider community" (OECD, 2013, p. 9).

In a wider meaning, "The term literacy implies a universal need, a condition that must be met to enable full and equitable economic and social participation. We view literacy as a tool that may be applied to simple or more complicated contexts […]. In its broadest sense, literacy is a dynamic tool that allows individuals to continuously learn and grow." (National Research Council, 1999, p.16).

Digital Literacy

Integration of ICT in daily life has led to the transformation of the concept from "literacy" to "digital literacy". Earlier, narrower definitions of digital literacy stressed the technological aspects, such as: Computer Information Literacy – CIL (Fraillon & Ainley, 2013), Information and Communication Literacy – ICT (Partnership for 21st Century Skills, 2014a), as well as other concepts such as cyber literacy, electronic literacy, new online social literacy, internet literacy, technological literacy, and mobile literacy (Lee, Lau, Carbo, & Gendina, 2013). Having digital literacy requires more than just the ability to use software or to operate a digital device; it includes a large variety of complex skills such as cognitive, motoric, sociological, and emotional skills that users must master in order to use digital environments effectively (Eshet, 2012). A more comprehensive definition is found in reference to "New Media" literacy (Ito, Horst, Bittanti, Boyd, Herr-Stephenson, Lang et al., 2008; Manovich, 2001) in the sense of access from every digital device, at any time and place, to any platform of content and information, and interactive and creative participation in information in cyberspace.

Today, digital literacy (2014) comprises a broader perception of capabilities required by the digital citizen or student, in a reality in which technology shapes conduct in the life of the individual and society. The distinctions among the various fields of digital literacy have become vague because of the fact that many aspects of digital functioning interface on the screen. The literacies form a net and are no longer separate, but are components of an umbrella of interconnected and overlapping literacies that, together, comprise a freestanding field (UNESCO, 2013). Digital literacy is no longer seen as a technology-focused literacy; rather, technology constitutes a common denominator for a broad net of multifaceted, pluralistic, interconnected, contextual, and dynamic abilities that create a new synergy among themselves (Lee et al., 2013).

Comprehensive description of digital literacy is also offered by Hall, Atkins, & Fraser (2014): "Digital Literacy refers to the skills, attitudes, and knowledge required by educators to support learning in a digitally rich world. To be digitally literate, educators must be able to use technology to enhance and transform classroom practices, and to enrich their own professional development and identity. The digitally literate educator will be able to think critically about why, how, and when technology supplements learning and teaching". While the digital student copes with such an explosion of "information" as data and facts in the public domain, the main issue is constructing the "knowledge," which refers to what we know, how we personally understand it, and how we can apply it.

Digital Competence

Dcom expands the concept of digital literacy into a multidimensional framework of capabilities, which comprises a comprehensive, integrated approach to the essence of the citizens' and students' characters in the 21st century and defines the conditions for his or her optimal functioning in society and culture.

The use of terminology of "competence" is far more extensive than the skills and strategies entailed in a specific literacy. Competence expresses the digital citizen's ability to successfully meet crucial requirements of life in the 21st century in a personal, proactive manner. These complex challenges and tasks, in their ever-changing contexts, require one to recruit and design cognitive and psychological resources (OECD 2002, 2005). The cardinal place of technology in these aspects requires formation of an up-to-date framework in which technology is interwoven in all the components of the net of literacies.

Dcom is defined by The European Parliament and The Council of the EU (2006) as one of the eight crucial qualifications for learning throughout life and participating in the information society. The wide-ranging nature of Dcom described in the document involves "The confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, access, store, produce, present, and exchange information, and to communicate and participate in collaborative networks via the Internet."

In the report "Digital Competence in Practice: An Analysis of Frameworks," Ferarri (2012) expands on the content of Dcom: "Digital Competence is the set of knowledge, skills, and attitudes (thus including abilities, strategies, values, and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socializing, consuming, and empowerment."

Dcom should thus be viewed as a whole complex of abilities that are part of the skills of the 21st century, as a key to the skills required by every graduate of the educational system and every digital citizen. Ferrari (2013) states in "A Framework for Developing and Understanding Digital Competence in Europe:"

"Digital Competence can be broadly defined as the confident, critical, and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion, and/or participation in society. Digital competence is a transversal key competence, which, as such, enables us to acquire other key competencies (e.g., language, mathematics, learning to learn, cultural awareness). It is related to many of the 21st Century skills, which should be acquired by all citizens, to ensure their active participation in society and the economy."

In Ferarri's report, a framework is proposed of Dcom that refers to the following fields: information, communication and collaboration, content and creation, security, and problem solving. This last includes identifying digital needs and resources, reaching intelligent decisions about adapting tools to a goal or need, and finding solutions by digital means through creative use of technology, such as solving technical problems.

The importance of Dcom is not merely in its capabilities for multi-faceted literacy functioning appropriate for the society and culture in real life, but also for nurturing and training active, critical, young learners who, as they mature, will be aware of the power of this competence and will see it as an important means of expression and empowerment, acquisition of knowledge, development, and consolidation of personal and social-cultural identity, finding suitable employment opportunities and advancement in life.

The proposed framework of Dcom comprises a net of literacies based on updating the literacies valid for every period and context, with the addition of the technological layer, which affects their shaping such as digital literacies, and expands the range of abilities with new capabilities derived from the use of technology.

Ethics as the Core of Digital Competence

Dcom is not only an ability, but also comprises a modern-world view and civil awareness; therefore, at the core of the net of literacies lie the ethics of the digital citizen.

The change generated by ICT is not only a technological revolution, but also a social and ethical change that far exceeds one new technology or another (Bynum & Rogerson, 2004). Digital culture is

global; its community is composed of digital citizens; it is fashioned as a complex tapestry of technology, its producers and users, its methods of use, and its social context.

The concept "digital citizen" is a modernized adaptation of the classical concept of "citizen" in the reality of the digital age. "A digital citizen refers to a person utilizing information technology in order to engage in society, politics, and government participation." (Mossberger, Tolbert & McNeal, 2011). Proper citizenship in the society of information and integration in the social communications culture, in which online presence has become an indivisible part of life, dictates ethics as a common denominator that lies at the base of the competences required in order to function in the digital age. Ribble (2014), in his proposal for an outline of the competences required of the digital citizen, emphasized the ethics of REP (Respect, Educate, and Protect) as the core of values and as a starting-off point for the digital citizen.

Dcom is manifested through ethical functioning, both personal and social, of the digital citizen. Included among the *personal* aspects of the ethical use of technology are the values of rectitude, equity, responsibility, credibility, protection of intellectual property, and privacy policy. The *interpersonal* aspects relate to respect for others, sharing, tolerance, and protection of rights such as freedom of expression, as well as values of global ethics such as social responsibility and social conduct that contributes to shared communities. These interpersonal core values are also the moral base for functioning in the global, pluralistic world, in which there are encounters that cross various social and cultural borders, requiring inclusiveness, openness to listening, and tolerance of a variety of opinions and voices. The importance of ethics increases with the expansion of collaborative communities, which break down traditional boundaries and norms, and with the increase in the perception of global sharing and the wisdom of the crowd as a social value and economic asset. Dcom, in this sense, is not a goal in itself but is rather a means of nurturing active citizenship.

Ethics in Dcom is inevitable, because of the adult citizen and the young student coping with a variety of ethical issues arising from the use of technology, which require ethical knowledge and the ability to make moral judgments. On the digital plane in which activity is interactive, public, shared, and social, there are many dilemmas such as property rights and copyrights as opposed to sharing and freedom of information, and freedom of expression as opposed to protection of privacy. The need to strengthen the crucial role of digital ethics also arises from occurrences of negative phenomena entailing exploitation of opportunities that technology presents, among them cybercrime and cyberbullying; these must be eradicated in order to protect the society functioning according to the rules and norms of conduct for the benefit of its citizens (Avni, 2012; Avni & Rotem 2009, 2010; Rotem & Avni 2008, 2010, 2011, 2012).

An ethical-educational perception views ethical literacy as a starting-off point for digital competence and as a transformative means with potential for effecting positive social change and advancing a free, egalitarian, just society. In the net of literacies of the framework of digital competence proposed here, ethical literacy constitutes "super-literacy," which is both situated above the net of literacies and is interwoven among its components.

Dcom can be defined as: *A human and civil need and right, vital for the intelligent, appropriate functioning of the personal, social, and professional aspects in the lives of all the citizens in society in the real world, by means offered in the current era by modern technology.*

CONCEPTUALIZATION OF DIGITAL COMPETENCE IN THE NET OF LITERACIES

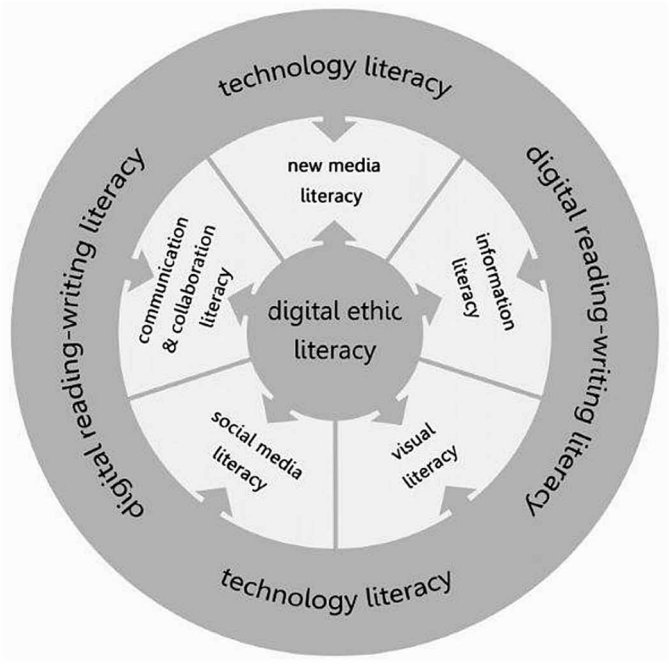
General Description

Conceptualization of digital competence currently required for the student and graduate of the educational system is vital for building a basis of knowledge for educational-public discourse, for defining updated goals of education and study, and for characterizing ways of implementing them. In accordance with the above survey and reasoning, a conceptual framework of digital competence is proposed here, in which technology gives modern meaning to the net of literacies needed by the digital citizen and student in the 2010s.

The digital competency framework proposed in this article encompasses eight realms of digital literacies, organized according to the following structure (Fig. 1):

1. *Literacy of digital ethics*, positioned at the top of digital competence and enveloping the net of digital literacies, in which ethics comprises the crucial component of perceptions, viewpoints, and values, essential for suitable application of technology by humans in every dimension of digital competence.
2. *Technological literacy and digital reading and writing literacy*, comprising a functional basis and interface for all the digital literacies included in digital competency.
3. **Fields of Digital Literacies**: Information literacy, visual literacy, new media literacy, communication and collaboration literacy, and social media literacy.

Figure 1. Framework of digital competence in the 2010s



Premises for selecting areas of digital literacy:

1. Inclusion of a complex of abilities needed by the digital citizen and student, required for optimal, suitable functioning in life in the age of ICT.
2. Modernization and adaption of the classical, familiar, pedagogically proven literacies of former times, for relevant needs and emphases of modern digital literacy.
3. Addition of new aspects of knowledge, skills, and values arising from the new technological means and use.

Digital Ethics Literacy

The literacy of digital ethics is the moral-behavioral base of technological use, and is integrated as an immanent part of each one of the other digital literacies.

Digital Ethics Literacy: Background

Digital ethics is a new field derived from an overall view of ethics as an essence and a moral foundation of human society since time began. Characteristics such as accessibility, transparency, interactivity, publicity, and sharing raise new, ethical issues. Principles like freedom of information, freedom of expression, perception of privacy, property, and so forth have become part of the digital citizen's routine in daily life. Digital ethics relates to ethical, responsible, cautious behavior in the digital plane, based on knowledge of the law, moral values, observation of the rules, awareness of dangers on the internet, and protection rights.

Alongside the benefits that digital means bring the citizen, they also cast him or her into a whirlwind of uncertainty and confusion, set traps in his or her path and expose him or her to injury. Society has not yet found effective ways to deal with these ethical challenges, which cast in doubt the perception of civil and public rights. Thus, it is important to raise awareness of the proper use of technology and to avoid dangers by developing the ability to guard against other people's malicious intentions that might damage a person's body, dignity, reputation, or property.

The foundation of literacy of digital ethics is *ethical literacy*. Ethical literacy is the personal ability of the individual to operate in the routine of his or her life with a conscious, moral standpoint, and to reach ethical decisions made in consideration of his or her obligations both to society and to himself or herself (Avni & Rotem, 2011).

The literacy of digital ethics is the interface between digital literacy and ethical literacy. It includes a complex of abilities for use and exploitation of digital means for the benefit of the individual, while relating morally to a variety of ethical aspects and issues. It is based on acquired knowledge that refers to protection of human dignity in every context on the background of characteristics of the digital age. Among the central issues are: the right to privacy, the right to a person's control over information about himself or herself, his or her decisions, and his or her personal space vis-á-vis freedom of information and freedom of expression (Birenhak, 2010); protection of intellectual property with respect to the principle of the public's right to derive pleasure from works that are part of its heritage and cultural world. The citizen possessing literacy of digital ethics can reach ethical decisions on the basis of moral judgment and critical thinking, through deliberation on a variety of possible options in a given context; his or her ethical behavior is manifested in digital stages.

A citizen's digital competence, therefore, must include the main components of digital ethics. In British Colombia's Digital Literacy Framework report of the American Library Association (2013) the components of the literacy of digital ethics are detailed, providing a full picture: internet safety, privacy and security, digital relationships and communication, cyberbullying, digital footprint and reputation, creative credit and copyright, legal and ethical aspects, and understanding and awareness of the role of ICT in society.

Digital Ethics Literacy: Definition

The ability of a person to operate in a proper, ethical manner though digital means and on the internet, through morally dealing with ethical aspects and issues entailed in the use of technology, and the ability to protect him/herself and other internet users from traps and improper use. (Avni & Rotem, 2011)

Abilities Included in Digital Ethics Literacy

- **Awareness**: The ability to comprehend human, social, and cultural issues concerned with use of technology for better or worse, and acquaintance with principles of legal and ethical behavior within the digital environment.
- **Online Presence:** Management of digital presence and fingerprints the user leaves, coming from awareness of his or her true, personal identity and consideration regarding the way to represent himself or herself online. This includes understanding of the importance of a personal label and the ability to have online influence.
- **Technological Means:** Proper, personal use of technological means, apparatuses, programs, applications, and the internet, while guarding the principles of the dignity of the individual and his or her property. For this purpose, technical tools and methods are necessary for securing information on one's personal computer and in the virtual, public space.
- **Intellectual Property:** Comprehension of the value of guarding one's intellectual property and copyright. Knowledge of laws and rules for protecting copyrights on the web, regulations for use and permission for use of materials belonging to others on the web.
- **Privacy:** Understanding the principle of the right to privacy and of the person's right to control over his or her personal information, personal space with regard to the right to freedom of expression. Making decisions regarding sharing of personal information, understanding the privacy of another when publishing information about him or her on the web, avoiding exposure of personal information of people that one does not know, activating mechanisms for guarding privacy and securing information, familiarity with mechanisms, and rules for securing information.
- **Connections:** Developing sensitivity to methods of interpersonal communication on the web. Having the ability to distinguish between a positive connection or relationship and an inappropriate one on the web. Recognition of the internet as a global space; consciousness of respect for different cultures and inclusion of the other.
- **Harm:** Awareness of cyberbullying and causes of its increase and severity, such as anonymity and mass distribution. Avoidance of deliberate, malicious injury caused by elements such as incitement, racism and distribution of hateful messages; opposition to distribution of injurious information, either personal or public.

- **Protection:** Familiarity with methods of production against harm on the internet. Ability to identify and know how to defend oneself against dangerous or injurious situations on the web, including: impersonation, identity theft, bulling, incitement, phishing, addiction, unpleasant or threatening situations; avoidance of discourse with and conveying personal details to unknown people; recognizing insecure environments, using help channels and mechanisms for personal and technical reporting when discerning injury, threat, or danger.
- **Collaboration:** Understanding the value of sharing, being part of an online community and contributing to collective wisdom, regarding the potential risks of sharing information.

Technological Literacy

Technological Literacy: Background

Technological literacy is an updated extension of computer skills required for intelligent operation of computer technology, information, and communication for personal use and for full participation in the global, digital society. This ability constitutes a crucial foundation for wise application of the other digital literacies included in Dcom. Technological literacy includes use of technological aids – tools, services, applications, and communication – for personal, academic, professional, and social needs. These updated, technological competences are vital in order to link the personal world of every citizen and student – which is implemented today through a personal computer or other device – to social conduct and to a variety of aspects of the reality of online life. It is highly important for the digital citizen to be able to manage him or herself through use of technology for personal needs, for professional development and acquiring an education, and for his or her overall social needs.

Technological literacy is based on three principles (Media Smarts, 2010):

1. **Use:** Necessary knowledge and skills for using a variety of digital applications and the ability to constantly adapt to relevant, new, frequently updated technological tools and to learn to use them by making them compatible with the user's needs in his or her work environment.
2. **Critical Understanding:** Comprehension of the effective, proper use of digital means, among them digital media and information, by acquaintance with the consequences of use of technology on perceptions, beliefs, and emotions of a person on the environment and on the personal health of the user, and taking actions leading to minimization of problems arising from them.
3. **Production:** The knowledge and ability to produce content and communicate via digital technology as an active consumer and producer in digital society.

Technological Literacy: Definition

The attitude and ability to properly and effectively use digital technology in daily use as needed. Technological literacy includes: accessibility to technological means; selection of means in accordance with needs; technological operation by acquaintance with the basic principles of actions and functions; ability to constantly learn and adapt to new means by adjusting to changing needs; intelligent, proper use including development of awareness of the consequences of use of technology on the environment and on health, and acquaintance with methods and tools to minimize their potential harm.

Abilities Included in Technological Literacy

- **Accessibility:** Access to computer hardware and personal digital devices; knowing how to use resources such as programs and wideband services.
- **Acquaintance and Use:** Familiarity with the principles of current, common human-computer interfacing. Knowledge and skills of the use and operation of devices, applications, programs, tools, services, browsers, means of communication by smartphones and internet and auxiliary applications; differentiating between hardware and software. Management of applications, operational set-ups and systems, installing programs, program updates, means of protection of hardware and software, restoration and backup.
- **Management and Ensuring Security of Personal Information:** Management of personal information, files, data, and personal online space using technological means and services that are compatible with the user's needs and his or her work environment. Intelligent, secure storage of digital information, enabling easy, accessible retrieval. Conducting backup in cloud computing and personal devices. Awareness of security, management of passwords and permission to access, including restoring access permission. Use of devices preventing illegal entry into one's computer and eliminating viruses.
- **Digital Communication:** Acquaintance with and use of means of communication in various media, including tools and services for storage and collaboration.
- **Cloud Computing:** Use of clouds of services, apps, tools, and information on the web, without dependence on personal digital devices.
- **Personalizing and Interfacing:** Operating a personally adapted technological infrastructure for personal needs. Producing interfaces and synchronization of information among personal, digital means, computer, tablet, smartphone, etc.
- **Navigation:** Intelligent, critical navigation among the multitudes of tasks and variety of digital tools.
- **Production:** Processing, creating and producing information products, wisely choosing the appropriate digital means.
- **Health and Ergonomics:**
    - **Minimizing Electromagnetic Radiation:** Consciousness of the consequences of use of technology on the environment and one's personal health, identification of possible risks and dangers, and taking steps to minimize them, with emphasis on usage habits that minimize harm caused by cordless electromagnetic radiation and by the electric network (ELF).
    - **Suitability of Furniture and Lighting Fixtures:** Making furniture and lighting suitable to the work environment according to conventional recommendations for ways to minimize physical damage, such as placement of the computer, height, distance, support, etc.
    - **Physical Awareness:** Taking care to position one's hands correctly, avoidance of unnatural posture and lack of physical exercise for extended periods of time.
    - **Avoidance of Visual Overload:** Awareness of the danger of damage to eyesight caused by prolonged focusing on the computer screen; importance of frequent blinking and resting one's eyes.
- **Ethics:** Awareness of the implications of the use of technology on personal and social, ethical issues, with emphasis in the field of civil rights and protection.

Digital Reading and Writing Literacy

Digital Reading and Writing Literacy: Background

In times past, the concept of "literacy" was a synonym for the basic meaning of reading and writing; at a later stage, it also included understanding and deciphering of written messages in local, cultural contexts. As a central condition for optimal learning and functioning as a citizen in modern society, even before the age of digital technology, the concept was found in every educational aspect and discourse dealing with civil welfare (Street, 1984).

Digital means have expanded the traditional concept of literacy as relating to a printed or handwritten text; it now relates to dynamic, multimedia, digital texts, by means of which humans absorb knowledge, produce, share, and communicate (Rotem & Peled, 2008). As opposed to the written or printed text, the digital text appears on a screen, organized units of text that are connected by links branching out to one another and to and from other resources of information and digital media. Digital text is interactive and allows for constant editing and updating; it is publicized in a variety of digital environments, among them e-mail, text messages, websites, discussion groups, social networks, smartphones and digital books.

Digital reading and writing literacy, as a foundation stone for the digital competence of every digital student and citizen, requires activation of different abilities and skills than those needed for traditional reading and writing, and includes collective, design and ergonomic challenges that are unique to the digital text. The reader is active and forms the experience of interactive reading by reasonable selection of the method for navigating a text and by use of a variety of digital aids such as dictionaries, search functions within the text and information resources. Gathering information from the digital text requires scanning of large quantities of material and instantaneous evaluation of its credibility. Thus, critical thinking has become an important component of reading literacy. Because the distinction between the receiver and the producer in digital text is often unclear, it frequently happens that the reader also becomes a writer. During the digital writing process, familiarity with a variety of tools and applications is required, including use of the keyboard and means of writing, processing, editing, and producing a text in various forms, applications, and formats (OECD, 2013). Digital reading and writing are also a process entailed in human connection and in social and cultural discourse that takes place in an increasing diversity of social platforms, on which there are exchanges of interpersonal or public messages. Social interaction requires dealing with legal and ethical aspects, including protection of privacy and freedom of expression.

The importance of this literacy is described by The European Commission (2001) as being the "key to all areas of education and beyond, facilitating participation in the wider context of lifelong learning and contributing to individuals' social integration and personal development." Reading and writing literacy is vital as a foundation for studying and learning in the framework of the educational system; it comprises a crucial condition for successful functioning in most fields in life.

Digital Reading and Writing Literacy: Definition

The ability required to read, decipher, write, and produce interactive, linked, multimedia, digital text effectively, characterized by a variety of representations and designs, including decentralization and sharing.

Abilities Included in Digital Reading and Writing Literacy

- **Characterization of Text:** Familiarity with the attributes of both traditional and digital texts; recognizing the contexts in which it is appropriate to use the different types and levels of text.
- **Accessibility:** Accessibility to create text on different platforms such as a computer screen, smartphone display, tablet, website, application, message board, social network, digital book.
- **Navigation:** Navigating among units of linked, digital texts that branch out through the information-rich space; using discretion regarding the proper track for reading purposes and critical consideration of suitability to the readers' needs.
- **Analysis, Deciphering and Comprehension:** Ability to extract information from a text and research a text by using designated means and applications.
- **Writing and Editing:** Acquaintance with means of digital writing in the required language, among them using the keyboard, touch and sound activation, copying and editing text, adding objects, creating links, updating, and proofreading.
- **Documentation and Management:** Documenting and managing digital text by means of storing, saving, securing, keeping records of different versions, restoring, following up on changes, comparing.
- **Creation and Production:** Creating a linked digital text, interactive, and multimedia.
- **Design:** Designing a digital text appropriate for the writing goals, target community and platform, using a variety of editing and designing methods.
- **Textual Representation:** Selection of different modes of presenting the text and converting it to the various forms appropriate for the goals for presenting information, the target community, and the tools available to the presenter.
- **Production and Publication:** Producing and publicizing by various means and digital environments, in accordance with the writing goals, the recipients, and different publication platforms.
- **Ergonomics and Accessibility:** Dealing with the ergonomic aspects of use and study of the text, including provision of special needs accessibility.
- **Collaboration:** Familiarity with characteristics of shared writing and awareness of the implications of involvement in writing and editing in a decentralized, shared environment, dealing with norms and conventions in writing on the web.
- **Ethics:** Awareness and comprehension of the legal and ethical aspects relating to writing and publicizing on personal and social platforms, such as protection of privacy, freedom of expression, and fair use of network sources.

Information Literacy

Information Literacy: Background

Information, a key resource to people, society, and the economy, has become accessible to all through the internet. The citizen has become not only a consumer but also a producer and distributor of information. The shared spaces allow information sharing and constructing collective knowledge. Coping with information is a vital asset for the personal advancement of every citizen, for development of social and cultural resources and for professional and economic achievement. Compared to traditional processes of accumulation of edited, arranged, controlled knowledge, in the current environment containing a wealth

of information, one requires a complex, astute ability to use the huge quantities of knowledge, far greater than those available in the previous generation, in a proper, critical, efficient manner, in order to derive benefit, reach decisions or solve problems.

A decade ago, UNESCO, in its Alexandria Proclamation (2005), proclaimed that information literacy is a vital precondition for efficient participation in the information society and is one of the basic human rights and a means to reduce inequality among people. The organization defined information literacy as a key to enabling effective access to production and transmission of content and to its use for economic, educational, and medical development as well as all other aspects of modern society (Horton, 2013). In the "Nine components of digital citizenship" (Ribble, 2014), aspects of information literacy are emphasized in the following fields: digital commerce, digital communication, and digital access.

The roots of information literacy are found in the previous era of computer technology (Zurkowski, 1974). Reference is made to an assortment of skills required for efficient use of information from different sources: to identify, locate, retrieve, store, organize, edit, analyze, process, distribute, and publicize information, in accordance with the purposes of the use of information.

The customary, widely quoted definition of information literacy is that of the American Library Association – ALA (1989): "the ability to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information".

Information literacy constitutes an approach that strives to develop an autonomous learner who is self-directed in his or her studies, who knows how to construct knowledge for him/herself, to think critically and to solve problems. It occupies a central place in the definitions of "21st century skills" (Partnership for 21st Century Skills, 2014b) and in the framework of digital competence (Ferrari, 2013). Different versions of standards and characteristics have been developed for it, based on the principles set by the American Library Association – ALA (2014): Know, Access, Evaluate, Use and Ethical/Legal.

Information literacy is a basic academic ability. People who are information literate are those who have learned how to learn. Learning in an information-rich, technological environment forms the set of critical skills for optimal learning and the dimensions of information literacy necessary to cope with the new characteristics of information.

Information Literacy: Definition

The ability to recognize when information is needed and to effectively locate, evaluate, and use the needed information

Abilities Included in Information Literacy

- **Accessibility to Information:** The ability to obtain and consume digital information and participate in its transmission on the internet.
- **Identification and Definition of Need:** Defining the question/problem/issue and focusing on it by surveying the information.
- **Presentation of Information:** Acquaintance with various formats for presenting information, in accordance with the need (e.g., textual, visual, vocal, audio-visual, artistic, scientific information) and manner of usage.

- **Sources of Information:** Familiarity with a variety of information resources, among them different types of information and different repositories of information sources; distinguishing among them according to their features, purposes, and target audiences.
- **Search Methods:** Familiarity with and selection of methods and means to find and retrieve information according to the information required and the character of the sources:
  - Identification of key features and formats for the purpose of focusing and filtering the process of finding information.
  - Familiarity with the mechanisms for finding information such as navigation bars, hyperlinks, site guides, internal search engines.
  - Filtering out and focusing on desired information via search engines by defining relevant terms and operators.
  - Help from human services and/or digital agents to find information.
  - Gathering data with digital tools for preliminary inquiry, data collection, and building databases.
- **Evaluation of Information:** Critically evaluating the quality of the information, its relevance, credibility and scope, according to the purpose and goal, and by means of comparison and cross-checking with additional sources.
- **Information Management:** Managing personal and shared information by designated tools and methods.
- **Processing and Analyzing of Information:** Use of methods and means for comparing, merging, processing, editing, and analyzing information in order to reach conclusions, make decisions, find solutions, and produce a suitable product of information.
- **Creation of a Product:** Consolidating, constructing, and presenting an edited, designed product of information in accordance with the goal, character of information, target community, circumstances, and platform for presentation, through operation of suitable digital means.
- **Presentation and Publication of Information:** Presenting the product of information clearly and in a style suitable for and supportive of the target community; publicizing it via digital means suitable to the purpose, characteristics of the information, target community, circumstances, and tools available to the user, by implementing effective presentation skills and methods to activate the target community.
- **Distribution of Information:** Distributing digital information to the intended target communities and relevant platforms by using distribution means and advertising strategies, branding, image, market analysis, and market promotion.
- **Ethics:** Awareness, comprehension and relating to responsibility to follow laws and rules of ethics regarding accessibility to and use of information, such as intellectual property, copyrights, fair use of open or free sources, freedom of expression, privacy, and information security.

Digital Visual Literacy

Digital Visual Literacy: Background

Since the dawn of human society, visual representations have served as a means for transmitting information, messages, and meanings. Digital means have expanded the possibilities of traditional, written texts into updated language and culture, including a dynamic, representative variety of data, information,

and messages. *Infographics*, as a general title for visual representation and illustration of information, was largely in the possession of advertising people and graphic artists and was intended primarily for conveying commercial themes. With the rising use of digital, visual media, it has become accessible to all. Visual culture, which enables anyone to produce a digital, visual text with its diversity of representations and platforms, has become common property (Morgan & Van Dam, 2008). Visual images in the digital environment play a major part in a variety of personal, professional, and social fields. Daily experiences, occasions, and events are conveyed by many media via digital photos, graphics, and video clips. Advertisements, games, computer applications, smartphones, user interfaces, operational instructions for electronic and other devices, digital content, and computerized media environments are currently presented through visual images. The availability of powerful design tools enables every individual to easily create designed graphic information in a variety of ways and means of expression. Visual representations have the power to convey ethical, humane, and social messages, and to express ideas, feelings, values, and worldviews.

The growing use of visual components in digital text has increased the need of the student and citizen to develop his or her visual literacy that will enable him or her to consume, comprehend, and use digital, visual images for thought, study, expression, creation, and production. The language of visual images requires the ability to decipher, understand, and derive meaning from visual messages as well as the ability to create and produce them. This ability deals not only with identification of visual components but also with comprehension of the context in which they appear, awareness of the viewpoint and specific intentions of the creator, identification of the target community, and comprehension of the possible effects of the images upon it. In addition, visual literacy relates to the skills of critical viewing and consumption of visual messages, avoiding being deceived or led astray by manipulations. Visual literacy of the digital citizen is manifested primarily in digital commerce and digital communication (Ribble, 2014). For the student, visual literacy constitutes an important element in learning and an effective way of handling styles of presentation and internalization of information, which increase understanding and motivation to learn.

Digital Visual Literacy: Definition

The ability to read, understand and analyze critically and to derive meaning from messages expressed in digital, visual texts; to communicate and convey visual messages efficiently; to produce expressions of visual messages by judging and selecting the way to represent them.

Abilities Included in Digital Visual Literacy

- **Deciphering of a Multidimensional, Visual Text:** Deciphering different types of digital, visual texts including three-dimensional, static, and dynamic text. The ability to analyze and understand visual, multimedia information by integrating its details into a meaningful, interpretational piece of work. The ability to read visual, user interfaces, and understand visual instructions.
- **Critical, Visual Reading:** Critical reading, evaluation, and interpretation of meanings and messages of visual texts through awareness of the ease of manipulation in processing, editing, and publishing visual information.
- **Production of a Visual Text:** Creating, processing, and designing a text by means of visual representations, among them graphics, photography, graphic organizers and tools of production, and

editing, by correspondence of the digital, visual text's configuration to the context, goals, intended recipients, and publicizing platforms.

- **Conversion and Correspondence of Information Representations:** Converting information, data, ideas, and messages into visual expression by means of digital tools.
- **Ethics:** Awareness of ethical, legal, social and economic issues included in the very meaning of creation, its copyrights and the use of visual images.

Communication and Collaboration Literacy

Communication and Collaboration Literacy: Background

Communication literacy is the ability to use a variety of means of communication intelligently according to need. Educational discourse about communication literacy is relatively new. Beginning in the 1970s, a link has been made between communication and literacy, the intention of which is the ability to communicate in the context of reading and writing. Communication literacy in the digital age is based on integration between information and communication technology and ways of communicating between people (Approaches to Information and Communication Literacy, 2007). In the online space, there is widespread communication going on between the personal and the social, on a variety of platforms and through diverse means. Each channel of discourse has its own unique features, intended goals, diverse target communities, and rules for appropriate discussion. Digital means offer a new, interactive dynamic between creators of knowledge and messages and their consumers, and enable new channels of active expression, exchange of information and ideas, learning, and personal development through social involvement.

The integration of technology in daily life has greatly increased the need to instill communication literacy, the ability to decipher and produce messages conveyed though digital channels, in every student and citizen. Components of basic communication skills include verbal, aural, and visual communications; nonverbal communication including ways of expression such as gestures; textual communication including various genres in the writing places on the web, and visual communications including a variety of visual representations (Communication Skills, 2014). At the basic level of literacy, this refers to the ability to decipher, produce, and convey messages via communications means. At the advanced level, this refers to comprehension of the place and contribution of communication in processes of creating meanings and in designing reality, as a platform for activity using digital communication services. The European Parliament and The Council of the EU (2006) has adopted this ability as the first of eight basic skills required by every individual for personal development, self-fulfillment, active civil participation, social belonging, and employment.

Digital communication constitutes a basic condition and foundation for sharing within personal, professional, and social contexts. One of the main challenges is to train the citizen and student living in the global environment to effectively communicate and share knowledge and ideas, to learn from colleagues and experts, to produce collaborate outcomes through teamwork with nearby or distant partners, and to actively participate in collaborative communities that cross borders and cultures. A person who is literate in communications and collaboration, who knows how to use, and is capable of using, tools and services of a variety of digital communications for his or her various needs, is conscious of the rights of those photographed and of the responsibility for their appropriate, secure use.

Communication and Collaboration Literacy: Definition

The ability to communicate in a variety of means of digital communication and to conduct efficient interaction that crosses boundaries and frameworks – whether interpersonal or collective, private or public, synchronous or asynchronous – by adapting the discourse to the characteristics of means of communication. The ability to share information and messages, using collaboration digital tools for personal and social needs, and to participate in online communities and networks, with ethical awareness of global citizenry.

Abilities Included in Communication and Collaboration Literacy

- **Characterization of Means of Communication:** Recognition of the attributes of the various means of communication, understanding of contexts and how it is fitting to use each of them according to need, goal, and target community. Evaluation of the efficiency of means of communication and awareness of their influence.
- **Accessibility and Operation:** Accessibility to diverse means of communications and ability to handle them.
- **Transmission of Messages:** Effective expression of ideas, opinions, and messages using a variety of forms and contexts by digital means of communication.
- **Collaboration:** Cooperation, exchange of information and efficient, respectful teamwork that appreciates each individual's contribution to the team, using digital means of communications and collaboration.
- **Dynamic Communications – Cloud Services:** Use of cloud computing and dynamic, mobile communications to derive meaning from messages and to publicize and share information.
- **Global Citizenship:** Use of means of digital communications to expand the network of acquaintances and connections crossing geographical boundaries; development of global consciousness and the practical meanings derived from them.
- **Ethics:** Protection of rights and appropriate rules of behavior such as property, privacy and freedom of expression, by awareness of the personal and social implications of behavioral norms in communications and in crossing borders.

New Media Literacy

New Media Literacy: Background

Media literacy in the 2010s has undergone significant changes, principally consolidating most means of media on a digital platform on the screen. This is the new media, in which a variety of media channels and different types of information, sharing, and social services are displayed together. The new media in the digital arena constitutes the "*Where*" (Peña-López, 2009) – publicized platform of the interpersonal, private, and public flow of information, messages, and communication. The new media is described by Jenkins (2006) as "media ecology". Ito et al (2008) explain the uniqueness of the term: "We have used the term *new media* rather than terms such as *digital media* or *interactive media* because the moniker of 'the new' seemed appropriately situational, relational, and protean, and not tied to a specific media platform."

The new media offers and creates interactive, multi-sensorial activation by means of a powerful integration of words, graphics, and sounds. In this respect, Ito et al (2008) claim that young people develop, through personal experimentation, a wide variety of new forms of literacy, among them personal adaptation of the media for their own needs: selection of definitions, consumption of video clips, creation of new genres of presentation, remix editing, hybridizing, computer video games, sharing of information and knowledge, and even taking on traditional roles of adults, such as public and political involvement and social criticism.

Traditional media literacy has focused on the critical, efficient consumption of information and messages on the various communication channels, through awareness of the effect of structuring and forming messages on the perception of reality. Because there is interaction in the new media with a large community whose members have changed from being media consumers to being producers of content and active partners in media, literacy has expanded to active consumption and production of content and messages by involvement of the individual in the interactive, social, online medium. Self-expression, conveying of messages in a variety of platforms, and construction of collective meaning, are important aspects for the digital citizen in a democratic society, which offer ethical, social consciousness, and responsibility for content and the ways it is distributed.

Gaming as an Updated Component of New Media

Expansion of new media literacy to a diversity of forms and modes of use has elicited new abilities, which until now have not been part of the educational-public discourse concerned with literacy competence required of the citizen and student. One of the abilities that has had an increasing place in our daily life is the digital game (Zimmerman, 2009), which offers personal enjoyment or social entertainment through gaming communications crossing borders of both place and partners. Furthermore, digital gaming is currently used for teaching and learning through experiences, challenges, and motivation and as a model for action in the real world. Gaming abilities involve complex aspects of reading and writing, advanced thought, problem solving, creativity, deciphering of various kinds of visual messages, psychological aspects of competition, and cooperation in social-ecological relationships of human interaction.

New Media Literacy: Definition

The ability to consume messages from a variety of digital media channels in a personally adapted and critical manner, to demonstrate involvement in interactive social media, and to produce and publicize communicative messages that have collective significance in social and cultural contexts.

Abilities Included in New Media Literacy

- **Characterization of Media Means:** Recognition of the attributes of new media channels consolidated on the screen or digital platform; acquaintance with modes of presenting, disseminating and publicizing information; evaluation of the effectiveness of media methods, and awareness of their influence on the user.
- **Active Viewing:** Critical consumption of messages and derivation of information and meaning from them by active viewing, research and synthesis, entailing comprehension of the goal sought in publicizing the messages and the effect of their form on the perception of reality.

- **Navigating, Managing and Updating:** Handling attentiveness among many simultaneously appearing media channels, applying discretion in choosing how to navigate among them. Acquaintance with tools and methods to receive constant communications information via manual and automatic update tools.
- **Processing, Editing and Producing:** Familiarity with tools and skills for use of media files, downloading, editing, processing, and production of media, and publicizing messages on a variety of digital media platforms.
- **Gaming:** Personal and social gaming by use of digital processes.
- **Updating and Involvement:** Constant but controlled updating of what is going on in the social and cultural media environment; involvement in interactive media for personal empowerment and social contribution.
- **Ethics:** Awareness of the variety of options for expression and use of various media and their implications, taking legal and ethical responsibility with regard to accessibility and use of media.

Social Media Literacy

Social Media Literacy: Background

The increased conduct through online social media offers empowering of personal, educational, professional and social processes that are vital for every citizen and learner who participates in a collaborative community. Social media are a complex of internet services enabling multidirectional communication in shared social places by sharing a variety of contents, including text, photographs, video, music, and internet sites. Among the online media places are social networks, apps (online applications) for sharing photos, videos and music, online discussion boards, Wiki, Twitter, blogs, and a variety of collaborative games.

The use of social media in effect expands existing social reality to a rich, diverse expanse of human information and communication in a shared, digital environment; thus, involved, meaningful activity in relevant social services is currently available to everyone. Goodman (2014), for example, points out the vital importance of the abilities needed by every digital citizen in the social media context – among them, the use of media for commercial needs, understanding and coping with propagandist media, being conscious of the effect of censorship and media ownership on information published in the social media, and identification of stereotypes in communications.

Social media literacy involves the ability to make intelligent choices of relevant places for collaborating and managing online presence through awareness of how to design a personal profile and its consequences for social interaction. This literacy includes intrapersonal, interpersonal, and social skills. Among the personal skills are self-orientation, time management, definition of limits, emotional management, self-expression, expressing opinions, designing messages, reflection and evaluating messages, creativity, reputation management, and aggression. The interpersonal and social skills include attentiveness, sensitivity, tolerance, sharing, communication, community management, discourse management, exchange of opinions, dealing with dilemmas, coping with criticism, giving and receiving feedback, social and sometimes commercial publicity, through ethical awareness that is personal, social, and global. Competence of the digital citizen, as a person who is literate in social media in the digital world, is manifested in consciousness of the right to free access to the web, to digital commerce, and to relevant laws and rules – among them, personal security mechanisms and prevention of injury (Ribble, 2014).

Social Media Literacy: Definition

A complex of qualifications that enable interconnectedness and interaction among people via communication and sharing of information. These competences allow one to communicate in a suitable manner, to be involved, to cooperate and participate actively, to give and take, in the social environment of communication and sharing of content. A person who is literate in social media forms his or her personality, worldview, and manner of social conduct, among other ways through tools for collaborating and managing information found on the web.

Abilities Included in Social Media Literacy

- **Characterization of the Social Media Environment:** Recognition of types of online social media places in order to make a wise selection: essence, platform, recipients, structure, types of pages, interfaces, conditions for use, manner of conduct.
- **Operation:** Registration, constructing a profile, definition of privacy, friends, interest groups, levels of collaboration, monitoring notices, posting and uploading information to various media.
- **Online Presence:** Construction of a personal identity, designing a profile, management of a reputation, participation in and management of a presence by awareness of consequences of digital fingerprints left by the user on the web.
- **Communication and Interaction:** Definition of circles of communication, management of notices, and responses by choosing suitable communication channels (wall, chat), wording appropriate for the community, and the characteristics of the social media.
- **Timing:** Setting of timing of updates. Intelligent, critical expression by understanding the proper timing and frequency of promulgation of messages.
- **Interfaces:** The ability to interface social media with mobile devices such as smartphones or personal tablets.
- **Intelligent, Critical Use:** Understanding modes of transmission in social media, circumstances of success in communication, and distribution of messages through analysis of data and statistics. Critical evaluation of relevance and reliability of information and messages conveyed via the social network and its implications for the user and the information he or she shares. Awareness of the immediate, public, shared, social platform used by many who are interactive partners, and its implications on motivation for writing.
- **Ethics:** Awareness of legal and ethics aspects on the social network: copyrights, fair and decent protection of privacy, limits of freedom of expression, understanding the significance of distribution of injurious messages and information and avoidance of such actions. Awareness of defense mechanisms such as identification of impersonators and acquaintance with mechanisms for reporting injury.

Solution and Recommendations

The proposed framework of Dcom offers ways to deal with the vital need to define and describe distinct conceptualization, broad awareness and clear guidance in feasible ways, in order to be able to implement them and instill them in citizens and students, This need includes supply, the current lack of efficient methods of control, and evaluation. Presently, the main challenge is to progress from terminology to

action, in order to instill all aspects of Dcom in the population – not as something that is nice to have but as a competence that is vital and essential to have.

Over the years, Dcom has been a hazy, protean term bearing various names and referring to different things. Along with this, there has been a widespread, mistaken assumption regarding the "illusion of knowing" that must be uprooted: in fact, young people born into the technological age are not necessarily digitally literate simply as a result of it. They do not necessarily construct knowledge as a result of using digital literacy. Gathered data from almost 60,000 Grade 8 students in more than 3,300 schools from 21 countries or education systems within countries - suggest that the knowledge, skills, and understandings described in the CIL scale (Computer Information Literacy), can and should be taught. Regardless of whether or not we consider young people to be digital natives, we would be naive to expect them to develop CIL in the absence of coherent learning programs (Fraillon, 2014).

Command of digital skills achieved through daily activity with computerized systems is far from constituting broad Dcom. Dcom is a complex, multifaceted field, part of personal development and empowerment. The process of acquiring it, both as a means and as a goal, does not happen circumstantially but rather requires deliberate, explicit study and experience. Therefore, both the social system and the educational system have the obligation to provide it.

Formal policies and messages presenting Dcom as a goal of highest importance raise the awareness and crucial nature of the subject, but are not a substitute for immanent integration in the routine of training and learning. A program of action that includes a variety of methods of implementation as an answer to the various target communities, as well as the allocation of appropriate funding and other resources, must be put together and integrated into the daily routine.

Instilling Dcom in citizens and students should be conducted through a variety of channels and paths of action, via synergy among partners connected with the various aspects of digital culture, such as government offices, economic bodies, organizations,, and educational systems. Suitable opportunities for training and experimenting in digital literacy must be developed and offered alongside deliberate, methodological study. For this purpose, it is important to supply access to available, professional mediation, relevant teaching materials, guidance, and exercises to the target communities. It is very important to demonstrate and present these materials in digital texts that will provide authentic experience in the reality of a lifestyle interwoven with technology.

In the educational system and in training Dcom should be implemented according to a number of principles:

- **The Principle of Integration:** Integrating the digital literacies in teaching programs by correlating fields of literacies to characteristics of the disciplines. According to this principle, the teacher is responsible for integrating aspects of Dcom into his or her work as well as demonstrating literacy work in his or her teaching and modeling literacy in his or her personal and professional conduct.
- **The Principle of Technological Focusing:** Instilling basic aspects of digital literacy, with the emphasis on technological literacy, as a field that stands on its own; alongside an updated definition of literacies, with the emphasis on digital reading and writing, and teaching it as an integral part of language and linguistic studies.
- **The Principle of Variation:** There must be variation in the aspects of digital literacies learned in each grade at school. In academic programming, which of the aspects are taught in each grade level must be decided. Some of the activities should be focused and short-term, in accordance

with their circumstances, and some of them are to be long-term and include complex, multifaceted processes and products.

- **The Principle of Spiraling:** Dealing with Dcom is not a one-time activity, but rather recurring during the different stages of study over the school years in the form of a spiral, with, expansion, and depth.
- **The Principle of Achievement:** Student achievement in the field of Dcom should be measured through a system of appraisal and evaluation.
- **The Principle of Modeling:** Dcom should become an immanent part of all academic conduct, including through indirect demonstration, routine conduct by the administrative and teaching staff and their requirements from the students, through integration of connected vessels and modern, technological methods, and means of teaching and learning.
- **The Principle of Authorization:** In order to emphasize the importance of Dcom in the academic, and employment world and to ensure sufficient competence for proper functioning by the public at large and by students, it is recommended to define a precondition to be required for authorization – a kind of license that is compulsory for completion of every training course, degree, etc., and that attests to the Dcom of the citizen or student.

FUTURE RESEARCH DIRECTIONS

Dcom is a complex, dynamic, developing field that offers many channels of research focusing on the effect of technological services, means, and tools on the behavior and conduct of the citizen and student. It is important to treat the framework of Dcom as a broad, open, dynamic expanse requiring constant updating, but at the same time include a clear, defined content of knowledge, skills, and abilities to wisely and properly use each aspect of Dcom. It is imperative to be open to research, to learn the new, developing language of young people born into the digital age, and at the same time, to research the effect on migrants – older citizens who must learn how to integrate technical processes into their personal and professional lives. Research on the methods of technology use in daily occurrences, on the essential knowledge required, the skills and viewpoints involved in ICT, and the ethical issues entailed in use of technology, will enhance the conceptual framework and instillment of Dcom.

In the educational field, it is recommended to research the ways the relevant educators and organizations deal with imbuing and nurturing Dcom, learning from successes and expanding support mechanisms, mediation, and teaching materials accordingly. It is important to formulate ways to evaluate the different dimensions of digital literacy, and to construct assessment rubrics for evaluation of the model.

It would be interesting to examine the effectiveness of instilling Dcom by comparing the various ways of teaching, such as, for example, teaching Dcom as a separate, distinct, focused field as opposed to integrating it in the disciplines of the an academic program.

CONCLUSION

This chapter deals with a proposal for a conceptual framework of Dcom, which constitutes a human and civil need and right that is essential in order to wisely and properly function in the world in the 2010s through means offered by technology. Digital citizens and students today need complex, multifaceted

qualifications, which until now have not yet been defined in a clear framework, have not been part of public and educational policy and civil consciousness, and are not instilled in a distinct, concrete manner in the public composed of citizens and students. The very fact of defining the essence and content of this competence is likely to contribute to the understanding of the essence of intelligent, proper functioning with literacy in the complex of possibilities offered by technology in the digital age.

In this chapter, a new view is presented of the literacies entailed in use of technology, as a synergetic complex. Dcom as presented here constitutes a *net of literacies* that do not focus on technology but on the forming and changing caused by the very presence of technology; on the knowledge, performance skills, thinking skills, viewpoints, and morals involved in conduct in a digital environment, which is the environment in which we now live and work. In this updated net, technology tints the familiar, traditional literacies in digital hues, that can be found in technological, digital reading and writing, information, visual, new media, communication and collaboration and social media, forming the updated character of literacies and the wise, efficient functioning with them. Alongside the conventional literacies, new abilities are integrated, which are derived from technological attributes that were non-existent before the digital age.

The net of literacies proposed here is based on the existing concepts of types of competences and literacies; it attempts, as far as possible, to provide content, interpretation, and updating to these concepts, and in this way to rely on the proven pedagogical principles that have been sufficient for every time and context, and to add to them a level of characteristics of new abilities that are relevant for current use of technology.

The structure of the proposed net consists of three layers:

1. **Digital Ethics Literacy:** Stands at the top of the net of literacies in which ethics constitutes a vital component of perceptions, viewpoints, and morals that are essential for proper application of technology by humans in every dimension of digital literacy.
2. **Technological Literacy and Digital Reading and Writing Literacy:** Constitute a basic foundation and functional interface for all the digital literacies and which are anchored as an inseparable part of them.
3. **Dimensions of Digital Literacies:** In accordance with main fields that information and communication technology touches. These dimensions range from the connection with the personal use of technology to the interpersonal, social collaborative connection: literacy of information, digital visual literacy, literacy of new media, literacy of communication and collaboration, and literacy of social media.

The importance of consolidating a framework of Dcom lies in the proposal of clear anchors that enable formulation of a common, agreed-upon language to serve the public and educational discourse, including all the relevant authorities, to serve as a foundation of knowledge for creation of a unified policy on the subject and to constitute a sturdy, accepted basis for instilment and evaluation of a complex of updated knowledge, competences and skills regarding the literacies required by citizens and students in the 2010s.

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KEY TERMS AND DEFINITIONS

Communication and Collaboration Literacy: The ability to communicate in a variety means of digital communication and to interact effectively, crossing interpersonal and collective, private and public borders and frameworks, synchronous and asynchronous, fitting the discourse to the characteristics of the means of communication. The ability to share information and messages by collaborative digital tools for personal and social purposes and to participate in communities and online networks through ethical awareness and global citizenship.

Digital Competence: A civil right and need, vital for appropriate, intelligent study and functioning for the personal, social and professional aspects of all citizens in a society in the real world, through means that modern technology offers the citizen.

Digital Ethics Literacy: The ability of a person to operate in a proper, ethical manner though digital means and on the internet, through morally dealing with ethical aspects and issues entailed in the use of technology, and the ability to protect him or herself and other internet users from traps and improper use.

Digital Reading and Writing Literacy: The ability required to read, decipher, write and produce interactive, linked, multimedia, digital text effectively, characterized by a variety of representations and designs including decentralization and collaboration.

Digital Visual Literacy: The ability to critically read, understand and analyze and to produce meaning from information and messages presented in visual, digital texts, to communicate and transmit visual messages effectively, to create and produce presentations expressing visual messages, by consideration and selection of how to present them.

Information Literacy: The ability to recognize when information is needed and to effectively locate, evaluate and use the needed information.

New Media Literacy: The ability to critically and suitably consume messages in a variety of digital media channels, to be involved in interactive social media, to produce and publicize communicative, public messages bearing collective meaning in social and cultural contexts.

Social Media Literacy: A complex of qualifications that enable interconnectedness and interaction among people via communication and sharing of information. These competences allow one to communicate in a suitable manner, to be involved, to cooperate and participate actively, to give and take, in the social environment of communication and sharing of content. A person who is literate in social media forms his/her personality, worldview and manner of social conduct, among other ways through tools for collaborating and managing information found on the web.

Technological Literacy: The attitude and ability to properly and effectively use digital technology in daily use as needed. Technological literacy includes: accessibility to technological means; selection of means in accordance with needs; technological operation by acquaintance with the basic principles of actions and functions; ability to constantly learn and adapt to new means by adjusting to changing needs; intelligent, proper use including development of awareness of the consequences of use of technology on the environment and on health and acquaintance with methods and tools to minimize their potential harm.

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Chapter 28
An Improved Security 3D Watermarking Method Using Computational Integral Imaging Cryptosystem

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ABSTRACT

Robustness and security are difficult to be solved by conventional two-dimensional (2D) digital watermarking technology. In recent years, three-dimensional (3D) digital watermarking has become a new hotspot in optical information security. This paper presents a new improved security 3D digital watermarking method based on computational integrated imaging cryptosystem. Firstly, 3D digital watermarking is generated and encrypted by computational integral imaging cryptosystem that is implemented with smart pseudoscopic-to-orthoscopic conversion (SPOC) model. Secondly, discrete wavelet transform algorithm is applied to embed and extract the 3D digital watermarking. Finally, the extracted watermark is decrypted,

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and3D digital watermarking is displayed by integral imaging system. The feasibility and effectiveness of the proposed method is demonstrated by experiment. A primary implication of encrypted processing is that the majority of integral imaging cryptosystem will be encryption-in-the-loop applications, and the majority of system will improve the security and robustness of 3D digital watermarking. The new method is able to meet the requirements of robustness and security. Image quality and display quality achieve these criterions of the human visual model. The proposed method can be applied in the aspects of cloud computing and big data.

1. INTRODUCTION

With the rapid development of modern communication technologies, threats on network information security are increasing, people are not only concerned about the multimedia information should not be illegally copied, distributed and tampered, but also pay more attention to security and confidentiality of information transmission. Digital watermarking provides secure means for copyright protection, content authentication, encrypted communication, and digital forensics of multimedia products. Watermark images is embedded into cover images in spatial domains (Cox, & Kalker, 2008; Abbas Cheddad, & McKevitt, 2010; Tang Qing sheng, & She Kun, 2005; Shen Chang-Xiang, 2007). Currently there are various methods for embedding and extraction of digital watermarks. The methods fall into two types: spatial domain methods and transform domain methods. In spatial domain methods, it is easy to realize embedding and extraction of digital watermarks but with weak robustness. In transform domain methods, watermarks are processed in transformed frequency domains, with better robustness and invisibility. To the best of our knowledge, transform domain technology of digital watermarking has become a new hotspot in digital watermarking research. Common transform domain methods are Discrete Cosine Transform (DCT) algorithm, Fast Fourier Transform (FFT) algorithm, discrete wavelet transform (DWT) algorithm, and so on. It becomes a new research hotspot on information hiding with optical techniques. Digital holography (Takai, & Mifune, 2002; Matoba, & Javidi, 2009) and random-phase encoding (Kishk, & Javidi, 2002; Peng, & Yu, 2006) are two major optical information hiding techniques. Digital holography is a technique (Takai, & Mifune, 2002; Matoba, & Javidi, 2009) to record with interferometer method the space phase of an object in intensity modulation form. Random-phase encoding, however, realizes information encryption via optical transformation processing (Kishk, & Javidi, 2002; Peng, & Yu, 2006) of random-phase marks and lens. Xiang Peng et al. introduced a 3Ddigital watermarking algorithm based on virtual optics (Peng, & Yu, 2006; X. Peng, & D. Zhang, 2005). The algorithm realizes embedding and blind extraction of 3D digital watermarks utilising the morphological variation of virtual Fresnel diffraction in 3D space. To enhance robustness and security of digital watermarks, multi-image digital watermarking was proposed in (Giakoumaki, & Koutsouris, 2006). The 3D digital watermarking algorithm is based on wavelet decomposition. Various watermark information is embedded into various wavelet subbands, watermark data may be digital signature and personal information of the copyright owner. This method, which can be also applied in image communication and copyright protection of images, significantly improves robustness of digital watermarks. The invisibility of watermarks, however, decreases as the watermark information accumulates. Processing time of watermark embedding and extraction will be extended.

Optical image encryption techniques have attracted significant interest as they offer the possibility of high-speed parallel processing of 2D image data, of hiding information in many different dimensions, i.e. of multiple degrees of freedom (Matoba, & Javidi, 2009; Refregier & Javidi, 1995). Refregier and Javidi (1995) proposed double random phase encoding technology based on $4f$ systems, which opened a new field of optical information security research, and since then, different transform domain algorithms have been proposed to improve the security level of the optical information hiding with double random phase encoding. Researchers are trying to make progress on these issues.

Integral imaging is a major technique in the next generation autostereoscopic display (Lippmann, 1908; Hong, & Lee, 2011; Xiao, & Javidi, 2013). In 2007, researchers from Korea including Dong-Choon et al. (2007) found that integral imaging could be applied in the research of digital watermarking. Information hiding could be realized if attacks were under control. The quality of reconstructed images would be significantly degraded by the interference between adjacent pixels because the reconstruction method to calculate integral imaging was actually cascading pixel reconstruction. Researchers including Yong-Ri Piao (2009) introduced a moderate image encryption method, in which pixels of cover images were scrambled using integral imaging and pixel scrambling techniques. Elemental images (EIs) were recorded, captured, and generated by a lenslet array. Researchers such as Chaochao Ji et al. (2012) proposed a content controlled stereoscopic display technique, in which various pixels were extracted from EIs and then reconstructed and displayed with integral imaging system. Observers could see different 3D scenarios from different view angles and directions. Privacy protection was realized. EIs generated by a computer were embedded into cover images in cellular automata transform domain utilizing the characteristics of the human vision system (Xiao Wei Li & Seok Tae Kim, 2014). The work, however, failed to analyze the impact of geometric distortion attack on watermarks. The literature (Muniraj & Lee, 2014) presents a new method for 3D scene acquisition via reconstruction with multispectral information and its Fourier-based encryption using computational integral imaging, by which the field of view, resolution, and information security are increased, respectively. Double random phase encryption (DRPE) in the Fourier domain is employed on Bayer formatted elemental image to encrypt the captured 3D scene. But the quality of watermark images was degraded with these algorithms which were presented in (Xiao Wei Li & Seok Tae Kim, 2014; Muniraj & Lee, 2014).

This paper proposes a new 3D digital watermarking method based on discrete wavelet transform and integrated imaging technology. 3D digital watermarking is generated and encrypted by computational integral imaging cryptosystem that is implemented with SPOC model. Secondly, DWT algorithm is applied to embed and extract the 3D digital watermarking. Finally, 3D digital watermarking is identified and showed by integral imaging system. The feasibility and effectiveness of the proposed method is demonstrated by experiment. The new method is able to meet the requirements of robustness and security. The quality of image can meet these criteria of the human visual model. The new method has some advantages of optical imaging systems such as multi-dimension, high design freedom, and high robustness. A primary implication of encrypted processing is that the majority of integral imaging cryptosystem will be encryption-in-the-loop applications, and the majority of system will improve the security and robustness of 3D digital watermarking. New idea and solution are introduced to copyright protection of 3D multimedia digital products. The work also promotes a promising approach to information hiding based on optical techniques.

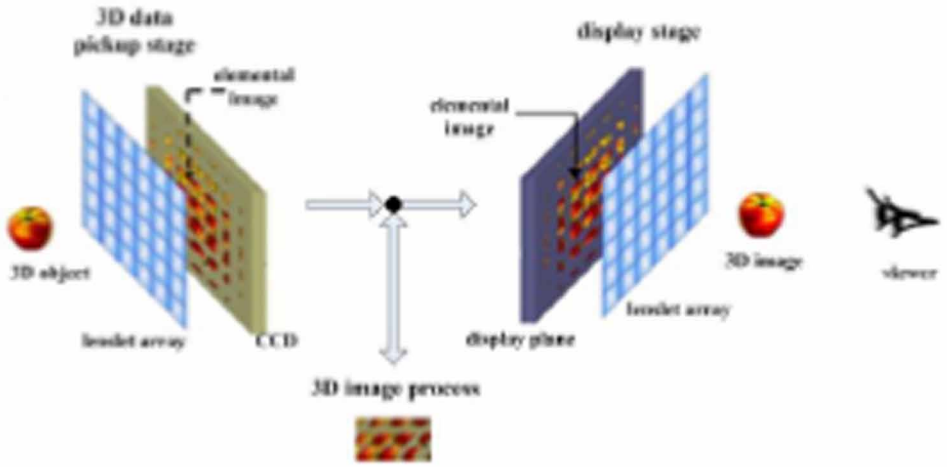
2. THE PRINCIPLE OF INTEGRAL IMAGING

Integral Imaging has been one of the promising autostereoscopic display technique which is capable of displaying 3D scenes in full natural colour utilising a lenslet array. It was proposed by Lippmann in 1908 (Lippmann L, 1908). Human vision is only by glancing around the scene and building up a large number of two-point comparisons that our brain constructs a map of the relative distances of many locations. These random-dot stereograms are formed by these relative distances. Stereopsis is fused by stereo pair images that are reconstructed with the random-dot stereogram from the left and right eye views. At Bell Labs, in 1959, Bela Julesz showed that the visual system is able to match patterns of dots that to a single eye appear chaotic and without structure, to form stereo images. Slight lateral displacements of the dots are interpreted as parallax and produce depth information (Russ John. C, 2011). Figure 1 shows the integral imaging consists of two processes, 3D data pickup, optical 3D reconstruction.

In the process of pickuping, rays from 3D scenes contain direction and intensity information, and form images through the recording lenslet array. Then spatial-sampling is completed by the 2D image detector behind the lenslet array. Finally, digital EIs are generated on the detector array. The elemental image corresponding to each lenslet is, essentially speaking, a microfiche projection image and intensity information distribution diagram of a 3D scene in a specific direction.

In the process of reconstruction, EIsare displayed on a large-size monitor (such as LCD and screen) and lighted by an illuminant. Illumination rays contain information of EIs. Reverse convergence of the rays happens through a reconstruction lenslet array the same as the recording process. Flat images along the output plane and relevant to depth are reconstructed by a computer according to a mathematical model relevant to the parameters of reconstructed images such as detail, gray scale, colour, and projection. Then stereo images of a scene are reconstructed at the same position as the original 3D scene (Arimoto, & Javidi, 2001; Hong, & Javidi, 2004; Stern, & Javidi, 2006; Xiaorui Wang, & Qingfeng Bu, 2009; Xiaorui Wang & Qiang Guo, 2010; Park, & Lee, 2009). Light field conversion can conducts pseudoscopic-to-orthoscopic conversion, generates a new set of EIs that suits the display characteristic and permits control of the depth of the reconstructed image. The SPOC algorithm can meet these requirements. A general SPOC is also reported (H. Navarro, & G. Saavedra, 2010), of which the depth order and the

Figure 1. The scheme of integral imaging system



display parameters can be controlled simultaneously. It is an updated version of SPIM in their previous paper (Martínez-Corral, & Javidi, 2005). Huan Deng et al. (2005) proposed a two-step pickup method by using an extended primary lens array. The research group of the authors studied integral imaging reconstruction calculation based on SPOC and made progress (Martínez-Corral, & Javidi, 2005; Huan Deng, & Fang-Ning Wang, 2011).

3. NEW 3D DIGITALWATERMARKING METHOD BASED ON INTEGRAL IMAGING

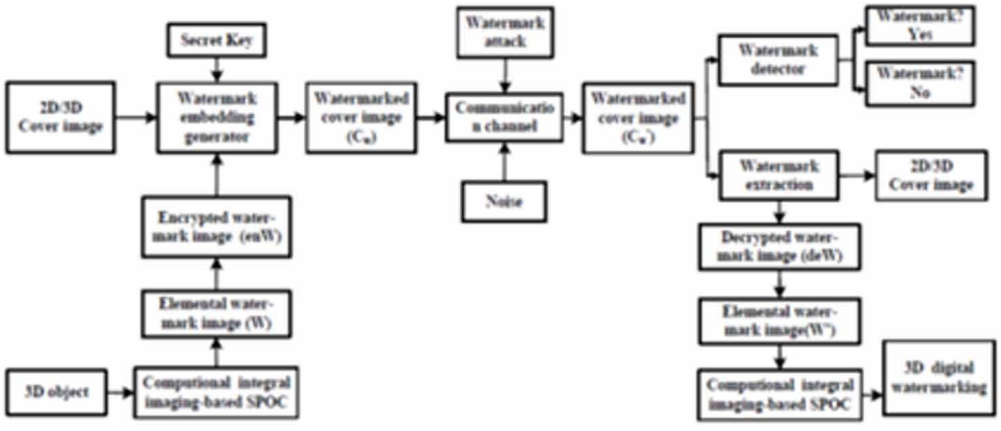
As shown in Figure 2, the 3D digital watermarking system based on integral imaging consists of the generation, encryption, embedding, extraction, decryption and display, etc. of 3D digital watermark.

3.1. Generation and display of 3D Digital Watermark

EIs are both used by cover image and watermark image which are generated by integral imaging system. The generation process of EIs is as follows: firstly, a 3D design software, such as 3DS MAX, is used to design a target model in a 3D scene; secondly, 3D graphics library Direct3D is used to generate EIs of the 3D model utilising the virtual camera model and the integral imaging system (Xiaorui Wang, & Qingfeng Bu, 2009; Xiaorui Wang, & Qiang Guo, 2010) based on the SPOC model. These images are then selected as cover images and watermark images. It is noteworthy that the most effective information hiding can be realized only when the size constraint relation between the cover images and watermark images as well as the watermark embedding and extraction algorithm are both considered.

To display 3D digital watermark images in the best quality, various display modes and methods are to be selected according to various applications. There are three display modes of integral imaging 3D display, real mode, virtual mode, and focused mode. Display methods consist of all-optical integral imaging display, combined display with LCD and lenslet array, combined display with multiple projectors and lenslet array, and so on. Combined display with multiple projectors and lenslet array can increase the number of orbs of light corresponding to each lens and improve the display quality of 3D images without reducing the pitch of the lens or increasing the number of projectors. Thus, this paper selects combined display with multiple projectors and lenslet array as the observation technique for experimental results.

Figure 2. The diagram of 3D digital watermarking system



3.2. Encryption and Decryption of 3D Digital Watermark

According to diffraction theory and Fourier optics theory, the general expression of discrete Fresnel diffraction transform is as the formula (1), which can describe discrete Fresnel diffraction process in digital space, abbreviated as DFD (Goodman, J.W., 2005; David Voelz, 2010).

Therein, A and B represent the two planes which separate spatially in the direction of propagation, the spacing between the planes is denoted as z_{AB} . m and n represent the sampling number of two adjacent orthogonal pixels. λ represents the wavelength of incident light. ξ, η represent two variables of the Fresnel transform domain. $DFD[-]$ represents the discrete Fresnel diffraction transform. C is a complex constant whose value may be calculated by the formula (2).

$$
\begin{aligned}
&DFD[A, B, m, n; z_{AB}, \lambda] \\
&= C \bullet \exp[j \frac{\pi}{\lambda z_{AB}} (m^2 \Delta\xi^2 + n^2 \Delta\eta^2)] \\
&\times \sum_{k=0}^{N-1} \sum_{l=0}^{N-1} U_A(k,l) \exp[j \frac{\pi}{\lambda z_{AB}} (k^2 \Delta {x_0}^2 + l^2 \Delta {y_0}^2)] \\
&\times \exp[-j2\pi (\frac{km}{N} + \frac{\ln}{N})]
\end{aligned}
$$

where $C = \dfrac{\exp[j2\pi z_{AB} / \lambda]}{j\lambda z_{AB}}$

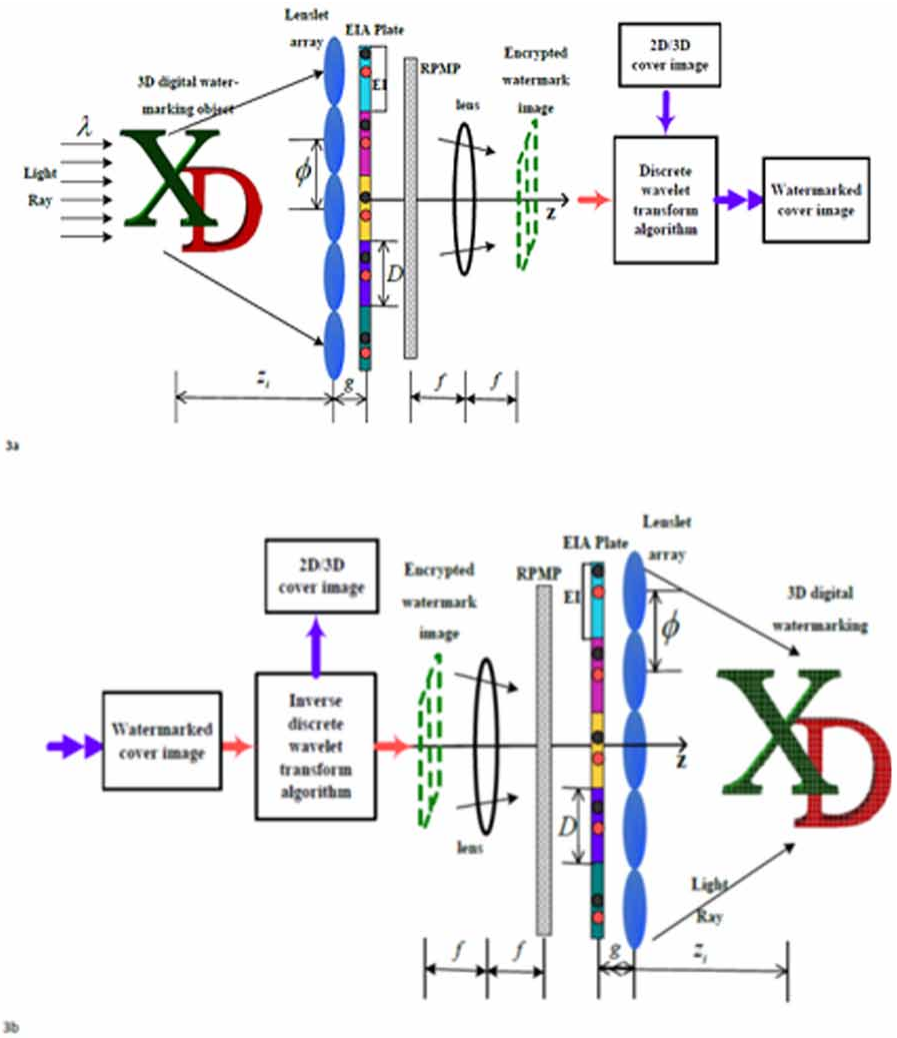
As shown in Figure 3(a), the encryption process of integral imaging cryptosystem. The subsystem is consisted of the acquisition record, beam splitter, random phase mask plate (RPMP), the imaging lens, encrypted watermark image, and so on. $Z_i, i = 1, 2, \cdots j \in Z^+$ represents the distance between the different planes, g represents the distance between the pinhole array and elemental image plane, D represents the size of EIs, φ represents pinhole spacing, the focal length of the imaging lens ρ is f , the function of RPMP is $R(x, y)$, the spectral transmittance function is $T(s, t; f)$. Thus, the transformation process of encryption in the frequency domain can be described by the following mathematical models, for example, the formula (3) is the mathematical model of integral imaging cryptosystem, while the optical field distribution for the rear surface of the imaging lens can be determined by $W_e(\omega, \gamma)$, and the relevant encrypted watermark image will be.

$$
\begin{aligned}
&W_e(\omega, \gamma) = DFD\{DFD\{[W(x, y) \bullet R(x, y), \\
&L(x, y), s, t; f, \lambda]\} \times T(s, t; f)\}
\end{aligned}
$$

where $\alpha_1 + \alpha_2 = 1, \alpha_1, \alpha_2$ is encryption weighting coefficient. $\bullet$ and $\times$ denote the operation.

As shown in Figure 3(b) is the decryption process of integral imaging cryptosystem. The process consists of 3D optical image decryption and display. The authorized users receive the correct watermarked cover image, and the encrypted watermarking $W_e(\omega, \gamma)$ is extracted from it at first. The watermark image $W^{'}$ would be calculated by the mathematical model of decryption process with the formula (4). Therefore,

Figure 3. The schematic of integral imaging cryptosystem (a) The encryption process (b) The decryption process



in the accordance to the optical Fourier transform theory (Goodman, J.W., 2005; David Voelz, 2010), the watermark cipher text images is decrypted into the plaintext image, the watermark plaintext image can be reconstructed on the elemental image planes. Finally, we can adopt the integral imaging reconstruction display system to restore the 3D optical watermark images transferred by communication link.

$$W^{'} = IDFD\{IDFD[W_e(\omega,\gamma), L^{'}(x,y),$$
$$s,t;z_R,\lambda]\times T^{*}(s,t;f)\}\bullet R^{*}(x,y)$$

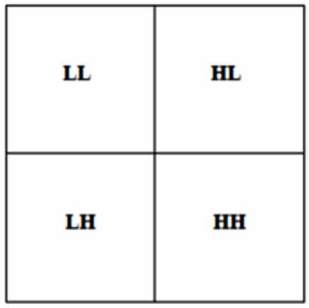
where $IDFD[-]$ represents the inverse discrete Fresnel diffraction transform. $*$ denotes the complex conjugate operation.

3.3. Embedding and Extraction of 3D Digital Watermark

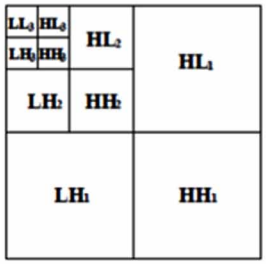
Wavelet transform is an analysis method of signal time-scale or time-frequency. The important feature is the capability of multiresolution analysis. The wavelet analysis method is a good local property in both time and frequency domain. That is to say, the window size is fixed but the shapes can be changed. The time window and frequency window can also be changed. What's more, Wavelet transform has higher adaptability. Compared with the Fourier transform, it has the advantage of good localization property. The signal can be denoted in the local time domain and local frequency domain. The wavelet transform is applied for abnormal phenomenon in the midst of transient normal signal detection and denotes its composition. The method has been widely used in the fields of signal analysis and image processing.

Under the different scales, wavelet transform decomposed the two-dimensional signals or images into three high frequency detail subband details step by step. Generally speaking, they are divided into horizontal subband HL_i, vertical subband LH_i and diagonal subband HH_i and a low frequency approximation subband LL_i, where level $i = 1, 2, 3$. Then, the low frequency approximation subband is decomposed iteratively into HL_{i+1}, LH_{i+1}, HH_{i+1} and LL_{i+1}. As shown Figure 4(a) one-level decomposition and 4(b) three-level decomposition. Low-frequency subband LL_i is the wavelet decomposition under the largest scale, the minimum resolution of the optimal approximation of the original image. There are high frequency resolution and low time resolution in the subband. The statistical characteristic of the subband is similar to the original image. The most of the energy is focus on this subband. High frequency subband is the details information of images under different scales and different resolutions.

Figure 4. Subband labeling schemes for discrete wavelet transform (a) One-level decomposition (b) Three-level decomposition



4a



4b

There are higher temporal resolution and lower frequency resolution than other subbands. The lower resolution is, the higher will be in the proportion of the useful information. That is to say, an image is decomposed into several layers by wavelet transform. For the same image, the low frequency subband LL_i of the image is the most important. The LH_i and HL_i take the second place. Decomposition for different layer, the bigger is layer number. The low frequency subband is the more important than others. After the image is transformed by discrete wavelet transform, the values of each frequency subband will be calculated with wavelet coefficients. According to the importance of each wavelet sub image, the values of the digital watermarking are embedded into low frequency approximation coefficients of the binary images.

Digital watermark embedding and extraction algorithm based on DWT is designed and realized in this paper. The main idea of the algorithm is to realize the hiding of watermark information by first respectively performing DWT decomposition of Red, Green and Blue (RGB) channels of cover images, then selecting the low frequency subband of each channel to be respectively embedded into the RGB channels of watermark images, and finally performing watermark information into transformation coefficients by DWT and inverse discrete wavelet transform (IDWT) embedding algorithm.

In the process, firstly, RGB channel decomposition is explicitly executed. Secondly, the data should be fused with the RGB channel of watermarked image after the digital watermarking is embedded/extracted. So the image could be obtained in high quality.

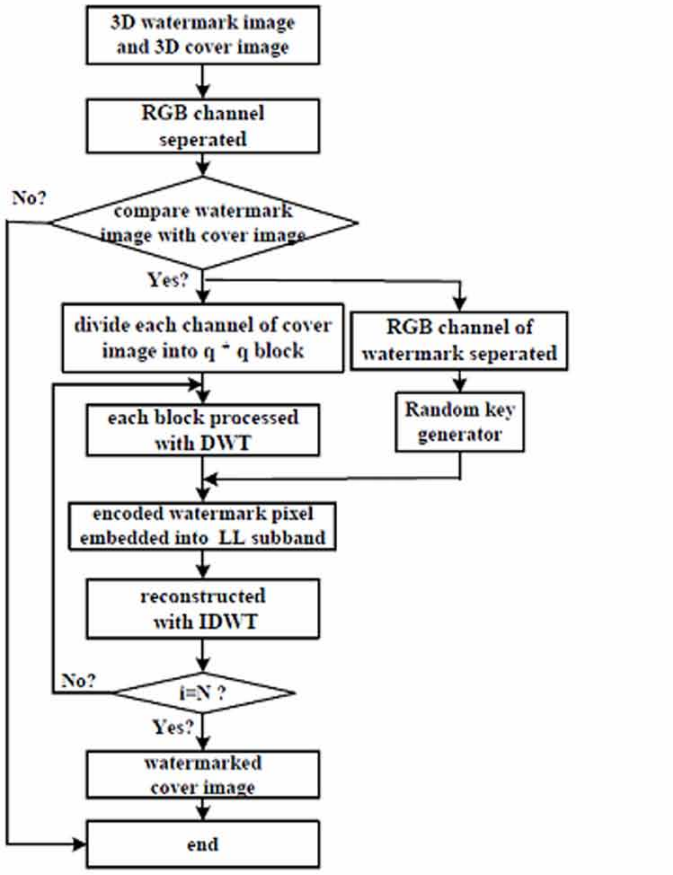
Main steps of 3D digital watermark embedding algorithm are shown in Figure 5 (a).

I. Separate RGB three channels of cover images.
II. Separate RGB three channels of watermark images.
III. Judge the size constraint relation between cover images and watermark images. Continue the following procedures if a cover image is larger than its relevant watermark image in size and thus meets the embedding condition. Otherwise, the program ends and returns the prompt of failure to meet the embedding condition.
IV. Partition each channel of cover images.
V. Perform DWT decomposition of each partition.
VI. Respectively embed in iterative method watermark images and their corresponding to pixels in the channel into DWT decomposed Low Low (LL) subbands to realize the embedding of watermark information into transformation coefficients under the control of random keys.
VII. Perform IDWT reconstruction of image partitions with watermarks embedded.
VIII. Repeat steps (V) to (VII) until watermark images are fully embedded and generate watermarked cover images.

Thus, the embedding algorithm can be described as follows:

Presume that a cover image with three channels separated is $C_{RGB}(x,x,3) = (C_R : C_G : C_B)$ and a watermark image with three channels separated is $W_{RGB}(y,y,3) = (W_R : W_G : W_B)$. If $C_{RGB} > W_{RGB}$, perform $q * q$ partitioning. The partitioning of images is:

Figure 5. The flowcharts of embedding and extracting algorithm of 3D digital watermarking system based on integral imaging



$$J_{i,R} = (q,q), i \in (0,[x/q])$$
$$J_{i,G} = (q,q), i \in (0,[x/q])$$
$$J_{i,B} = (q,q), i \in (0,[x/q])$$

Finally, finish the embedding of digital watermark data.

$$J'_{i,R}(x,y) = IDWT[DWT(J_{i,R}(x,y))_{LL} + \alpha J_{i,R}(rkey \times x \bmod q, rkey \times y \bmod q)],$$
$$J'_{i,G}(x,y) = IDWT[DWT(J_{i,G}(x,y))_{LL} + \alpha J_{i,G}(rkey \times x \bmod q, rkey \times y \bmod q)],$$
$$J'_{i,B}(x,y) = IDWT[DWT(J_{i,B}(x,y))_{LL} + \alpha J_{i,B}(rkey \times x \bmod q, rkey \times y \bmod q)]$$

In the formula, α represents the intensity factor of the embedded watermark. $rkey$ represents random key.

As shown in Figure 5 (b), main steps of 3D digital watermark extraction algorithm are briefly as follows:

I. Separate RGB channels of watermarked cover images which hidden watermark information.
II. Perform $q * q$ partitioning of each channel.
III. Perform DWT decomposition of each partition.
IV. Extract q number of watermark embedding values in every $2 * 2$ zone of low frequency subbands.
V. Calculate the average value of q number of watermark embedding values.
VI. Repeat steps (III) to (V) until all watermark information is extracted.
VII. Reconstruct watermark images according to the average value calculated in step (V).

4. EXPERIMENTAL RESULTS AND DISCUSSIONS

According to theoretical analysis, the experimental process is composed of four procedures.

4.1. Generation of 3D Digital Watermarks

The performance of the proposed algorithm is tested over a various number of images. As shown in Figure 6, respectively generate XD model and ball-stick model utilising the collecting part of integral imaging. Select ball-stick EIs as the cover images, with sizes from 256*256 pixels, 512*512 pixels, 1024*1024 pixels, to 2048*2048 pixels. Select XD EIs as watermark images, with sizes from 64*64 pixels, 128*128 pixels, 256*256 pixels. Portable Network Graphic (PNG) is the format of cover imagesand watermark images.

Figure 6. EIs of ballstick and XD models (a) cover image (b) watermark image

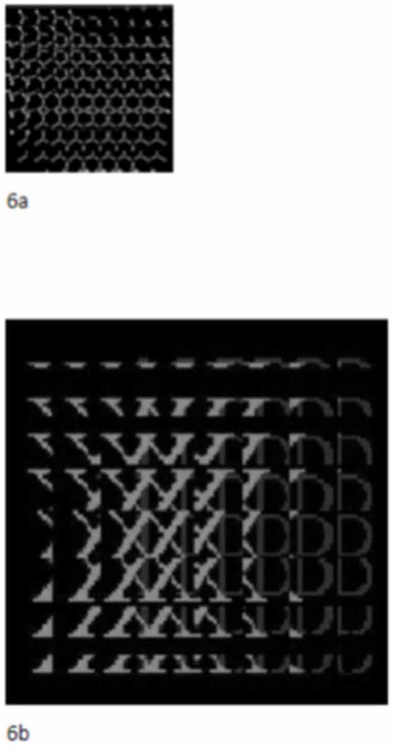


Figure 7. The light field image in front surface of lens and cipher text image (a) the light field image in front surface of lens (b) cipher text image

4.2. Encryption and Decryption of 3D Digital Watermark

In accordance with the principle of section 3.2, the plaintext XD elemental image array(EIA) is transformed into the ciphertext images with the mathematical model of the 3D optical image encryption. Figure 7(a) represents the optical field distribution of the front surface of the lens, Figure 7(b) represents the generated cryptograph image. It should be noted that, after the complex amplitude distribution calculation, the modular square calculating should be done on the complex amplitude distribution to get the light-field intensity distribution images.

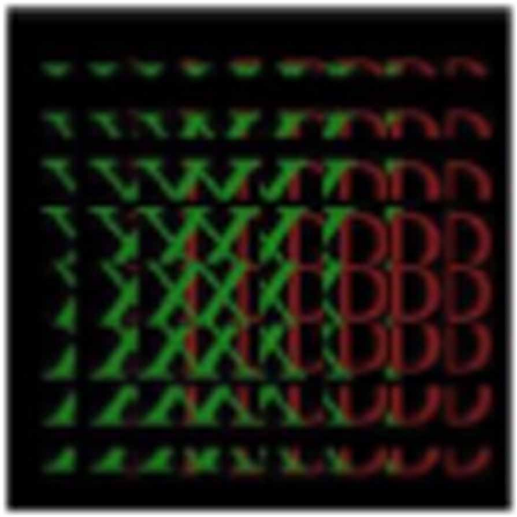
Assuming that the contribution of the random phase mask in the encryption process has been defined, the decrypted and restored plaintext images are as shown in Figure 8.

4.3. Embedding and Extraction of 3D Digital Watermarks

Perform DWT decomposition of the cover images and watermark images utilizing the embedding algorithm. Partition images $4*4$. Repeatedly embed a pixel of watermark images in every $2*2$ zone of LL subbands of cover image to finish the embedding process and get cover images with watermarks.

In engineering applications, it is an important problem that how to select the optimal wavelet function. Different wavelet function can be applied in wavelet analysis process. For one engineering problem, the results would be varied widely when different wavelet function is used in the program. However,

Figure 8. The decrypted image and displaying image of 3D optical image



because the orthogonality of the wavelet basis function, it is eliminated the wavelet space caused by redundancy link between two points. It becomes smaller in calculation error. The nature of the signal itself is characterized by the results of time-frequency domain function of DWT transform. Now, for the engineering problems, optimal wavelet function is determined by practical error between the process result of wavelet analysis and theoretical results. Therefore, the Haar wavelet basis function is used in our work. Because the Haar function is a compactly supported, orthogonal wavelet basis function. Haar function is also a simple function. The quality of reconstructed image is improved by its orthogonality and symmetry, decomposition and reconstruction.

To extract watermarks, calculate the mean of the four embedded values in the a bove mentioned $2*2$ zones to get the mean of a corresponding pixel of a watermark. Then reconstruct images and recover watermark images with correct keys.

To objectively evaluate the quality of watermarked images, Peak signal noise rate (PSNR) is used to measure the watermark invisibility. That is, the greater the PSNR is, the higher the quality of the watermarked image is.

$$PSNR = 10\log_{10}(\frac{C^2}{MSE}\max)$$

In the formula, $C^2_{\max}$ represents the maximum grey scale of an image.

$$C^2_{\max} \leq \begin{cases} 1 & ,double\ precision \\ 255, & 8bit \end{cases}$$

$$MSE = \frac{1}{MN}\sum_{x=1}^{M}\sum_{y=1}^{N}(S_{xy} - C_{xy})^2$$

In th formula, M, N represents the size of the image pixel array. S_{xy} and C_{xy} represents the pixel size of a watermarked image and cover image.

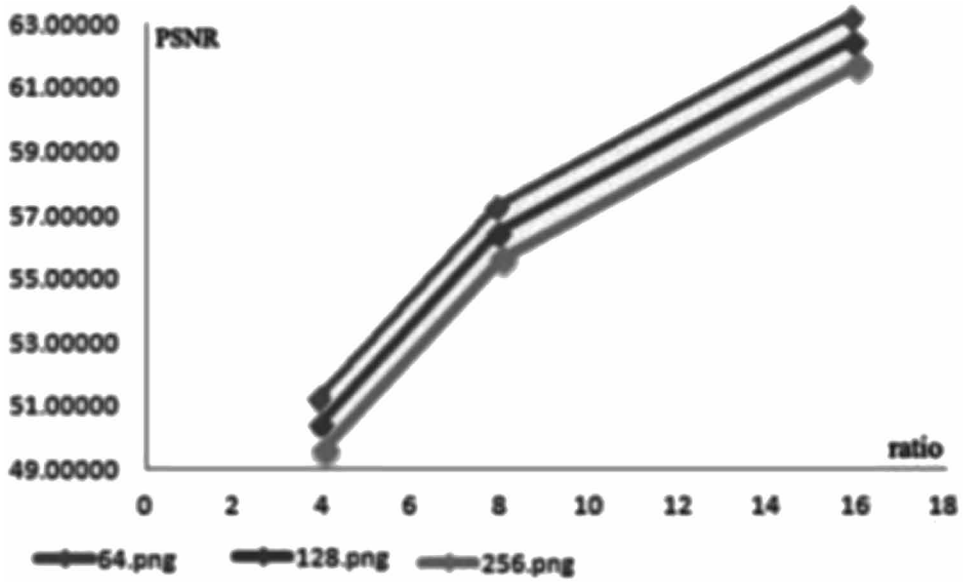
After measurement of experimental samples, the PSNR curve of various 3D digital watermarks is shown in Figure 9. The horizontal axis is the size proportional relationship between watermarked images and cover images. The vertical axis is the PSNR value. The larger the PSNR value is, the less image distortion is. If PSNR is larger than 30dB, it can be considered that the PSNR is a reasonable value (Dong-Choon Hwang, & Eun-Soo Kim, 2007). Human eyes cannot recognise the distortion at this level. The value is, thus, generally considered as an acceptable distortion standard.

According to the Fidelity formula (5):

$$Fidelity = 1 - \frac{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(f(i,j) - f_s(i,j))^2}{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1} f^2(i,j)}$$

In the formula, $f(i,j)$ represents the pixel data of the original image. $f_s(i,j)$ represents the pixel data of the reconstructed image. According to the measurement of experimental samples, fidelity values are all no less than 0.9966, i.e. the approximate value of fidelity is 1. This means that the extracted and reconstructed images are of high fidelity with original images. As the experimental values reveal, the applied algorithm is feasible and correct.

Figure 9. The PSNR curve of different 3D digital watermarking



4.4. Display of 3D Digital Watermarks

Corresponding 3D digital watermark images of EIs can be recovered in the reconstruction algorithm of the integral imaging system. 3D images are reconstructed along the output plane to generate images of different depths on various depth planes. Then the most optimal position and the best pixel are selected as the position of the image point to determine 3D images with the best image point (Stern & Javidi, 2006; Xiaorui Wang, & Qingfeng Bu, 2009; Xiaorui Wang & Qiang Guo, 2010). As shown in Figure 10, 3D digital watermarks are observed with the combined display which is accomplished by multiple projectors and lenslet array in real mode display using reconstruction display technique based on SPOC algorithm. From the perspective of integral imaging image quality evaluation and actual experimental conditions, the resolution, depth, and field of view of the reconstructed 3D digital watermark images all meet the requirements of the HVS model and comply with the subjective quality evaluation criteria for integral imaging images. Low display quality and resolution of 3D images can be affected by the characteristic parameter and resolution of projectors, technological level of the lenslet array, and so on. A portion of the 3D image reconstruction plane exceeds the image depth range. Thus, images are fuzzy and of low resolution. Security and robustness are critical in the application of digital image information hiding. For digital watermarking, techniques, such as anti-intentional and anti-tampering, detection of intentional tampering, and resistance of malicious attacks represented by geometric attack, are to be urgently resolved. EIs from integral imaging are of good The picked-up EIs have a hologram-like characteristics of data redundancy, and the orders of the pixel scrambling as well as the pickup conditions of the EIs can be used as the keys to decrypt the original image, so that its robustness against various types of attack expects to be dramatically improved. 3D images after the cropping or shading of 3D digital watermarks are respectively shown in Figure 11. As the results reveal, integral imaging can effectively recover embedded 3D digital watermarks. The 3D digital watermarking system can improve the capability of 3D digital watermarks to resist cropping and localized tamper attacks because 3D digital watermark-

Figure 10. Display the extracted 3D digital watermarking

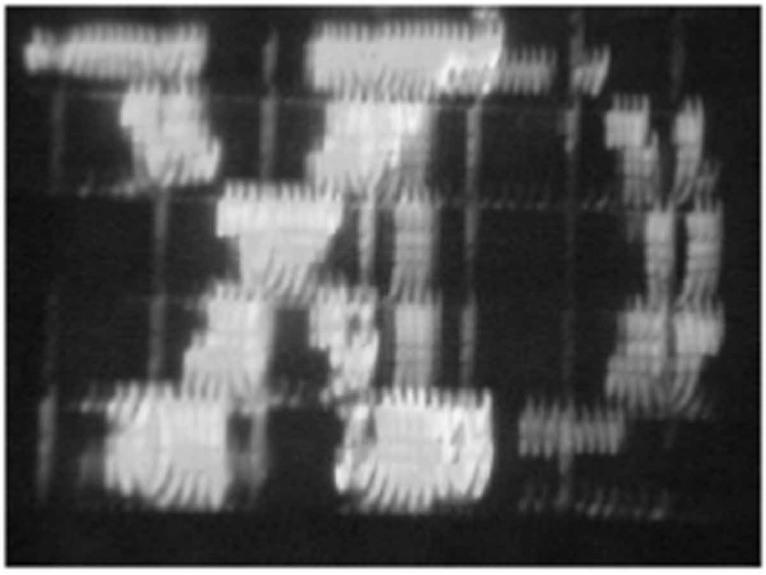
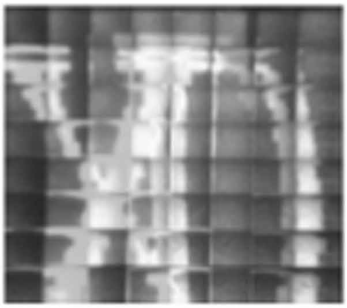
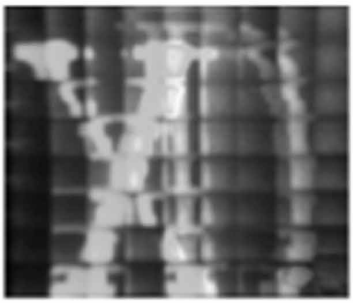


Figure 11. The hologram-like characteristics of 3D digital watermarking (a) partial cropping (b) partial shading



11a



11b

ing, similar to holographic imaging, has spreading effect, i.e. the extracted EIA watermark information is a group of overlapping EIs. The overlapped images contain various brightness and direction information of 3D digital watermarks. Embedded watermark images can be reconstructed and recovered to the largest extent to authenticate copyright information using reconstruction algorithm and a portion of the 3D watermark information. Traditional 2D digital watermarking systems use 2D images as watermarks. These systems are, however, vulnerable to various attacks such as noise, cropping, and distortion. Experiments have been conducted to analyse the robustness of the 3D digital watermarking system based on integral imaging to resist noise attacks. Three types of noise attacks are considered: uniform noise, Gaussian noise, and cropping noise. 2D "X" and "D" were embedded into ball-stick cover images in a traditional watermark algorithm. Watermarks were extracted in the experimental conditions mentioned above. New and traditional watermarking methods were compared in terms of performance. As shown in Figure 12, three solid lines represent the PSNR of 2D watermarks. According to the experimental results, the PSNR values of the new method on average increase by 5.27 dB compared to traditional 2D watermarking. In addition, the attacked 3D digital watermarks can be extracted and authenticated using the reconstruction algorithm. As shown in Figure 13, the 3D images meet the HVS feature requirements. The attacked images are, however, of some degree of distortion and obvious quality decrease. Thus,

Figure 12. The contrastive PSNR curve after different noise attacks

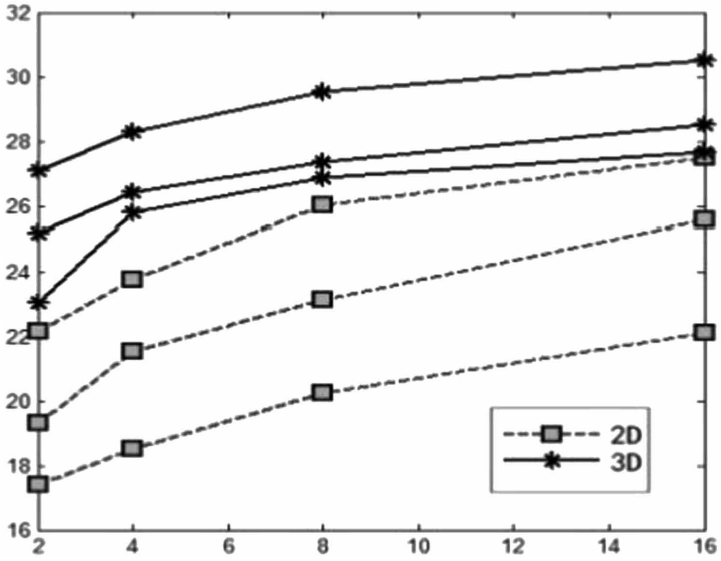
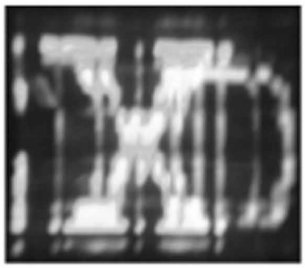


Figure 13. 3D digital watermarking display after noise attacks (a) uniform noise attack (b) Gaussian noise attack

13a



13b

proposed new 3D digital watermarking has some advantages of high feasibility, robustness, tamper-resistance, and attack-resistance.

The new method can enhance security. 2D EIs look meaningless. They can become a group of meaningful and depth-related watermark images and be applied in copyright authentication (Dong-Choon Hwang, & Eun-Soo Kim, 2007) via integral imaging reconstruction and display on the output plane. The imaging system is closely associated with the settings of optical device parameters in the process of reconstruction in integral imaging system and the recording of EIs. Once an illegal user tampers EIs, the reconstruction quality of 3D digital watermark images will be significantly reduced. Moreover, original 3D watermark information may not be recovered and displayed. In the new method, the optical device parameters and functionality parameters of integral imaging system can be used as keys. In the embedding algorithm, the modulation parameters for watermark embedding level can also be used as keys. Multiple keys synthesizing the above mentioned keys will enhance security. It could be more difficult to crack.

By redistributing signal energy and diffusing hidden signal energy embedded into transformation coefficients in spatial and temporal domains, the DWT embedding and extraction algorithm applied in the new method effectively resolves the contradiction between imperceptibility and robustness of information hiding. Thus, the new method can meet robustness and security requirements.

Through the experimental analysis, we found that there are two disadvantages that are long time consuming and weak real-time performance for the DWT embedding and extracting algorithms. In the experiment, the execution time is 8.22 min from the embedding process to extracting process.

5. CONCLUSION

This paper introduces a new 3D digital watermarking method based on discrete wavelet transform and integrated imaging. Information hiding of 3D digital watermarks is realized based on the DWT embedding and extraction algorithm. The feasibility and effectiveness of the proposed method is demonstrated by experiment. A primary implication of encrypted processing is that the majority of integral imaging cryptosystem will be encryption-in-the-loop applications, and the majority of system will improve the security and robustness of 3D digital watermarking. The new method is not only able to meet the requirements of robustness and security, but image quality and display quality achieve these criterions of the human visual model. The proposed method opens up a new research perspective for the copyright protect of 3D digital multimedia products. Although Integral imaging is a major technique in the next generation autostereoscopic display, most of the basic ideas and 3D digital watermarking algorithms were proposed more than tens of years ago or even 100 years ago, none of them are without critical issues that are obstacles to catching a mass market of the integral imaging. Future, we will optimize the DWT algorithm. The efficiency will be improved in the aspect of computational. The property of the real-time performance will be also enhanced.

ACKNOWLEDGMENT

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Chapter 29
Digital Forensic Analysis of Cybercrimes:
Best Practices and Methodologies

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ABSTRACT

This paper reviews the existing methodologies and best practices for digital investigations phases like collecting, evaluating and preserving digital forensic evidence and chain of custody of cybercrimes. Cybercriminals are adopting new strategies to launch cyberattacks within modified and ever changing digital ecosystems, this article proposes that digital investigations must continually readapt to tackle cybercrimes and prosecute cybercriminals, working in international collaboration networks, sharing prevention knowledge and lessons learned. The authors also introduce a compact cyber forensics model for diverse technological ecosystems called Cyber Forensics Model in Digital Ecosystems (CFMDE). Transferring the knowledge, international collaboration, best practices and adopting new digital forensic tools, methodologies and techniques will be hereinafter paramount to obtain digital evidence, enforce organizational cybersecurity policies, mitigate security threats, fight anti-forensics practices and indict cybercriminals. The global Digital Forensics community ought to constantly update current practices to deal with cybercriminality and foreseeing how to prepare to new technological environments where change is always constant.

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1. INTRODUCTION

Nowadays, cybercrime continues to grow at accelerated rates due to global connectivity and the advancements of networks, information exchange and mobile technologies. Furthermore, digital investigators and prosecutors need to understand how cybercriminals behave in order to assimilate their modus operandi including Techniques, Tactics and Procedures (TTP) of criminal hacking.

Cyberattacks continually increase its sophistication to avoid detection, monitoring, remediation and eradication. The proliferation of digital devices has attracted countless possibilities to commit cybercrimes or to utilize these devices to perpetrate common crimes.

Cybercriminals are continually launching cyberattacks that tend to grow in sophistication, the adoption of anti-forensics techniques and the use of procedures to avoid cybercrime detection and tracing.

In 2015, the IC3-FBI received over 8,000 complaints with a combined loss of around $ 275 million, the IC3 dealt with 3,463,620 cybercrime complaints during a period of six years (2010-2015) and they estimate that only 15% of the cyber victims file a complaint. According to their Internet Crime Report (2015), the top 5 cyber victimization by country occurs in the USA, UK, Nigeria, China and India mostly linked to non-delivery of products or payment, 419 schemes, identity theft, online auctions, personal data breach, cyber extortion, employment fraud, credit cards, phishing and cyber harassment. The IC3 follows specific procedures to fight cybercrime including detection, victim complaint, mitigation, liaison with industry/law enforcement, cybercrime analysis, deterrence, investigation, prosecution and prevention.

McAffee (2014) estimated that cybercrime costs $ 400 billion to the global economy on an annual basis, but this can easily reach a maximum of $ 575 billion. Stolen personal information could cost $ 160 billion per annum, G20 nations experience most financial losses due to cybercrime activities especially the USA, China, Japan and Germany. Developing countries are only experiencing small losses yet this trend will likely change in the future as business use Internet for commercial purposes particularly mobile platforms and network connectivity. Nevertheless, most cybercrime activities go unreported on the organizational level to avoid further impacts like harming business operations, customer relationships and company reputations. The cybercrime effect targeting end users is not different when it comes to the theft of personal information.

For years, digital forensics methodologies and practices have not been evolving at the same rate that cybercriminality exploits Information and Communication Technologies (ICT) vulnerabilities. In our paper, we evaluate existing methods and how is necessary to revisit cybercrime and digital investigations operations to cover a vast number of technological environments. Our proposed Cyber Forensics Model combines the most relevant phases of digital investigations and targets multiple environments in digital ecosystems.

Arief et al. (2015) argue that because cybercrime losses are normally presented using surveys, these surveys do not provide a representative sample of the losses. Furthermore, surveys can be distorted and it does not exist an authoritative source for calculating cybercrime losses as many incidents are never reported to not lose reputation. They highlight that the number of cybercrime losses is arguable but what is undeniable is the rising threat of cybercrime. In order to examine how cybercrime operates, we ought to comprehend the attackers, the defenders and the victim's environments.

This paper studies in Section 2 the new digital ecosystems for cybercriminality; the literature review in Section 3 compares 26 Digital Forensic methodologies organized in three periods (1984-2006; 2007-2010 and 2011-2016). Section 4 highlights the importance of Digital Forensic investigations; Section 5 presents an overview of Digital Forensics tools and in Section 6 we emphasize the importance of digital

evidence to prosecute cybercriminals. In Section 7, we propose our Cyber Forensics Model in Digital Ecosystems (CFMDE) and Section 8 includes concluding remarks and future work.

2. DIGITAL ECOSYSTEMS FOR CYBERCRIMINAL

According to Cano (2016), cybercriminals modus operandi has been elevated from traditional cyber operations to cybercrime digital ecosystems where they take advantage of logic infrastructures, digital platforms and highly connected users. He defines a Criminal Digital Ecosystem (CDEco), as the group of relationships between local and global participants that interact to create a flexible network to engage in criminal activities by exploiting vulnerabilities of cyber victims; above all, aiming at specific goals under full anonymity and leaving untraceable digital evidence when possible.

He argues that the intent of the cybercriminal's actions is set on five premises:

1. Maximum effectiveness with minimum effort;
2. Maximum anonymity, with the minimum possible evidence;
3. Maximum legal ambiguity, with minimal technological knowledge available;
4. The use of free digital platforms, assisted by specialized communities;
5. Using cryptocurrency as payment. Being Bitcoin, the digital currency mostly used for hacking communities and underground operations in the Deep Web.

Cyber investigators must adapt to the way cybercriminals operate, by developing new skill set based on data analytics, revisiting the search and collection phases of digital evidence and analyze the hacking scenario design aimed to comprehend these new criminal digital ecosystems.

3. DIGITAL FORENSIC METHODOLOGIES

Digital forensics (DF) is defined as the use of scientific methodologies to preserve, collect, validate, analyze, interpret, document and present evidence from digital devices for civil or criminal investigations, to prove and prosecute cybercrime.

We studied 26 models and frameworks related to digital forensics investigations for digital crime and cybercrime (Table 1,2 and 3). Starting from its inception with the Politt Process (1984) until one of the latest, the Digital Forensics Cybercrime Ontology developed by Talib et al. (2015).

Table 1 highlights an overview of digital forensic methodologies from 1984 until 2006.

While there are many options out there for cyber investigators to choose from and follow a specific framework or model, there isn't a globally accepted or an universal digital investigation methodology.

In Table 2, we present the DF methodologies in the 2007-2010 period.

With the adoption of new technologies, it is necessary to adapt DF practices and we have to keep in mind that the cyber threat landscape will keep growing as well (Table 3).

By studying the aforementioned digital forensic methodologies, we were able to detect similar patterns when comparing all its different phases. In Table 4, we compared the similarity of DF methodologies in the identification, investigation, collection, analysis and presentation phases.

As shown in Figure 1, we depict the number of DF methodologies that share similar phases.

Table 1. An overview of digital forensic methodologies (1984-2006)

Digital Forensic Methodology	Phases
Politt (1984): Computer Forensic investigate process	Acquisition, identification, evaluation and admission
Kruse and Heiser (2001): Basic computer investigation model	Assess, acquire, analyze and report
Digital Forensic Research Workshop -DFRWS (2001): DFRWS Investigative model	Identification, preservation, collection, examination, analysis and presentation
Casey (2001): Six-step model	Identification/assessment, collection/acquisition, preservation, examination, analysis and reporting
Reith et al. (2002): Abstract Digital Forensics Model (ADFM)	Identification, preparation, approach strategy, preservation, collection, examination, analysis, presentation and returning evidence
Carrier et al. (2003): Integrated Digital Investigation Process (IDIP)	Readiness, deployment, physical crime scene investigation/digital crime scene investigation phase. The digital crime scene investigation phases are preservation, survey, document, search for digital evidence, scene reconstruction and presentation
Ciardhuain (2004): Extended Model of Cybercrime investigations	Awareness, authorization, planning, notification, search, collection, transport, storage, examination, hypothesis, presentation, proof/defense and dissemination
Baryamureeba et al. (2004): Enhanced Digital Investigation Model (EIDIP)	Readiness, deployment, traceback, dynamite and review
Beebe et al. (2004): A Hierarchical, Objectives-Based Framework for the Digital Investigations Process	Preparation, incident response, data collection, data analysis, presentation and incident closure
Rogers et al. (2006): Computer Forensics Field Triage Process Model (CFFTPM)	Planning, triage, usage/user profiles, chronology/timeline, Internet and case specific evidence
Kohn et al. (2006): Framework for a Digital Investigation	Preparation, investigation and presentation
Kent et al. (2006): Four-Step Forensic Process	Collection, examination, analysis and reporting
Ieong (2006): FORZA- Digital Forensics Investigation Frame	8 layers: Contextual investigation, contextual, legal advisory, conceptual security, technical preparation, data acquisition, data analysis and legal presentation
Venter (2006): Process Flows for Cyber Forensics Training and Operations	Inspect & prepare scene, collect evidence & evidence information and debrief scene & record seizure information

Table 2. An overview of digital forensic methodologies (2007-2010)

Digital Forensic Methodology	Phases
Freiling et al. (2007): The Common Process Model	Pre-incident preparation, detection of incidents, initial response, formulate response strategy, investigate the incident and reporting
Khatir et al. (2008): The Two-Dimensional Evidence Reliability Amplification Process Model	Five major phases (Initialization, evidence collection, evidence examination and analysis, presentation and case termination). Under two dimensions that include 16 sub-phases and umbrella activities (computer tools utilization, case management/team setup, preservation/authenticity and documentation)
Selamat et al. (2008): Digital Forensic Investigation Framework	Preparation, collection and preservation, examination and analysis, presentation and reporting and disseminating the case
Perumal (2009): Digital Forensic Model on Malaysian Investigation Process	Planning, identification, reconnaissance, analysis, result, proof & defense and diffusion of information
Pilli et al. (2010): A Generic Framework for Network Forensics	Preparation and authorization, detection, incident response, collection, preservation and protection, examination, analysis, investigation and attribution, presentation & review

Table 3. An overview of digital forensic methodologies (2011-2016)

Digital Forensic Methodology	Phases
Agarwal et al. (2011): Systematic Digital Forensic Investigation Model (SRDFIM)	Preparation, securing the scene, survey & recognition, documenting the scene, communication shielding, evidence collection, preservation, examination, analysis, presentation and result & review
Ambhire and Meshram (2012): Phases model	Planning phase, scene phases (Identification, collection and preservation) and the lab phases (Examination, analysis and report)
U.S. Department of Justice (2014): Process model	Collection, examination, analysis and reporting
Prayudi et al. (2015): Digital Forensics Business Model	Identify purpose of digital investigation, identify principles for handling evidence, identify object involved in the digital forensics activity, recognize environment and how digital forensics activity works and construct a business model of digital forensics
Jain et al. (2015): Digital Forensic Framework	Plan, authenticate, gather evidence, categorize cybercrime, report and future update
Talib et al. (2015): Comprehensive Ontology Based-Investigation for Digital Forensics Cybercrime	180 classes, 179 subclasses and 84 instances related to digital forensics crime cases. Digital forensics phases are readiness, investigation, physical crime scene, digital crime scene, presentation and deployment
Jadhao et al. (2016): Digital Forensics Investigation Model for Social Networking Site	Check, analyze context, scan suspicious words, call heuristic method, call knowledge base rule, report to E-crime department and check connection

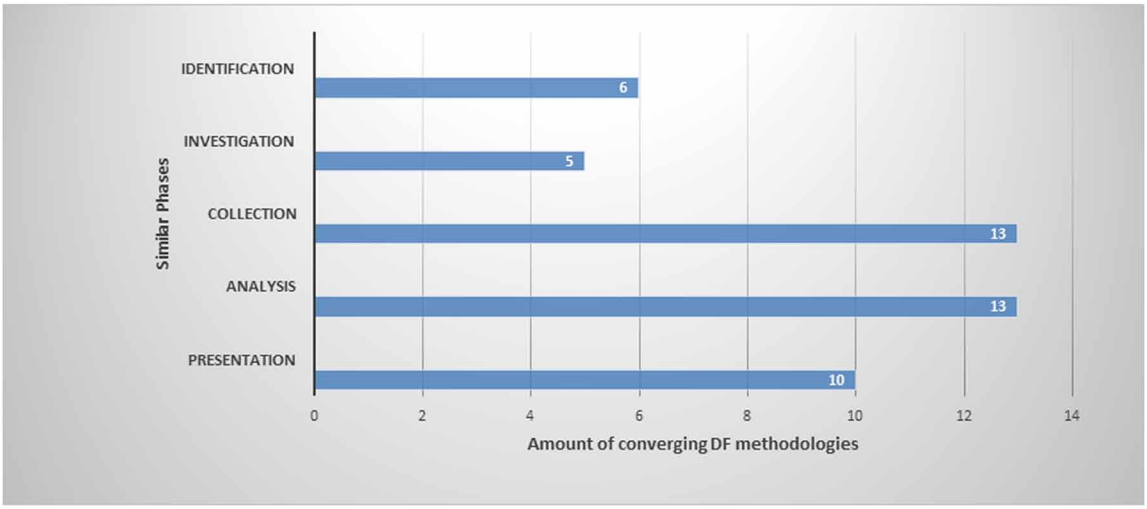
Table 4. Similar phases in DF methodologies

Identification Phase (6)	Investigation Phase (5)	Collection Phase (13)
1) Pollit (1984) 2) DFRWS (2001) 3) Casey (2001) 4) Reith et al. (2002) 5) Perumal (2009) 6) Ambhire and Meshram (2012)	1) Carrier et al. (2003) 2) Kohn et al. (2006) 3) Freiling et al. (2007) 4) Pilli et al. (2010) 5) Talib et al (2015)	1) DRFWS (2001) 2) Casey (2001) 3) Reith et al. (2002) 4) Ciardhuain (2004) 5) Beebe et al. (2004) 6) Kent et al. (2006) 7) Venter (2006) 8) Khatir et al. (2008) 9) Selamat et al. (2008) 10) Pilli et al. (2010) 11) Agarwal et al. (2011) 12) Ambhire and Meshram (2012) 13) U.S. Department of Justice (2014)
Analysis Phase (13)	**Presentation Phase (10)**	
1) DRFWS (2001) 2) Casey (2001) 3) Reith et al. (2002) 4) Beebe et al. (2004) 5) Kent et al. (2006) 6) Ieong (2006) 7) Selamat et al. (2008) 8) Perumal (2009) 9) Pilli et al. (2010) 10) Agarwal et al. (2011) 11) Ambhire and Meshram (2012) 12) U.S. Department of Justice (2014) 13) Jadhao et al. (2016)	1) DRFWS (2001) 2) Reith et al. (2002) 3) Carrier et al. (2003) 4) Ciardhuain (2004) 5) Beebe et al. (2004) 6) Kohn et al. (2006) 7) Ieong (2006) 8) Agarwal et al. (2011) 9) Talib et al. (2015) 10) Pilli et al. (2010)	

4. DIGITAL FORENSIC INVESTIGATIONS

According to Sindhu et al. (2012), a digital forensic investigation is an inquiry into the unfamiliar or questionable activities in the cyberspace or digital world. ISACA (2013) points out that cybersecurity investigations or forensics analyses are merely based on previous assumptions and hypotheses that will

Figure 1. Converging phases in DF methodologies



require further testing; a specific scenario will require flexible cyber investigative responses for the verification of the cybersecurity incident, a complete analysis of the cyberattack and investigation of persistent attacks like Advanced Persistent Threats (APT).

There are three existing categories of digital investigations:

1. **Internal investigations:** These investigations are sponsored by organizations or corporations and are treated as corporate secrets;
2. **Civil investigations:** These investigations are initiated when intellectual property is at risk. Possible attacks include intrusions, denial-of-service (DoS) attacks, malware, malicious communication, cyber harassment and abuse of resources;
3. **Criminal investigations:** Cybercrimes include the computer or the computer data as the objects, the computer as the instrument or tool of the act, or it is used to intimidate cyber victims. Some cybercrimes include cyberfraud, cyberextortion, child pornography, cyberespionage, identity theft, cyberstalking, cybertheft, data breach, online gaming, phishing and revenge porn.

5. DIGITAL FORENSIC TOOLS

Graves (2014) classified digital forensics software tools in two categories: Basic and functional. These software tools are organized as follows:

- Basic Categories:
  - Operating system utilities;
  - Open source applications;
  - Commercial applications and suites;
- Functional Categories:
  - Physical interception;

- Memory capture and examination;
- Application analysis;
- Network capture and analysis.

We also added further tools and techniques for mobile device forensics (MF), Cloud computing forensics, physical forensics and anti-forensics tools (Table 5).

While there are no right or wrong criteria when selecting DF tools, each cybercrime investigation scenario can utilize one or several categories of tools that could be either open source applications or commercial suites. The most comprehensive forensic tool taxonomy comes from the 'Computer Forensics Tool' – NIST, that basically contains twenty-six categories classified by functionalities:

- Cloud Services;
- Deleted File Recovery;
- Disk Imaging;
- Email Parsing;
- File Carving;
- Forensic Tool Suite (Mac Investigations);

Table 5. Digital forensic tools

Categories	Tools, Utilities and Techniques
Operating systems	Windows: Regedit, event viewer, sysinternals, autoruns, EFSDump, PendMoves, PSFile, PSList, PSService, Roorkit-Revealer, Streams and Strings
	Linux: Disk Dump, GREP, Linux Disk Editor and PhotoRec
	Mac OSX: GREP, HEAD, Finder and Spotlight
Open Source apps	Safecopy, Metaviewer, Hash, Filematch, Disk Explorer for NTFS, Disk explorer for FAT, DriveImageXL, Captain Nemo, DriveLook, Disk Investigator, Directory Snoop and Winhex
Commercial applications and suites	AccessData: EDiscovery and SilentRunner Guidance Software: Encase Forensics and Neutrino Paraben: P2 Commander, Forensic Replicator, Decryption Collection and Lockdown Pinpoint Labs: SafeCopy, Metadiscover and PG Pinpoint X-Ways: WinHex, Capture and Trace
	Windows: AccessData, Guidance Software, Paraben and X-Ways Forensics/Investigator Linux: The Sleuth Kit, Forensic or Rescue Kit (FoRK) and FCCU Forensic Boot CD
Mobile Device Forensics (MF)	For Operating systems including Android, Blackberry, iOS, Maemo, Symbian, WebOS and Windows Mobile
Cloud Computing Forensics	There are many existing challenges to overcome in terms of legal issues, jurisdiction, data replication, multi-tenancy, location transparency, remote data acquisition, large data volumes, distributed/elastic data handling, data ownership and chain of custody for cloud digital forensics investigations
Hardware tools	Phillips, flat, nut and torx screwdrivers Tweezers, 3-claw part grip, nose pliers, write protected interfaces, plastic scribe, digital camera, antistatic bags, Faraday shield, presslock bags, adhesive labels and forensics workstations/laptop
Anti-Forensics	To fight anti-forensics techniques like datahiding, artefact wiping, trial obfuscation and attacks against the cyberforensic process/tools. EFS, TrueCrypt, Onion routing, Burneye, rootkits, Slacker, FragFS, RuneFS, KY FS and Data Mule FS and BGP (Border Gateway Protocol). Memory injection, buffer overflow exploits, Userland Execve, Syscall proxying. The use of CDs, bootable USB tokens and virtual machines to run code without leaving digital traces.

- Forensic Tool Suite (Windows Investigations);
- Forensics Boot Environment;
- GPS Forensics;
- Hardware Write Block;
- Hash Analysis;
- Image Analysis (Graphics Files);
- Infotainment & Vehicle Forensics;
- Instant Messenger;
- Media Sanitization/Drive Re-use;
- Memory Capture and Analysis;
- Mobile Device Acquisition, Analysis and Triage;
- Peer-to-Peer (P2P) Analysis;
- Password Recovery;
- Remote Capabilities / Remote Forensics;
- Social Media;
- Software Write Block;
- Steganalysis;
- String Search;
- Web Browser Forensics;
- Windows Registry Analysis.

Furthermore, The Software Engineering Institute (SEI) from the Carnegie Mellon University has developed the Digital Intelligence and Investigation Tools (DIID) with restricted access tools exclusively for law enforcement agencies (Live View LE, CCFinder, CryptHunter and ADIA) and unrestricted free access tools (AfterLife, Live View, DINO, LATK and CERT Linux Forensics Tools Repository). SEI also offers a wide range of methods and tools in the areas of acquisition support, cybersecurity engineering, cyber risk and resilience management, digital intelligence and investigation, insider threat, measurement & analysis, network situational awareness, performance & dependability, risk management, secure coding, smart grid, software architecture, software product lines, system of systems and vulnerability analysis.

And last but not least, digital investigators using freeware or shareware must be aware that some tools may be inacceptable for courts, lawyers and judges in terms of validating credibility, functions, reliability and acceptance of the digital evidence conclusions. The US National Institute of Standards and Technology (NIST) hosts the Computer Forensics Tool Testing Program website to help improving quality, for knowledge sharing and to understand tool capabilities. In addition, the Computer Forensics Tool Catalog features tool searching, tool taxonomy access and vendor access for continually updating information about the tools.

6. DIGITAL EVIDENCE

Modern society has citizens that are well connected with technology through digital devices. Starting a crime or cybercrime investigation will lead to access these digital devices that contain potential digital evidence.

According to Davidoff et al. (2012), digital evidence is any documentation that satisfies the requirements of "evidence" in a proceeding, but that exists in electronic digital form. NIST also includes digital evidence in the form of information on computer, audio/video files and digital images but it helps to recognize people's faces, image/video analysis and to solve common crimes and cybercrimes as well.

In order to detect and obtain digital evidence, cyber investigators must follow certain principles like maintain intact the cybercrime scene, always avoid unnecessary risks, record everything in a chronological order and follow the proper chain of custody.

The Scientific Working Group on Digital Evidence (SWGDE) provides best practices for computer forensics specifically for collecting, acquiring, analyzing and documenting digital evidence found in computer forensic examinations.

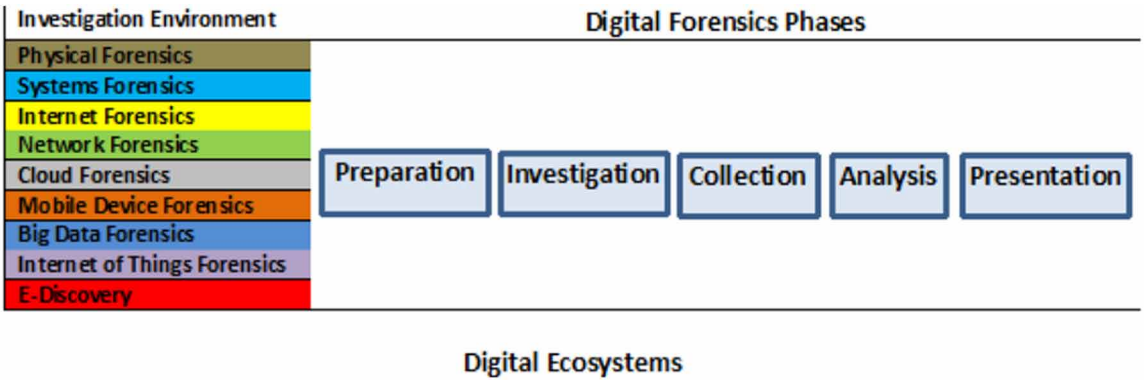
7. CYBER FORENSICS MODEL IN DIGITAL ECOSYSTEMS (CFMDE)

We propose a cybercrime digital forensics model called "Cyber Forensics Model in Digital Ecosystems", we wanted to introduce a model that combines the traditional cyber forensics phases with all the diverse digital environments that create digital ecosystems. The main phases of the model (Figure 2) are preparation, investigation, collection, analysis and presentation that can run on a specific investigation or combined with several forensic environments.

The model comprises the following phases that are applicable to any or multiple investigation environments:

- **Preparation:** This initial phase involves all the required planning for a specific environment or in multiple environments;
- **Investigation:** This phase deploys the response plan to the incident;
- **Collection:** Relevant data is collected based on the approved methods and techniques;
- **Analysis:** Significant digital evidence is selected and the drawing of conclusions;
- **Presentation:** The findings of the digital investigation are presented.

Figure 2. Cyber Forensics Model in Digital Ecosystems (CFMDE)



The investigation environments are suitable for physical forensics, systems forensics, Internet forensics, network forensics, cloud forensics, mobile device forensics, big data forensics. IoT forensics and e-discovery.

This model in comparison with the studied DF methodologies focuses on:

- Defining emergent environments for digital investigations;
- Identifying all data sources and digital evidence acquisition;
- Determining the digital evidence requirements and chain of custody management;
- Integrating DF practices in digital ecosystem environments.

The main objectives of this proposed model are to consider emergent technological trends in cybercrime investigations and to align digital forensic investigations within digital ecosystems.

8. CONCLUSION AND FUTURE WORK

Cybercrime is global problem that creates many financial losses and jurisdictional and political issues as well. Cyberattacks and further consequences can affect people's privacy, corporate's image and in many cases are never ever reported for a follow up action or investigation.

In this paper, we highlighted the importance of aiming digital investigations towards criminal digital ecosystems. Somehow, the DF methodologies in the last three decades are not being effective in dealing with the international expansion of cybercriminality.

The Digital Forensics community is in need of new approaches to investigate and prosecute cybercriminals. Traditional digital forensics phases need to be redesigned to keep up with vast amount of new technologies and to counterattack new and diverse Techniques, Tactics and Procedures (TTP) of cybercrime.

Digital forensics methodologies, phases, tools, techniques, digital investigations, digital evidence collection and cyber investigators must constantly adapt to new technologies, environments, scenarios, best practices and regulations. The functionalities of DF tools need global frameworks and standards in order to conduct better cyber investigations and above all, international cooperation and collaboration ought to improve to start fighting cybercrime more aggressively.

DFRWS (2016) has identified future digital forensics challenges like forensic analysis for the Invisible Internet (I2P), evidence in the cloud, Windows 10, Internet of Things (IoT), unmanned aerial vehicles (drones), abstraction of digital evidence, malware, pattern searching, graph queries of digital evidence, visual analytics techniques and automation of forensic artifacts. Future research of these new DF challenges must aim at creating new tools, methodologies and technologies to improve early detection, investigation, containment and eradication of cyberattacks.

The proliferation of new digital devices will continue to grow at accelerated rates, likewise more advanced and sophisticated technologies will emerge in the years to come. Digital Forensics must evolve with new holistic approaches and paradigms to face these coming challenges.

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Section 3
Tools and Technologies

Chapter 30
Making It for the Screen:
Creating Digital Media Literacy

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ABSTRACT

We are immersed in a culture of spoken media, written media, and now irrevocably, digital screen media. Just as writing and speaking skills are keys to functioning in society, we must consider that the world increasingly demands proficiency in "mediating" as well. Doing anything less leaves this powerful medium in the hands of a relative few. By offering instruction in what digital screen media is, how it is effectively created, how the Internet continues to alter communication, and how this all informs everyday teaching and learning, digital media literacy can become more broadly understood and accessible. This chapter follows a program developed by the Rosebud Institute and looks at how—using simple, accessible technology—people can become more digital media literate by creating screen products themselves. The creation process also enables deeper, more authentic learning, allowing us all to communicate more effectively, to self-assess more reflectively, and to thrive in a screen-based world.

DIGITAL MEDIA: LITERACY ON SCREEN

You may well be reading this text on paper, but it remains increasingly likely that you are reading some or all of it on a screen right now. In many cases, as you read this chapter, it seems not that big of an issue. After all, it is simply words on a page and the medium of delivery may not be all that crucial. Inverting the classic phrase of communication scholar Marshall McLuhan for a moment, the medium does not really seem to alter or affect the message all that much in this particular case.

However, with the tectonic media shift in which we find ourselves, the lines we think we know, and think we can count on, seem to be blurring. The myriad machinations and goings on in our convergent media world, while a fascinating and rich topic, understandably extend beyond the scope of this chapter. Rather the focus here is to look more at what we are doing now. Now that the explosive growth and pervasive penetration of new media is upon us, are we doing the best that we can to get a firmer grip on the reins? The wave of buying and handing out expensive devices designed to merely access the con-

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versation continues to grow and swell, threatening to eat up shrinking resources. In light of that, what are steps that can be taken to move beyond the latest techno wizardry and instead convey real skills that allow more people to effectively join in, to make clear meaning, and to affect the change they seek?

One way is to take a step back – get back to basics a bit and begin to give people some simple tools that they can use to more effectively be a part of the burgeoning world of what is happening on screens around the world. Yet another related approach is to seek out existing resources and systems that are already in place, but are ripe for innovation, change and a refreshed perspective. As mentioned, you may be looking at a screen right now but if not, you have probably looked at one if not several already today and most certainly – unless you make a concerted effort to the contrary – you will be bombarded with screen images all day, telling you what to do, what to think, what to like – even what to say.

And that trend continues to grow with abandon. As Eva and John Waterworth state in their discussions on mediated presence "Our everyday lives are more and more pervasively experienced through media… There are very few places where one is out of reach of [these] devices…" (Waterworth & Waterworth, 2010)

This ever-expanding world of screen-based electronic media encompasses such an understandably and incredibly broad array of media types, paradigms, and histories that even finding a name or term to refer to it all can prove difficult. Under the auspices of the

Rosebud Institute, introduced in the next section, we have used the term broader term 'digital media' as well as the more specific 'screen media'. These terms work somewhat interchangeably to describe media specifically produced, created for, and unfolding on the screen yet are general enough to encompass a broad array of different media, both moving (film, video, television, and gaming) as well as those which are generally more static (websites, social media, blogs). As mentioned, this chapter has a necessarily refined scope. It looks at a very practical and doable approach that is giving people a baseline way to become more active and informed members of a screen media world. Interestingly, it is in this more simple approach that the potential becomes highly expansive, giving people the tools to literally go wherever they want, much like the effect of teaching a person to write or to read.

But what *people* or *persons* are we talking about? In attempting to define who really needs to be digital media literate, to say *everyone* may well elicit a raised eyebrow or two but literally, digital media literacy is so crucial that virtually everyone will need some baseline understanding of what it is and how it works. This is not a new concept of course. The term media literacy has been around since the 1970's and in 1988, one of the most relevant and enduring quotes comes from a former president of the Carnegie Foundation for the Advancement of Teaching, Ernest Boyer: "It is no longer enough to simply read and write. Students must also become literate in the understanding of visual images" (Boyer, 1988). What is new however, is how far-reaching and therefore undeniable the screen has become. If screen media is virtually everywhere, then its literacy is in demand virtually everywhere if we are to have an informed and literate public. "The ability to both read and write visual information; the ability to learn visually; to think and solve problems in the visual domain—will, as the information revolution evolves, become a requirement for success in business and in life." (Gray, 2008) That said, keeping the sites of this chapter on achievable goals and not biting off more than is manageable, the immediate audience addressed mostly herein are students and educators – both in a K-12 environment and in post-secondary education as well.

Without delving too deeply into program specifics, we will outline a broadly prescriptive approach that we have pursued and continue to develop – a program that takes achievable steps towards reducing and addressing what has been referred to as our rampant media *illiteracy* (Baker, 2012). While the

method is simple enough, there have been some speed bumps and even roadblocks along the way but the promise of a more informed, empowered, and literate digital citizenry seems a worthy enough cause to overcome the obstacles.

Toward the end of the chapter, there is a look at ongoing program efficacy and the exploration of ideas for growth, refinement, and expansion, giving attention to where things can go and furthering the mission of creating digital media literacy for all.

THE NEW DIGITAL DIVIDE

It has been said that those who control the media, control the future. Setting aside a more manipulative connotation of "control," and focusing rather on an interpretation more aligned with understanding and effective use, it seems a natural, logical extension that in order to more positively affect our future we must not only increase the *number* of future media makers, but we must also increase the number who are truly and more fundamentally literate (Chilsen & Wells, 2012).

If you accept this "proliferating mediation of our everyday lives" (Waterworth & Waterworth, 2010) as perpetual and expanding, and embrace the intrinsic notion that we are therefore irreversibly immersed in a screen media culture, then one could argue that just as we are taught and know how to write and speak in a text-based society, now, in order to function competently in a screen-based society, we all would do well to start becoming more proficient at "mediating" as well.

Given the massive realignment that continues to unfold in the broad world of digital media, it seems both right and pressing that we realign the thinking and approach taken towards defining what screen media is, who ought to know how it works and how we can democratize the understanding and use of these powerful and exploding media.

Unlike fashionable pedagogical trends, the need for screen media literacy and ability is here to stay. Embracing and expanding what Elizabeth Daley, of USC's School of Cinema-Television once called "the greatest digital divide," the approach outlined herein seeks to close the chasm between those who can read and write in screen media, and those who cannot (Van Ness, 2005). Put simply, because so many now have access to and can therefore create media for the screen, everyone ought to be learning the basics of how to read and write in its unique language. To do anything less leaves this awesome and expanding power in the hands of a relative few and by virtue of its relevance and importance, a *new* digital divide has opened before us.

The term 'digital divide' has been around since the 1990s and originally defined technology's haves and have-nots (Richtel, 2012). According to the World Economic Forum in a 2014 report on global information technology, the original divide is still a problem and progress is slow (Cann, 2014). However, not unlike the way phone service or even electrical service eventually found its way to wherever it could reasonably go, this seems more an economic question rather than an ideological concern. As with phone and electricity, it may seem callous to say but there's simply too much money to be made for high speed internet to not also eventually reach everywhere it can logically go. Eventually screens will literally be everywhere and like the current internet joke about Afghan rebels being able to send a video from a mountain cave when we can't get cell service in our living rooms, everyone will be using its power. Since the mid 1990s, many have expropriated the digital divide term, refining it as the issues continue to morph. But one of the earliest realignments of the term has followed the logic that since eventually most all will have the access, what do we *do* with it now? This is truly a new divide.

It is from this wellspring of possibilities that the Rosebud Institute was formed. Given the somewhat prescriptive nature of this chapter, it seems prudent to at least briefly discuss this umbrella organization, in the interest of giving a point of reference for the approach taken. To that end, it is important to point out the Rosebud Institute is at least partly inspired in name and independent spirit by the enigmatic and prodigious filmmaker Orson Welles, (*Citizen Kane, The Magnificent Ambersons, Touch of Evil*). The institute seeks to embody both Welles' revolutionary approach to motion pictures as well as a sort of can-do, hands-on approach to addressing a growing need – a need to better equip future media makers in a world virtually drowning in images on the screen.

ROSEBUD INSTITUTE: MISSION

Even five or six years ago, things looked quite different in the increasingly intersecting worlds of media and education. At the time, most were grappling with how and whether to effectively put the expanding technologies to work in the classroom. The Rosebud Institute was formed around this time, at least in part as a response to the call for more technology in schools. Schools were doing a decent job of "infusing technology in schools" but the general notion could be summed up with a "now what?" mentality – now that it's here, how can we make better, more comprehensive use of the technology to enhance teaching and learning (NEA, 2008). The Rosebud Institute found an appropriate and constructive association at Carthage College in Kenosha, Wisconsin, a private, liberal arts institution, nestled between the twin metro areas of Chicago and Milwaukee. The newest department at Carthage is Communication and Digital Media (CDM). Tangentially affiliated with CDM, the Rosebud Institute found obvious alignment with a substantial portion of the department's stated mission in that CDM is devoted to the advancement and development of a student's knowledge and ability with media on the screen. Grounded in the liberal arts, and taking a modest, non-film-school approach – just far enough away from the trappings of the entertainment industry – the Rosebud Institute seeks an appropriate combination of exploring where and how education may change in the area of digital media literacy. It is neither an easy nor insular task, and challenges, encouragement, input and even inspiration are sought from every corner. Even the very name Rosebud Institute – as mentioned, inspired by a Wellesian sensibility – has a geographic alignment; Orson Welles was born in Kenosha and lived there for the first formative years of his life.

Irrespective of any ethereal inspiration Welles may provide, it is the broader notion that all students need at least a basic, core knowledge of creating media, wherein exists a powerful motivator – for Carthage, for the Communication and Digital Media department, and for the Rosebud Institute. This motivation lead to action and the Rosebud Institute was formed. Since then, the institute has developed and expanded a program that is finding better ways to teach and utilize digital media literacy. Building on this, and collaborating with a large and robust Education department as well as Office of Graduate and Professional Studies, the Rosebud Institute's larger, more universal mission – defining and exploring screen media literacy for all in order to better equip individuals to communicate and thrive – seems connected at Carthage College, both in ideal and setting.

Rosebud continues to seek and find new associations and connections, both at Carthage and beyond. Later in the chapter we will look at new curricular programs being explored that are highly interdisciplinary, leveraging the almost inborn tendency of students to want to blend sources, texts and technologies in order to more fully explore their world and more deftly direct their own learning. New affiliations will be looked at with Library and Information Services at Carthage, (LIS) where the development of a

Center For Digital Literacy is being imagined that begins to grapple with the changing role of libraries in a technology-centric and media-centric society. Additionally, there are new initiatives in the surrounding communities – outreach programs to organizations, workshops for professionals, and effective K-12 programs being instituted. All of these enterprises function to more fully bring digital media literacy literally out of the dark and into the mainstream where technological advancement has already placed its many and varied tools.

A MEDIAFESTO: PLEASE "LIKE" THIS…

When one currently teaches writing or speaking, it is not necessarily to create great novelists or orators. That may happen, but the main driver is literacy and all that comes with it – especially cultural, social and political literacy and along with that cultural, social and political efficacy. As Carl Casinghino (2011) asserts in the preface of his text *Moving Images*, we do not teach math to young students in order to prepare them all to become professional mathematicians. Similarly, we are not teaching motion picture studies to crank out a new generation of Spielbergs. Instead we are "helping learners to develop cooperative skills, to enhance their problem-solving abilities, and to participate in cultural and social processes as capable, engaged interpreters" (Casinghino, 2011). Rosebud is interested in pushing the idea of skills development further, insisting that both reading and *writing* in screen media are important, and intrinsically interconnected.

In short, we need both. It seems increasingly a given that education needs to improve student understanding of how screen media work, how they make meaning, and how they construct (or reconstruct) reality. But more and more are coming to understand that true screen media literacy must also provide students with the ability to *create* media products. (Baker, 2012). With the written word, we know that people are better readers if they have at least a working understanding of how to write, and the same seems to hold true for media.

The notion of cultural context pushes the importance further still. David Buckingham (2007) in his piece on Digital Media Literacies, extracts this notion from the discourse on "multiliteracies": that literacy education cannot simply be confined to the acquisition of skills but rather must include a framing by cultural and social contexts. In media for the screen, there is always a maker and there is always an audience. Without an understanding of who made what, for whom, and for what reason, there will always exist a danger of painting media with too broad a brush. With due respect to the late Roger Ebert, especially with matters of the screen, we live in a "thumbs up-thumbs down" world where it seems everyone has an opinion and the conversation quickly gets judgemental, political, even vituperative. In a world where we are merely asked to "like" something, and aren't really all that well trained or even asked to look at the who or why behind what we see, media products get passed off as temporary, mundane and far too easily dismissible. When discussing media, tangential arguments surface on all sides, a good portion of which come under the "media is too…" lead in: media is too violent, it's too much about entertainment, it's too difficult, it's too expensive, it's too liberal, it's too sexy and perhaps the biggest one in education circles: it's just too much more for teachers to teach. However, one could easily make the argument that media is simply too important – too important now to just let it go.

If you take a moment to look around the American mediated landscape, you may quickly come to the conclusion that the average teenager seems to do precious little thinking outside of the four walls of the screen. Given the chance, they will let the addictions of Facebook, YouTube and Twitter usurp their

time (along with any number of current online trends, e.g., Instagram, Pintrest, StumbleUpon) But we currently give them no formal training to navigate these byways even in the most basic of ways, to say nothing of inculcating them with any sense of how best to spend their time there. An increasing number end up simply "wasting time," and the reality is only increasing that a computer's "use for education or meaningful content creation is minuscule compared to its use for pure entertainment" (Richtel, 2012)

It's not surprising given that we are unrealistically expecting young people to develop an enlightened sensibility on their own, basically giving them the keys to drive without requiring they obtain any kind of license. By comparison, if we took an average child, but one who had been given no formal training in any of the disciplines of reading, writing and speaking, and set them down anywhere in a modern culture, leaving them to their own devices, expecting them to develop a culturally recognized proficiency solely from the multiple channels of stimuli around them, would they be able to function in society? Some of them certainly would, eventually, but intrinsically, we recognize that many of them would not function all that well, and that overall, their proficiencies would remain at the lower end of that functionality. Just as a rising tide lifts all boats, in this case, the opposite is also true. Our reasons for teaching any basic literacy may seem to be a given to many, but in this case it requires a retrospective, even deconstructed look. We teach these basic literacies for many reasons, not the least of which is to elevate our society and level the playing field, as it were. The more who know the language of the land, the more who are able to come to, and participate at, the tables of meaningful discourse. If we accept the fact that digital screen media is here to stay, in perpetuity, and recognize that its literacy is important and unique, then it stands to reason that we must take a more formal approach to its pedagogy (Chilsen & Wells, 2012). Media on the screen has become, in effect, how we communicate…now.

And yet, in at least the broadest sense, in this culture of *like*, we are generally taking the opposite approach. "Most uses of computers in schools signally fail to engage with the complex technological and media-saturated environment in which children are now growing up. For the most part, they are narrowly defined, mechanical and unimaginative" (Buckingham, 2007). If that is still the case – and it appears that little has changed in that arena – then what we are doing is leaving it up to the surrounding stimuli to teach our children how to read and write in this pervasive, growing medium. In that way, students – and the general public – are developing a skewed and undiscerning way of relating to screen media in general. A University of Wisconsin and Northwestern University colleague, Laura Kipnis, has referred to this phenomenon as a "marginally-trained sensibility" – one based almost entirely on the unregulated consumption of commercial television, film and internet programming in a comparatively indiscriminate fashion. If the educational system produces students with little or no formal training in digital media literacy, we are passing on that legacy and sending them out into the world as comparative babes in the wood, rather ill-equipped to function at the level the rapidly-converging world demands. Filmmaker, George Lucas has been quoted as saying "If people aren't taught the language of sounds and image, shouldn't they be considered as illiterate as if they left college without being able to read and write?" (Lucas, 2004). This may seem a strong and biased opinion but it raises a valid point. If we can begin to address the often-vast differences in a student's understanding of how screen media is made, how its language works, and how it affects change in ourselves and the culture around us, we will start students on a path of developing and refining the tools they need to function as capable, engaged individuals in a digitally mediated world.

As the downward trend in cost and the concurrent upward trend in quality in consumer electronics continue to expand both the reach and cultural power of screen media technology, the core knowledge of making media is even further democratized. And as accessibility continues to spread, so do the

expectations of a modern culture. The whole idea of "media making" becomes a lingua franca of the future. In order to keep up, people – students and their teachers – need a basic tool kit of these specific skills as they venture out into the real and professional world, regardless of their eventual vocation. It is a new literacy – a language that continues to be accessible and used by greater numbers of people. It is a natural step then to guide, educate, and form the possible ways students can use this language across virtually all professions, in a more engaged, enlightened and effective manner (Chilsen & Wells, 2012).

Creating Those Who Can

The challenge for the Rosebud Institute has been to translate its mission and ideals into action and come up with an approach that can address a need in current and future pedagogy. A pilot program launched in June 2010 lead the way to develop a curricular series called *Media and the Moving Image.* Building off these beginnings, a number of offshoot programs, explorations and successes have grown, and reviewing them here is at least one way to look at both the importance and the possibilities of what can be done about digital media literacy and even fluency.

Originally offered under Rosebud's program header *Summer Series for Teachers*, Media and the Moving Image (MMI) is now a regular offering at Carthage College both in the summer and during the regular academic year. Using current resources at Carthage College and remaining affiliated programmatically with the Education Department as well as the Office of Graduate and Professional Studies, the courses can still target elementary, middle and high school teachers who are interested in learning to better understand digital media themselves and want to be able to teach it in their classrooms.

The core instruction takes place in a highly regulated and rigorous classroom component. Available also to graduate students, the course is designed to address new approaches for teaching media literacy by exploring the basics of reading and writing in the language of screen media. Outside of the education ties, the course has also become a sought after offering for many across the disciplines. It offers students not only an opportunity to re-explore their creativity, but the ePortfolio segment gives them a much needed baseline in setting up a professional representation of their work and what kind of employee they can be.

Following a dynamic yet simple hands-on approach, participants learn a two-pronged approach to screen media. They each create two somewhat modest media pieces designed to help them begin to find their own voice in the often-cacophonous world of digital media. Participants conceive of a simple, relevant motion picture project, which they write, film and edit, trying their own hand at using basic narrative, cinematic language to tell a simple, visual story. Alongside the film project, they each build an eFolio website of their own design, creating a timely, accessible and expandable way to display, manage, and share their projects, their ideas and even themselves. The film is not simply a slideshow movie and the eFolio is not simply another website repository, but rather both projects carry the weight of audience and are a true expression of what one can call the maker's 'digital self'. While the projects may seem modest in scope, they are rife with importance and significance. The gratification of getting a solid grip on using technology more effectively, coupled with the thrill of truly creating something from nothing, lends a palpable air of accomplishment to the work. All of the projects are done in a guided, supportive learning environment where collective work, feedback, interaction, and sharing are all fostered and encouraged.

Creating a short first film of this nature seems to give most people a heightened sense of ownership along with the empowering feeling of "I can do this." They get to see how it is done, and – contrary to their assertions at the beginning of the course – they learn to become *better* watchers of film and television, not "ruined" as they often fear. An additional benefit of both projects is a deeper, richer and

more authentic learning experience. We have found this to be even more significant in younger students but literally, one cannot help but learn something more deeply by going through the process of having to create a piece about it for the screen. The very creation process itself, seems to imbue the creator with knowledge and insight that reportedly surpasses any number of pedagogical activities. As inverted classrooms and project-centered learning continue to grow in importance and efficacy, this is one of the areas we are most excited about exploring further.

As mentioned, both projects have a strong sense of audience – the idea of *who is watching*. In an attempt to address this issue even further, we give some focus to eFolios as a form of self-distribution. Again, these are not simply a way to show work, but rather ePortfolios can also give the maker a sense of the potential power and reach of their creations. This is not art or expression created in a vacuum. This is work that potentially the world can see, and that is a lot of power and responsibility to consider.

The motion media component, while relying on basic precepts of moviemaking, is decidedly removed from a Hollywood mode and instead approaches film grammar as new language of expression and making meaning. To lay the groundwork for effective communication, the coursework introduces a process encompassing fundamental aspects of

1. **Preproduction:** Treatments, scripting, storyboarding and planning,
2. **Production:** Basic camera use, angles and filming, and
3. **Postproduction:** Importing and editing clips, exporting, and delivery, as well as addressing issues of aesthetics, ethics and cultural impact.

The eFolio component extends communication beyond creation and into the arenas of audience and distribution via internet presentation. Participants build a base of knowledge with which to create their own purposeful, comprehensive collection of work and information. Through the process of building their own site throughout the course, they learn about the collaborative potential of online portfolios as well as the means by which they are able to create, upload and share their own original media in the form of video and audio podcasts.

With the pervasive spread of social networking, and its ever-younger-skewing clientele, a concurrent and integrated approach to creating, managing and distributing digital assets seems a viable, connected and crucial initiative to pursue. The additional benefit is to stimulate teachers to think about instructing their students on some of the how and why – and need – of managing their digital personae…their digital selves. As stories continue to hit the news about school-age sexting and other inappropriate interactions on the web, and as employers, schools and organizations increasingly support their personnel decisions by what they find on someone's Facebook site (Hechinger, 2008), the time seems perhaps even a bit overripe for educating students in the art of representing themselves appropriately in virtual reality, at a young enough age to begin building essential and culturally suitable lifelong skills. Of course the hope is that eventually there will come a day when most everyone is able to instantly capture, identifiably own, intelligently store, and instinctively know what to do with their digital assets (Chilsen & Wells, 2012), but until that time, we need to guide, to prod, even to insist.

As the discussion of mediating continues to unfold, a natural progression continues to build towards presentation; the dovetailing of eFolios or other Web 2.0 interfaces with motion media is a natural occurrence and a means of distributing originally created digital media via the use of a well-designed, well-placed, and well-managed websites. As designed, anyone can simply take the course for their degree, their

enrichment or their professional development, but teachers taking the class have the additional option of coming away with interrelated curriculum modules which they may want to use in their own classrooms.

As the MMI program continues to modestly expand its reach, building from the baseline notion of how best to communicate on the screen, several other related affiliations and connections continue to present themselves. The courses are finding connections with a much broader array of constituencies beyond education, such as professional development and undergraduate distribution coursework.

One way this has been successfully explored, at least in its initial stages is with a Rosebud program launched as a pilot with a local high school in spring 2011. Dubbed the Intensive Onsite Training Approach (IOTA), the program gives individuals working within their organizations the chance to work closely with Rosebud Institute instructors to implement their own version of teaching the MMI series directly in their schools. Five highly successful IOTA programs have been completed to date including an Illinois College professional development program working under a 2011 Mellon grant.

Another exciting measure of the program's success is an ongoing program by one of the IOTA graduate students, Cindy Renaud. As a teacher, Ms. Renaud implemented a modified version of the Rosebud screen media approach at her high school, launching new coursework in the fall of 2012 at Harborside Academy, an Experiential Learning (EL) school in Wisconsin. The program continues to this day and has been successfully implemented throughout the school. Ms. Renaud may not seem the rule, in that she is a very driven teacher who is drawn specifically to more intentional use of technology in the classroom, but highly effective classroom teachers are out there in great numbers and it is up to the educational structures to give them the training and support to more fully utilize the tools they – and their students – are being handed. A growing number of teachers recognize that "technology is a tool, not a solution. [and] what really matters in the classroom is teacher quality" (Day, 2014). As a quality classroom teacher, Renaud's words are convincing and cut to the core of a broader necessity for more integrated screen media instruction:

Today's students will live their lives in a competitive, technology-driven global society. The ability to create relevant, content-specific, professional quality products using screen media will give students a foundation for being proficient digital citizens…. The aim of today's educator, then, is to engage the media-centric population of youth and prepare them for the competiveness of a global society and economy. (Renaud, 2012)

Another approach and angle that Rosebud programming has pursued is going directly to younger students by launching a summer camp for students ages 13-17. Originally called *Screen Media Boot Camp*, and now being reworked under a more structured summer program at Carthage College as the *Summer Media Experience*, this weeklong overnight camp essentially takes the same type of program offered to the adults, tweaks the coursework and activities for a younger audience, and takes kids through the steps to make their own movies and eFolios with intentionality and purpose.

The Department of Communication and Digital Media at Carthage College (CDM) continues to grapple with these emerging issues. Under new leadership at many levels, the college and the department are working to find a balance between what students seem to want, what employers seem to need and what the future of education seems to demand. As educators, programmer and administrators, it seems increasingly important to get the balance right. Education has never really relied on what's trending well with students in the hope of figuring out what they need, and we really only can depend on employers to know what they need today. Therefore, it must be up to educators to look to the near and upcoming

futures and try to educate and prepare students for those futures. We need to be aware of the trends and try to stay ahead of them as much as we can, but ideally, we are building not only their practical skills, but we are giving students essential understandings and protocols so they can re-tool and modify their abilities as the world inevitably shifts under their feet.

As core curricular choices, clarifications and enhancements are contemplated, some startup interdisciplinary initiatives show great promise at Carthage. Working with Modern Languages Professor Matt Borden, two different courses have been implemented that effectively draw on the notion of communicating and learning by creating with media. One course is called *Filming Don Quixote*, where students read the full text of Quixote and also extract and create a couple short films throughout the term as adaptations of inspiring or interesting aspects of what they have read. The results of the initial offering garnered some attention in tangential academic circles and have given the program some needed feedback and insight from international colleagues (Borden & Chilsen, 2012).

The other is a course called *Filming Cultures: Explorations Beyond Tourism*, which is originally designed as a month-long course that has a two-week study tour component where students travel to a foreign country and are then required to interact with the culture, cuisine and commerce of the target destination. The student participants film all the interactions –interviews, personal digital essays, student travel, etc – and the results are edited together and shown upon returning to campus. The success of the course has lead to the development of a semester-long version that will hopefully be launched in the near future.

Another of the more promising and new explorations has come in the form of working with Dr. Todd Kelley of Library and Information Services at Carthage (LIS). Originally invited as part of a Rosebud panel at the popular Charleston Conference, a gathering of all things library, Dr. Kelley has been a strong supporter of creating learning environments that allow students to become not only literate, but *proficient* with digital media. In a follow-up series of articles called *Digital Conversations*, in the industry trade bimonthly *Against The Grain*, Kelley is sharing his department's exploration of how to manage the necessary change that libraries must go through to remain current and viable. As libraries buckle under the strain of new and varied uses by a screen-driven society (Crawford, 2011), Kelley sees the need to shift our understanding of what a library is and what it can be. Far from eschewing the strong traditions of a library, Kelley sees a necessary blending of mission. He is strongly aligned with the idea that media spaces need to literally and figuratively come out of the basement – out of the small dark rooms that are typically associated with media creation – and up into the bright and common areas where everyone can see their existence and understand that these newly imagined "maker spaces" are for their use and for their creating. The ultimate hope is for the eventual establishment of something preliminarily called the *Center for Digital Literacy*, a new and visionary part of the academic library, further asserting that these are not ideals housed in a single department or discipline, but are foundational components of how we teach and learn (Chilsen & Kelley, 2014).

All of these interdisciplinary and cross-curricular initiatives – the programming, the outreach, the camp, the library – are highly intentional and are attempting to address what is seen by more and more as a core necessity. As screen time increases for students, up to one quarter of their day and rising (Herring & Notar, 2011), the need to educate to, through and with screen media is becoming crucial. With this in mind, the current Rosebud approach, albeit developing, offers recurring rotation of courses, enabling participants to expand both their own skills in making media, as well as guide and assess the work of their peers, graduates and students. When applicable, course credit has been configured for the necessary flexibility in today's transfer-laden and professional development landscape. Additionally, other options

offer more choices for virtually anyone seeking general professional development, giving individuals and teachers more – and more media-savvy – options that can apply toward advancement, and licensure renewal, extending their abilities, their strengths and their own digital media literacy.

With the IOTA onsite exceptions mentioned above, most classes and initiatives are currently somehow related to or physically located on the campus of Carthage College. But as the IOTA and other programs demonstrate, the courses and ideals are a movable feast of sorts, able to go virtually anywhere and effectively instruct at almost any level. Altered as appropriate for various constituencies, programs attempt to offer realistic and useful options for participants, giving them differing viewpoints and ideas through a number of atypical sessions including film screenings, story circles, panel discussions, emerging technology lectures, and relevant supplemental coursework. What has been witnessed in programs thus far is that the close-knit structure of the course and the necessity to collaborate offers ample opportunity for participants to work and learn together while networking and sharing with their peers.

In a tangential fashion, the veritable explosion of social networking, self-promotion, and digital media distribution via the internet creates another opportunity for learning. As mentioned above, the sheer accessibility of virtually anything, anywhere at anytime necessitates that students learn to build, discern, shape, maintain, organize, and share their own *original* selves through the creation and management of their online presence. Additionally, it is increasingly in the nature of younger students to want to pull together all the elements they can get their hands on, in an effort to better understand and communicate in the world as they see it. They don't really have any formal training or guidance, hardly even in the basic issues of ethics and the law that quickly arise in these endeavors, but they are venturing forth, with or without our help. Especially for young people, it is important to "think twice about the online personae they are presenting to the world" (Coutu, 2007). What they post or even expropriate today, will be available for years, and they may not understand this until they are sitting in a job interview years from now, and the potential employer opens a file that includes their résumé as well as their latest online rantings and party photos (Coutu, 2007). In short, students must manage and contextualize their digital selves, and if they do not, someone will begin to do it for them.

By offering instruction in these areas, focusing on what screen media is, how its language is constructed, what it looks like, how to make it, how it impacts the culture around us, and how it informs everyday teaching, learning, discourse and commerce, Rosebud Institute programs and initiatives are seeking to make screen media literacy more broadly understood and accessible, allowing us all to communicate and thrive in an increasingly media-saturated world (Chilsen & Wells, 2012).

FASTFORWARDING

How do we keep moving forward? Just as the tendrils of digital media pervade all channels and insistently drive and necessitate a literacy entirely its own, how do we approach the need for a more global paradigm shift? This is not a disciplinary expansionist view nor is it intended to simply add to the increasingly overwhelming cacophony and unrelenting focus on technology tools, interface, and software. Rather, it is an assertion and potential solution towards a refocus – a shift towards communicating rather than simply responding, embracing a baseline process that is inherently multi-platform and upgrade-proof rather than chasing the newest toys, a step that puts technology's tools to work for our learning and efficacy and sets aside the notion of like.

Recognizably, this is almost as challenging and exciting as arriving at this point in the first place. The interconnected nature of this kind of literacy exploration – a pioneering attempt to define, codify and teach a basic screen language and the subsequent digital and screen media literacy it will hopefully engender – is most certainly not an isolated undertaking, nor should it be. Instead, it demands input, guidance and molding not only from the ongoing development of learning technologies and teaching, but from the many other pursuits – academic, social, and professional – which will continue to shape its content as well as its analysis.

Therefore a look forward involves not only assessing the results of the ongoing and expanding programs of the Rosebud Institute – their overall acceptance, efficacy and usefulness according to the participants – but also seeking and considering a veritable multitude of other viewpoints and approaches. As mentioned earlier, just as screen media is not created in a vacuum, so too, the analysis, definition and program development toward broader digital media literacy – even the most basic grammar, syntax and structure of the language as well as how best to teach this literacy – is an ongoing and multi-dimensional subject which, like most areas of study across the academy, will thrive best as it becomes part of the rich discourse on how we now communicate, interact and get along.

A growing number of academics, theorists, educators and pundits from varied walks of life are seeing the need. MIT Computer Scientist Mitch Resnick embodies many of the same baseline ideals with his assertion that it is crucial to teach kids to code, so they can do more than just "read" new technologies (Resnick, 2013). Popular Kansas State anthropologist and self-proclaimed digital ethnographer Michael Wesch touts similar ideals, asserting that critical thinking is having to share its importance with the need for educators to create learning environments where students can harness and leverage this screen-driven world, allowing them to learn to not only examine and question it, but be able to re-create it as well (Wesch, 2012). The innovative education portal Edutopia often espouses similar views and seems based on a notion of access *and* ability, recognizing that students need to see these new devices as more than merely toys, but as useful learning tools that their teachers and parents also know how to use and can help guide them (Day, 2014).

These are critical issues; would that they were a sitting target. They are not, and complicating the discourse is the fact that it's all changing, often before we can grasp what happened yesterday. Kathryn Montgomery, noted theorist and pundit on children and youth interactions with media, pointed out over a decade ago that "the explosion of the new digital media culture is occurring so rapidly that its growth is surpassing the ability of scholars…and educators to grasp fully its nature, its direction and its impact…" (Montgomery, 2000). And it's only getting worse.

All the more reason it seems, to work to get a better understanding of it now. In the interest of not chasing the elusive dragon of expanding media portals and their pervasive, seemingly unruly effects on our culture, the Rosebud Institute programs are attempting to take a more stripped-down, basic approach. How can educators arm themselves in what many see as a battle for attention in an ever-dizzying cacophony?

One way is by realizing that there is a *me* in media. As the personal increasingly becomes public, it will be the clearer voices that rise above the din. As with any form of communication, if you want to be heard you must strive to be the more effective communicator. More and more, what the world seems to want and even demand are unique and personal views. Witness how the phenomenon of "mommy blogging" continues as an important resource for those in search of the best consumer goods. As with the voyeuristic attraction of cinema, the more personal someone is on the screen, the more drawn in the viewers seem to become. Why else would the seeming mundanity of Twitter be so engaging for so many?

The aproach outlined herein is designed to give individuals the tools they need to find their voice and become more effective "mediators." The approach is simple. The equipment is accessible. The results are measurable (Chilsen & Wells, 2012).

Initial, pre-course feedback from Rosebud Institute program participants thus far reveals that a general and pervasive fear of technology poses a significant initial hurdle, especially among established professionals who are looking for fewer challenges in their busy days, not more. *Digital Natives* – kids who grew up with technology, and "spent their entire lives surrounded by and using computers…phones, and all the other toys and tools of the digital age" (Prensky, 2001) – seem to have a great deal less of this anxiety. In many cases they are naturals, but it still does come up. In view of this fear, it is important to continue to assess the effectiveness of the coursework's attempt at demystifying and deemphasizing the technical interface, in favor of a more basic exploration of reading and writing in the language of the screen. Is the program ultimately encouraging participants to first embrace and then look beyond the technical, towards a future that will eventually equate camera and screen technology with pencil-to-paper technology? Can cloud computing, where digital assets and computing resources are delivered over the web, be accepted by educators as a natural extension of teaching, learning and self-assessment? Will we be willing to start down the road of affirming that "writing" with a camera in a basic cinematic language or communicating with images on a website, are no more or less "natural" than depositing ink on the page or even painting on the walls of a cave?

Ongoing analysis of post-coursework comments and survey results indicate that many aspects of the offerings are finding an effective and relevant niche. Comments such as the following are representative:

- "I'm getting a lot of ideas that I can take back to the classroom."
- "The ePortfolio portion of the course was also inspiring."
- "I learned more technology here than I've learned in my whole life. It's been an amazing class."
- "I think it's interesting that every single person in this class is going to do something different with what they've learned once they leave."
- "I was afraid of this stuff at first. But when my work heard I took this course, they asked me to make a film for our company website; I did, and they loved it!"
- "I was not getting any response from job applications until I included a link from my new ePortfolio. I got three calls the next week and have now landed a job!"

These comments seem to indicate that the general structure of the program is headed in the right direction and is garnering the kind of ownership, engagement and buy-in initially hoped for.

Further assessment, refinement and development of the coursework and its results will also include investigation of participants' responses to and incorporation of the ongoing application of what they learn. How the participating teachers deploy program elements in their classrooms, how professionals use their new skills to communicate more effectively with their constituencies, even how graduating seniors use these skills to land a job – all of these are important and measurable indicators of people's capacity and willingness to inject digital media literacy and fluency into the ebb and flow of their lives.

The creation of more streamlined and organizationally specific approaches that can be remapped onto different circumstances according to need also seems a critical component of expansion. Potential school in-service visits to directly introduce, assess, and promote further program application and efficacy should be further explored. The hope is that such follow-up activities will nurture a more complete, ongoing acceptance and integration of the foundational principles that the programs espouse and embody.

Continuing the look forward, program outcomes are extrapolated across visions for further coursework modification, integration and expansion in order to continue to effectively meet the needs of professionals, both within education and outside of it, as well as the mediated learning abilities of their constituencies.

TEACHING CONVERGENCE

A few final thoughts revolve around perhaps somewhat overrun notion of convergence – that we indeed find ourselves nearing what feels to many like an apex in mediating, a veritable disolution of old ways and a tumultuous, aggressive and often calamitous scramble for finding a new modus operandi. While access to technology remains an issue, it seems to be turning more into a matter of effectively accessing one's own voice. "When people talk to me about the digital divide, I think of it not being so much about who has access to what technology as who knows how to create and express themselves in this new language of the screen" (Lucas, 2004). Even more so today, with phones becoming cameras and cameras becoming mobile devices and iPods becoming iPads and tablets and movie screens and televisions, and everyone scrambling to reach the almighty consumer where they live, eat, breath and sleep, the time does indeed seem to be now. While not everyone agrees how this will unfold, most are clear that as the crescendo ensues, the best way to use this new power and reach cannot be left to its own devices:

Learning depends crucially on the exact character of the activities that learners engage in with a program, the kinds of tasks they try to accomplish, and the kinds of intellectual and social activity they become involved in…technology may provide interesting and powerful learning opportunities, but these are not taken automatically; teachers and learners need to learn how to take advantage of them. (Salomon & Perkins, 1996)

Since simply having technology in the classroom "does not automatically inspire teachers to rethink their teaching or students to adopt new modes of learning" (Hiltzik, 2012), handing out $2000 pencils is not enough. Technology is here to stay and digitally native students relate to it differently. We therefore need a different approach (Chilsen & Wells, 2012). We can't simply add screen media literacy "to the curriculum menu, hiving off 'information and communication technology' into a separate subject" (Buckingham, 2007). Rather, in a world that is increasingly dominated by media and even basic communication on the screen, we need to reconceptualize our definition of *literacy*. We have both the ability and the duty to educate young and old alike in the language of the screen; to do anything less would be to leave them unprepared in an often hostile world – a world where the immediacy, manipulation and message of today's media have the potential to dramatically alter the classic modes of teaching, learning and communicating.

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KEY TERMS AND DEFINITIONS

Digital Asset: An originally created piece of work that has been imported or converted into digital format and therefore can be deployed in any number of digital media. Digital assets can include but are not limited to: photos, videos, music, blog entries, podcasts, files, résumés, and/or any other work created in an academic setting.

Digital Divide: Originally a term to define the gap between those who have access to internet and related computer technologies and those who do not.

Digital Immigrant: A person born before the existence or current pervasive nature of digital technologies who is not naturally familiar or instinctively comfortable and therefore must adapt to using digital technology, interfaces, and software.

Digital Media Literacy: The acquired ability to understand, access, evaluate, and analyze types and avenues of information created online or with available software and hardware to communicate and participate in civic life as competent media consumer, contributor, and creator of media in the online community.

Digital Native: A person who is indigenous to the digital world, has grown up with and uses a wide variety of available and continually evolving technology with an inborn, instinctive sense of how to communicate, record, understand and share in society.

eFolio (Also ePortfolio): A website created for or by an individual, that manages their digital assets and online presence, communicating learning or professional progress, which continues to change as long as its creator continues to develop and refine the content to reflect current experience, skill, and/or career focus.

Media Convergence: The natural, continual, accelerating evolution of technology resulting in a more integrated, inescapable coming together of multiple avenues of information, entertainment and online communication.

Mediate: To create original work for and effectively communicate through the technology, tools, and language of the screen.

Screen Media: Any media that is produced for or distributed via the screen, including the entire spectrum of what constitutes 'the screen': the cinematic screen, the television screen, the computer screen, and the small screens accessed on a smartphones and other handheld devices.

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Chapter 31
Digital Media, Civic Literacy, and Civic Engagement:
The "Promise and Peril" of Internet Politics in Canada

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ABSTRACT

It has been asserted that digital media can improve literacy, engagement, and activism so long as it is promoted and judiciously encouraged by state, political, and societal actors committed to expanding the scope of policy-making to those that otherwise feel 'left-out'. More specifically, it has been averred that social media, 'clicktivism,' and electronic referendums have the potential to educate and energize voters on the day-to-day challenges that confront government, and give them a direct say into how certain issues ought to be addressed. However, this chapter argues that while there are still good reasons to be optimistic, looking forward, we also need to critically appraise the false promise(s) of digital media, and do so in a more nuanced fashion. It will be suggested that Canada's comparably low civic literacy rates provide us with some insight into the underlying perils of plebiscitarianism should a more sincere form digital empowerment prevail. It will also be argued that political institutions, culture, Internet usage, populism should also be accounted for.

INTRODUCTION

It has been almost 15 years since Henry Milner (2002) published his wonderfully crafted book on the indispensable link between civic literacy and political participation. In it, he argued that well-informed citizens are perhaps the most critical component to genuine political discourse and engagement. Indeed, voters that possess high levels of moral and instrumental competence can reasonably contribute to governmental decision-making and hold their legislative representatives to account. Conversely, those lacking in adequate knowledge of local, provincial, and/or federal affairs typically become complacent and unwilling to appraise the performance of those elected to preserve and uphold broadly shared com-

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munity (and/or national) values and visions. They become little more than subjects to be managed and ruled over, and their silence or disinterest tends to reinforce a form of creeping elitism that is patently out of step with meaningful participatory politics. 'Democracy,' in all of its uses, devolves into a kitschy slogan rather than a system of government and governance designed to empower the myriad stake-holders that compete for power in liberally oriented societies.

It has, however, been asserted that digital media can improve literacy, engagement, and activism so long as it is promoted and judiciously encouraged by state, political, and societal actors committed to expanding the scope of policy-making to those that otherwise feel 'left-out' (Peters and Abud, 2009; Perimutter, 2008; Kim, 2008; Behrouzi 2006a). More specifically, it has been averred that social media, 'clicktivism,' and electronic referendums—to name a few of the possibilities—have the potential to educate and energize voters on the day-to-day challenges that confront government, and importantly, give them a direct say into how certain issues ought to be addressed (Kempo, 2013). Furthermore, we are told that e-governance and e-voting are the future and that governments will have no choice but to submit to the demands of 'emerging digital citizens' (Tapscott, Williams, & Herman, 2008)! In all, information and communications technologies (ICTs)—that is, the Internet and Web-based services—are liberating, and embody a logical, necessary, and irresistible revolution in democratic politics. They innervate, cultivate new and promising forms of expressiveness, and in significant ways, make it easier for people to get involved in the fine art of politicking at multiple levels.

Yet, much of this positive zeitgeist seems to be taken as an article of faith. There is an obvious disconnect between how ICTs are being used to improve government services and efficiency and how they are being used to improve the overall quality of democratic intercourse. Put differently, the Internet's 'potential' and government e-services are often conflated with how Internet based applications can be deployed—and are being deployed—to enhance public trust, government transparency, and genuine political activism.

As well, there is considerable variation in how democratic states apply and utilize 'digital media.' The Canadian case, in particular, provides us with some intriguing insights into the limitations of Internet politics on real and/or purposeful political participation. In general, Canada stands out because it has been designated by the Organization for Economic Cooperation and Development (OECD) as a knowledge based society that ranks relatively high when it comes to adult 'problem solving in technology-rich environments,' but that also possesses rather mediocre—and in some instances disturbingly low—numeracy and literacy rates (OECD, 2016; Statistics Canada, 2013). Moreover, as Milner (2007, 2002) and Llewellyn et al (2007) have convincingly shown, the country's general competency level in the specific area of public affairs—that is, how legislatures function, how government is financed, how and where tax revenues are collected from and distributed to, and so on—is dangerously thin. Hence, it is useful to examine—and comment on—the extent to which Canada's federal and provincial government efforts to facilitate a higher degree of political engagement via digital media (the supply), and voter interest (the demand), have made any positively measurable or eventful progress in the realm of citizen empowerment.

Canada's experience is instructive because despite government initiated investments in electronic or digital media—i.e., to promote more transparency and trust in public institutions—it has been unable to reverse stagnating or declining voter participation rates. Curiously, more 'access and opportunity' have failed to renew the citizenry's lingering lack of faith or confidence in governing institutions and officials. In addition, evidence from Statistics Canada (2011) reveals that the 'political uses' of the Internet are consistently incidental to other more hedonistic or personally gratifying tasks—the data actually show that the Internet has now basically evolved into a tool for consumption purposes and inter-personal

communications. What is more, the OECD's 'Programme for the International Assessment of Adult Competencies' test results seem to confirm that a significant number of Canada's ballot casters lack the necessary skill(s) set needed to make well-informed choices (Statistics Canada, 2013a). This has not gone unnoticed, and many of the country's most important political offices—municipal councils, provincial premiers, and the federal executive—ostensibly remain unconvinced of the ultimate value of enabling voters via various digital channels—as can be evidenced by the near universal appeal of 'executive predominance.'

The findings in this chapter derive from comparing and evaluating the claims made by cyber-optimists and cyber-pessimists against the available evidence on Internet use in Canada and how Canadian governments have typically used 'Web-based' applications to improve public services and engagement. Civic literacy represents a critical component to this discussion, but no attempt is made to uncover the extent to which civic literacy influences 'digital political participation' more than traditional forms of political participation—an interesting line of inquiry, to be sure, but one that remains outside the scope of this chapter. Instead, it is argued that while there are still good reasons to be hopeful, looking forward, we also need to critically appraise the so-called benefits or false promise(s) of digital media, and do so in a more nuanced fashion. For example, Canada's comparably average to low civic literacy rates—which have contributed to substandard collective outcomes such as counter-active referendum results on taxation and/or infrastructural improvement proposals—underscore the underlying perils of plebiscitarianism should a more sincere form digital empowerment take root.

Policy-making and political decisions are complex by their very nature, and while consulting 'the people' (i.e., populism) has become a well-entrenched feature of many democratic regimes, it does have drawbacks. What makes 'the people' the ultimate arbiter of crucial matters of public policy anyway? Before we even consider increasing the consultative and decision making capacity of voters, should we not first expect a reasonable level of competence to prevail? The Canadian case provides us with a better sense of what the Internet is actually being used for, and some other institutional and cultural 'realities' that tend to impede the country's complete conversion to a more robust and e-inspired 'citizen-centered' governing system.

Predictably, this subject has become an intensely polarizing one with contesting parties generally falling into one of two intellectual camps. On one side of the spectrum we have the cyber–optimists who envisage a central and prominent place for ICTs in the worlds of democratic politics and social activism. This chapter begins by surveying the claims made by these writers because it would be naïve to deny that digital media can be used to enlarge the depth and breadth of political participation. Some discussion, then, on how digital media are transforming the public sector and democratic governance is warranted—much of the focus, however, will be on the Canadian case only. Following this, the second part of this chapter highlights some of the more salient concerns, criticisms, and reservations expressed by the cyber-skeptics—located on the other side of the spectrum—in relation to what can truly be achieved by applying digital media to the various operations of government and governance. It is here where we begin to see a conflict emerge between the most appropriate and ill-advised uses of ICTs in a democratic context. Again, emphasis will be placed on the Canadian case. The final part of this chapter considers and weighs up the merits and deficiencies of both perspectives and then attempts to provide a clearer picture of what has actually happened in Canada. The news is not all bad, but there is very little indication that government initiated Web-services and programs have done much to improve civic literacy or political participation. Rather, one of the more predictable developments has been to use

digital media to facilitate a more sophisticated form of image building among Canada's major federal and provincial party leaders.

The Promise of Digital Media and Internet Politics?

Extolling the virtues of Internet government, governance, and democracy was all the rage in the mid-1990s, but it began to gain considerably more traction at the turn of the 21st century. The OECD, for example, produced several comprehensive reports on the merits and shortcomings of using ICTs to improve administrative efficiencies and citizen engagement (2003a, 2003b, 2005). Not to be outdone, several prominent scholars and techno-luminaries such as Mark Zuckerburg (Facebook) and Eric Schmidt (Google) have chimed in and commented on the transformative impact that digital media can have on public sector reform and modern democratic politics (see, Zuckerburg, 2016; Aladalah, Cheung, & Lee, 2015; McNutt 2014, 2008, 2004; Peters & Abud, 2009; Eaglesham, 2006; Roy 2013, 2008, 2006; Behrouzi, 2006a; Scott, 2006; Coleman & Norris, 2005; Chadwick, 2003). Today, it is now widely accepted that we have moved into an era of 'Government 2.0,' largely characterized by efforts to implement 'social collaborative' technologies to increase access to government information, services, and public engagement opportunities (McNutt, 2014; Dixon 2010).

Over the past two decades, e-government has been used as a catch-all phrase to accentuate the technological changes that have been adopted in many advanced liberal-democratic states—though, authoritarian regimes have also experimented with selected e-government related initiatives. However, it is actually a phenomenon that "consists of two mutually supportive developments:" e-governance and e-participation (Lacharite, 2011, p.3). Moreover, up to this point, e-government programs appear to have evolved along a specific time-line and in two distinct stages. Stage one centered predominantly on employing ICTs to improve administrative practices and lean-up government bureaucracy; that is, apply Web 1.0 processes to government agencies in an attempt to emulate the purported success and efficiencies enjoyed by private sector entities. More specifically, it aligned wonderfully well with the desire to contain the accumulating public debt costs harassing redistributive governments in the 1980s and early 1990s. For all intents and purposes, 'corporatizing' government and reconfiguring so-called industrial age bureaucratic structures with sophisticated communications systems would accelerate the mutually compatible goal(s) of using ICTs to: 1) supplant or replace superfluous public sector employees; and 2) (towards this end) automate certain services and provide more information to citizens to make government more accessible, transparent, and responsive (McNutt & Carey 2008; Borins 2004; Danzinger & Anderson, 2002).

By any objective measure, the use of Web 1.0 technologies to reshape the contours of late late 20th century government and governance was an impressive undertaking. Most high income regimes took up the challenge of public sector reform with a fair degree of ebullience and converted many of their outmoded services to ones that were far more streamlined and consistent with the consumer-friendly and customer feedback schemes employed by multinational corporations. Indeed, filing a tax return, paying for a speeding ticket, applying for a passport, retrieving a transcript from a recent parliamentary debate, filling out a complaints form, or receiving a pension cheque are now all done online and have become both normalized and standardized features of government and governance in the new millennium. The Government of Canada's principle web-portal (www.canada.ca) is a superlative illustration of how access to important 'public services' is being encouraged, centralized, and enabled through various digital mediums. Whether users are looking to apply for employment insurance benefits, explore the

government's national jobs data bank, check up on the status of their work visa, prepare for a citizenship test, or look to take advantage of a small business grant or tax credit, they are directed to a single site that asks them to navigate through the appropriate content, set-up a service account, and then 'follow the instructions.' Simply put, many of the country's federally oriented services are supplied online, and as a matter of course, citizens are expected to make these electronic service options their first point of contact. Of course, some 'bricks and mortar' service outlets remain intact, but when and where these options are available, they are supplemented by a host of personal computers and users/visitors/citizens are urged to resolve their queries via the hardware and software provided.

Again, by any objective measure, the uses of ICTs to better systematize archaic administrative practices and improve critical services such as benefits disbursements and application reviews—refugee status claims, licensing, and so on—remains relatively unproblematic and eventful. Most democratic governments have clearly embraced the notion of digitization and have committed considerable resources to revolutionizing their Keynesian based (and other related) service delivery operations. Yet, this is where the promise of Web based technologies to enhance real political participation, government transparency, and civic literacy generally begins and ends. This discrepancy will be discussed in more detail below, but first it is important to point out that some experimentation, particularly in the areas of e-consultation, e-activism, and e-voting, has been conducted with varying degrees of success, and it is to this second dimension or stage in government use of technology that we now turn.

Using ICTs to incrementally recalibrate government administrative activities, with the benefit of hindsight, was probably initiated by design. Information and communications revolutions can have a strikingly disruptive impact on conservative institutions and actors. Conventional operators typically resist rapid change and therefore make a concerted effort to only gradually introduce devices and processes—should they be perceived as inevitable—that can lead to significant organizational disorder and/or a lateral diffusion of power (Kovarik, 2016). Yet, shortly after high income governments began testing the efficacy of ICTs on the administrative structures of the state, a new set of communications technologies started to materialize.

Known as 'social collaborative' technologies (or just social media), applications such as Twitter, Facebook, MySpace, Flickr, and the like reflect recent improvements in both fiber optic and satellites based networked systems and represent a fundamental evolution and revolution in personal communications. Governments everywhere are now using these types of communications platforms to reverse the scourge of political disengagement, stimulate myriad forms of collective action, and buttress public information campaigns on vital social, economic, and health and safety programs (McNutt 2014; Dixon, 2010; Wooley et al., 2010; Osimo, 2008). The literature abounds with dozens of reflective pieces on how digital media are being deployed by elected officials to reinforce some of the more essential qualities of public/democratic engagement (Landsbergen, 2010; Hill, 2008; Scott 2006; Culver & Howe, 2004; Kersten, 2004). And, while many of these offerings are circumstantial, sporadic, and highly specific, they nevertheless provide us with some insight into how second generation communications technologies can be positioned to animate democracy at the local, sub-state, and state levels of government.

For the most part, 'social collaborative' tools are used in one of five ways. First, techno-savvy politicians routinely attempt to establish a personal bond or connection between themselves and their constituents via social media. Here, Web 2.0 technologies like Twitter or Facebook are used to keep professed 'followers' abreast of what is happening during an election campaign, at the local riding office, or on Capitol Hill (Cogburn & Espinoza-Vasquez, 2011). Naturally, 'supporters'—and detractors—can

subscribe to an elected officials Twitter feed and/or befriend him/her on Facebook, and then repost or 'retweet' an update or news item that they find intriguing and/or informative.

A second mode of e-inspired participation relates to both public and private efforts to get citizens to collectively resolve an immediate or persistent domestic or global crisis. In these instances, Canadians, Americans, or Australians are asked to engage in a form of direct, formal, and shared engagement and to draw on the expertise and resources of already well established online entities. This phenomenon has been popularly referred to 'crowdsourcing' or 'crowdfunding.' The idea is to get Internet users to lend their time, money, and voice to a political cause or relief effort, and many high income states have now regularized a national appeals strategy to foment collective action where it is needed. The Canadian government's desire to assist the fire ravaged residents of Fort McMurry by encouraging Canadians to support the city's recovery through a Red Cross matching donation(s) scheme is just one of the ways that people can contribute via digital means. The Red Cross itself actually uses a crowdsourcing framework to maintain a virtual community of volunteers to monitor social media and to provide victims of all sorts with valuable information on where to find food, medical supplies, and so on.

A third method of empowerment relates to the rather new idea of social voting; that is, "a process that allows citizens to vote for their preferred policy outcomes" or political candidate on the basis of other popularly held attitudes, beliefs, and preferences (McNutt, 2014, pp. 61). This has developed into a fascinatingly exciting way to encourage citizens to participate in a more direct and personally responsible manner. For example, a news report carried on *Science*'s webpage in 2012 highlighted the results of a survey of 61 million Facebook users that found that online social network usage influenced voting behavior more 'than spamming users with information via television ads or phone calls' (Bohannon, 2012). An interesting development, to be sure, but the report also questioned the extent to which online behavior translated into 'real-world activism.' Morozov (2013) has pursued a similar line of inquiry in his book '*To Save Everything Click*' and has concluded—based on substantial evidence—that there is a tendency to use technology as a substitute for more sincere and conspicuous engagement—an alarming trend that is also discussed in the next section.

A forth area that deserves some mention is what McNutt (2014) describes as 'social networking' and how public administrators can use digital media to connect to user groups that frequently observe the day-to-day travails of governments and other political actors. In these instances, we are assured that government administrators can seek out, and are seeking out—through multiple social media channels—opportunities to 'communicate messages and to listen to what people are saying about issues that are important to them and important to an agency's or department's mandate' (McNutt, 2014, pp.62).

Finally, several governments have used digital mediums to test the practicality of electronic voting and e-consultation. There has been extraordinary interest in using various electronic devices and systems to make voting more convenient and accessible, and to 'reach-out' to citizens, stakeholders, and other governments (Mishra, 2012; Peters & Abud, 2009; Coleman & Norris, 2005). However, security and privacy concerns remain the most obvious obstacle to more widespread adoption, and as we will see below, e-democracy and e-consultations are not likely to relieve low civic literacy rates or voter apathy in places like Canada.

The Web 1.0 and 2.0 variants of political and administrative engagement differ in a number of meaningful ways, but they can probably be best understood as communications systems that are either generally passive in nature or generally active in nature (Calista & Melitski, 2007). One requires deeply held convictions about a particular issue and some sort of purposeful or consequential initiative. The other also requires a degree of initiative, but prohibits deliberate user input and is more about conditioned responses—insofar

as it functions as a reward(s) based mechanism. Passive technologically driven government programs and services can be controlled and generate very little controversy or exposure. Active technologies, on the other hand, have the potential to undermine government authority and complicate decision-making on highly sensitive political matters—mostly because they are participatory and self-directed. Moreover, they can be manipulated to serve powerful interests and can be utilized to weaken the pillars of liberal democracy, and this why many cyber-skeptics have continued to express serious reservations in relation to how, when, and where 'active' and social collaborative technologies should be used.

Unfulfilled Promise(s) and the Perils of Digital Media and Internet Politics?

Cyber-skeptics tend to view investments in digital infrastructure through a vastly different lens. That said, a careful survey of the scholarship seems to confirm the belief that using ICTs to transform government was probably inevitable. Yet, it is also cynically pointed out that this conversion, initially at least, had less to do with improving public services and more to do with cutting costs (Lacharite 2011; McNutt & Carey, 2008; Borins, 2004; Danzinger & Andersen, 2002). In essence, the image and act of eliminating good jobs and 'corporatizing' services was softened significantly by the promise that technology would make government more cost-effective. Nowadays, there is very little debate that governments have achieved this objective—though, it remains unclear how important ICTs have truly been in this regard. Hence, installing Web 1.0 technologies to disentangle oppressive bureaucratic practices and programs has now largely been granted a universal 'seal of approval.' Still, cyber-skeptics remain ever vigilant and cautious when it comes to the newer issues of government and social collaborative technologies, e-consultation, and e-democracy.

In response to the social media and e-democracy developments presented above, critics usually consider a number of intriguing counter-points to take, what some believe to be, the artificial 'sheen' off the potential of digital media to transform modern democratic politics. Beginning with e-democracy, Lacharite (2015, 2011), Van Dijk (2012), Chevallier (2009), Liptrott (2007), Kampen & Snijkers (2003), and Lenihan (2002) make a number of compelling arguments and remind us that embarking on a course of hyper-egalitarianism—that is, one expedited by digital media—needs to be examined within the political, cultural, institutional, and 'user' contexts in which it is trying to take root—if only to avoid falling victim to a form of 'Internet-centrism' (Morozov, 2011). For example, Lacharite (2011) asks us to pay more attention to roles of elitism and executive predominance in parliamentary and republican regimes and to acknowledge the factors that underline voter apathy. The notion that (eligible) voters "should have [a] direct and substantive role in making legislative and policy decisions" is sacrosanct to some extent, and "constitutes the main ideal (and a primary moral component of the idea) of democracy" (Behrouzi, 2006b, pp. 2). However, this particular viewpoint, cherished though it may be, does not embody an empirical reality that is consistent with the politics of places like Canada and the United States. Indeed, as Laswell and Kaplan (1950) so eloquently put it several decades ago: 'elites, not masses, govern all societies.' Alas, 'elitism' as a feasible and rival theoretical and conceptual model for understanding modern democratic politics, has been systematically undone and overshadowed by intellectual frameworks that promote pluralism (Dahl, 2006, 1989). But we would do well to remember that policy and decision-making are a decidedly top-down affair and process, and are influenced by well-organized, well-financed, and well-resourced interests (i.e., single issue and pressure groups and other stakeholders) at all levels of government. Voters continue to merely legitimize competing policy agendas and little else (Wolin, 2008; Rothkopf 2008; Domhoff 2002; Dye 2002, 2001, 1978; Bottomore 1993). Perhaps

nothing exemplifies this reality better than the institutionalization of executive power. Prime Ministers, Presidents, Premiers, and Governors are typically reluctant to cede power to constituents because they see political decision-making and policy initiation and reform as the exclusive preserve of governing officials. This is not to say that they do not, on occasion, consult 'the people' for the purpose of maintaining positive public relations, but for all intents and purposes, the instances of authentic and effective citizen involvement remain patchy and subject to considerable oversight (Margo 2012; Lacharite, 2011) Put simply, the 'leaders and lemmings' relationship that exists in many democratic states is not likely to be significantly altered by digital media.

With regards to the factors that contribute to voter apathy, Docherty & White (2004) and Pammet & Leduc (2003) demonstrate that in the case of Canada political disengagement is normally linked to a lack of interest in politics, an inability to discern between policy alternatives and quality candidates, and a lack of awareness and/or motivation. These types of eligible voters are unlikely to be persuaded by the prospect of greater access to e-consultation or e-participation opportunities—or even benefit from them. Even so, it is not immediately clear why more citizens need to participate in policy-making or why their opinions really matter? Certainly, soliciting expert commentary and advice on a proposed piece of legislation can be constructive, by why then do 'the people' need to get involved and do they, in a collective sense, possess the intellectual capacity to vote on issues related to tax reform, national unity, or individual rights? This question will be examined in more detail in a Canadian context in the next section. For now, it is sufficient to point out that there is a downside to many of the positive characteristics of social media. For example Lacharite (2015), the United Kingdom's House of Lords' Select Committee on the Constitution (2010), Lenihan (2002), and Marquis (1993) warn us of the dangers of embracing plebiscitarianism. In sum, xenophobia, religious fanaticism, demagoguery, and populism have had a pernicious and corruptive influence on well-reasoned debate and otherwise useful policy proposals—see, for example, 'Brexit 2016,' California's 2008 proposition 8 on eliminating rights for same sax couples, and British Columbia's 'Harmonized Sales Tax' proposal and campaign (Lacharite, 2015; Bell, 2011). The question that follows then is: why would facilitating and exploiting peoples' emotions via digital networks, e-referendums, and so on be undeserving of serious refection? There are several contemporary examples of populist decision-making gone awry. Yet, putative political instruments such as recall, popular initiatives, and referendums remain the clarion call for anti-elitists looking to dismantle what they consider to be unrepresentative political systems and processes. In the 'heat of battle,' voters can often find themselves susceptible to an agent's 'cult of personality' or misleading rhetorical salvos that simply confirm already, but entirely inaccurate or unsupported, biases (see Lacharite 2015; Shermer, 2012). Representative democracy, for all its faults, provides an indispensable check against the unbridled enthusiasm and energy of voters motivated by special interests in privilege positions. Hence, utilizing digital media to enhance political participation is not without costs.

A raft of other reservations has been expressed in relation to e-voting, e-consultation, and social media as well. One of the more prominent concerns revolves around the issues of privacy and security. In February 2014, an 'Independent Panel on Internet Voting' in British Columbia (a province in Canada) advised Elections BC and the provincial government against experimenting with a system of e-voting because of persistent security challenges—such as preserving ballot anonymity and voting-system integrity (IPIVBC, 2014). In addition, accessibility issues and the digital divide, have yet to be fully resolved in many democratic states. In Canada, approximately 20 percent of residents remain disconnected or insufficiently connected to participate equitably in digital politics—especially those confined to non-metropolitan regions (Statistics Canada, 2013b). Furthermore, while McNutt (2014) and Colledge (2013)

regard the 54 percent of Canadians visiting social media sites—and an additional 26 percent '[seeking] information and joining conversations on political, social, or policy related issues'—as a victory or sorts, it still strongly indicates that a significant minority and majority of users remain indifferent to the alleged opportunities available to them.

Unsurprisingly, this brings us to one final observation that bears a great deal more scrutiny, and that is: Internet usage. More than anything, Canadians use the Internet to communicate with friends and family, bank online, obtain information on weather conditions, book vacations, and shop (Statistics Canada, 2011). Statistics Canada also reports that 65 percent of Canadian Internet users visit or interact with government web-sites. On the surface, this is an impress number, but other evidence from Statistics Canada illustrates that much of this activity is of the non-consultative or 'direct-input based' variety (Underhill & Ladd, 2007). 'Government online' users mainly connected to Ottawa's principal web-portal to search for ministry-related information, access a program or service, download a form, submit a completed form, or file a completed income tax return. Alternatively, very few used government web-sites to vote, provide an opinion, or communicate with an elected official (Underhill & Ladds, 2007). Disturbingly, the authors identified a considerable number of users who did not care to connect with government at all—incidentally, the majority claimed that they had 'no need' or 'interest' in using the government's online platforms.

Above all, the counter-arguments supplied by cyber-skeptics provide more 'food-for-thought' and uncover some real deficiencies in the desire to enhance political participation and democracy through Web 2.0 technologies and applications. The last section in this chapter attempts to illuminate some of these limitations and weaknesses even further by focusing on the state of civic literacy and political participation in Canada.

HAVE DIGITAL MEDIA AND INTERNET POLITICS MADE A DIFFERENCE IN CANADA? CIVIC LITERACY AND POLITICAL PARTICIPATION

Canada provides additional substance and evidence to support the broader claim that in some instances the benefits of digital media have been wildly overstated. Put differently, the instrumentalist view of the Internet as a tool for 'enhanced democracy,' in the Canadian case, has yet to materialize, and is unlikely to materialize when the factors of civic literacy, trust in government, and current citizen interest in politics are taken into account. One of the critical problems with reports and analyses that assert that modern democratic governance—both the parliamentary and republican varieties—remain conspicuously out of step with 'today's digitally and socially networked world,' are the assumptions that: 1) citizens are now more learned than ever because of more access to relevant information; 2) that they necessarily want to be engaged in state and sub-state politics; 3) that they possess the requisite levels of moral and instrumental competence to make well-informed decisions and/or contributions when called upon; and 4) that a modern digitally enhanced citizenry necessarily translates into more genuine and legitimate political power. In the Canadian case, however, none of these assumptions are supported by the available evidence. Still, one would have to concede, that liberal democratic states differ considerably in terms of their eagerness to promote civic literacy and political participation, which means that low civic literacy societies can address this condition by investing more generously into the non-technological components of education that actually facilitate interest in politics and governance.

Proponents of e-government, governance, and democracy generally fail to clarify what they mean by participation and engagement in a conceptual sense. Of course, there are exceptions, but by and large we are left wondering what qualifies as real, meaningful, or authentic participation or engagement. This omission is critical and while it would have to be conceded that digital media can resolve the 'engagement gap' in certain instances, it will not suffice to draw on a collection of mere anecdotes and then present them as proof of the efficacy of social collaborative applications. Instead, we need to rely on, and consult, a broader range of interdisciplinary source material(s) to cultivate a better understanding of why digital media is not the panacea that it is made out to be. To this end, investigating this issue on a case by case basis is critical, and Canada represents an excellent place to start because of its low levels of political participation and high levels of technological adoption.

Canadian governments (federally, provincially, and municipally) have been trying to restore trust in the country's institutions, political parties, leadership structures, and electoral system for several years now (Conference Board of Canada, 2013). Voter turnout in the last federal election (2015) reversed a two decade long decline in overall participation, but it is probably too early to tell how significant this change in fortunes will be. Moreover, only 68 percent bothered to cast a ballot—hardly a cause for sustained celebration—and profoundly low voter turnout rates in many provinces and municipalities continue to be the norm (Siaroff & Wesley, 2015; Uppal, S., & LaRochelle-Cote, S., 2012; Nakhaie, 2006). Of course, much of this reflects a lack of trust in government institutions and political representatives, but it is also important to note that Canada still possesses fragments of a highly deferential political culture—which implies that while some distrust might exist, there is also confidence in the ability of elected officials to govern in a more or less satisfactory fashion. This is important insofar as political 'participation' has been said to exist on a 'ladder' that reflects multiple forms. There are citizens in certain democratic countries that are happy to take on the role of subject and are perfectly content with the tokenism offered up by their elected representatives. Others want more delegated power. Arnstein (1969), articulated this distinction exceptionally well by breaking down and describing the various levels of accepted engagement in his Maslow-inspired hierarchy of citizen participation and power. The point here is that 'citizen control' of policy agendas, processes, and outcomes is not the end-game for most voters, and there is not a lot that ICTs can do to change this. In Canada, the general lack of input and participation is suggestive of a voting population largely situated at the bottom and middle rungs of Arnstein's participation model.

One reason why this may persist is the relatively low levels of civic literacy that characterize Canadian voters. The OECD, Statistics Canada, and others have noted that Canada is currently experiencing an unusually acute literacy and numeracy crisis—unusual because Canada produces exceptionally high numbers of well-credentialed post-secondary graduates. As Milner (2007) and Llewellyn et al. (2007) have demonstrated this appears to be especially true of young Canadians in the area that concerns cyber skeptics the most: political knowledge. Still, it is not isolated to this cohort alone. The Canadian Council on Learning (2006) and the OECD's Programme for the International Assessment of Adult Competencies (2013) clearly indicate that a good number of Canadians have serious problems in the areas of prose literacy, document literacy, and quantitative literacy. Reflecting these deficiencies, Lacharite (2015) quipped that 'if a high percentage of potential voters have difficulty calculating a tip or discerning basic points in a 750 word article, how can they be expected to pass reasonable judgement over a provincial tax initiative or an infrastructural project intended to lower greenhouse gas emissions? The argument here is that many Canadian voters are not equipped with the appropriate educational training or qualifications to participate in highly complex matters of public policy. But to sufficiently redress this situation, Canadian governments will need to commit more financial resources to curriculum redevelop-

ment and information campaigns. Investing in more online networks is unlikely to improve the literacy and numeracy skills of Canadians.

CONCLUSION

Attempting to button-up a complex issue that rests, in part, on 'potential' is notoriously difficult. However, a number of conclusions—some obvious, some not so obvious—can be drawn from the preceding analysis. First, in most cases using ICTs to tighten-up the administrative operations of government, improve service delivery, and eliminate excessive staff was probably to be expected, but remains largely uncontroversial. Digital media continue to have a prominent and beneficial role to play is this specific area of governance. But some of the evidence presented in the Canadian case also confirms that universal accessibility continues to undercut Ottawa's best intentions and that investments in more digital infrastructure will need to be undertaken to mitigate the gaps that tend to disenfranchise rural and remote residents and citizens—the Liberal Governments' 2016 budget actually commits $500 million to this endeavor, but whether it will be enough remains to be seen (Digital Canada 150).

A second conclusion that can be made is that for all their 'potential' ICTs cannot, at the moment, undo well-established political conventions and practices in parliamentary regimes like Canada and are unlikely to eliminate deeply embedded preferences for executive governance. Consulting a close-knit collection of cabinet officials and policy advisor will almost certainly continue unabated, which will also continue to limit the scope and potency of e-governance.

Third, any discussion on the efficacy of ICTs has to include some commentary on the nature and scope of political participation—i.e., why it is necessarily a good thing—and the ways that digital media can be used by governments and other powerful societal agents or actors to overthrow proactive, well thought-out, and constructive policy plans and proposals. As Morozov (2013, 2011) and others have argued, there is a 'darker side' to Internet politics that needs to be more thoroughly examined and considered.

Finally, we need to accept that civic literacy—and more generally literacy and numeracy—is an indispensable component to a well-functioning and enlightened democracy. In the absence of a robust and critically oriented educational curriculum that places considerable emphasis on civics and the value of participating in politics, we will continue to see a good number of citizens simply 'check-out' from all things formally political—as Canada illustrates.

Of course, a real commitment to 'civics' could take on multiple forms, including more time and energy being devoted to a study of contemporary political history, political economy, political culture, foreign relations, or perhaps even designating any 'voting day' as a public holiday—to better celebrate the importance of political participation and what it really means. In any event, in Canada's case, this will require the country's provincial governments to review and improve the scope of civics instruction at the elementary and secondary levels of education. For example, in British Columbia, Kindergarten to Grade 7 Social Studies curriculum covers such a wide range of subject materials—'identity, culture and society, governance, economy and technology, and human and physical environment'—that it makes it difficult to discern how effectively the province's recommended instructional hours are being use, whether they are indeed being committed to reinforcing the lessons of 'responsible, active, and thoughtful citizenship,' and given the new and rather cryptic methods of evaluation, whether students are actually retaining any of the crucial lessons being delivered by their teachers (Ministry of Education, 2016). At B.C. high schools, while some importance has been placed on an integrated Civics/Social

Studies course package, it is restricted, for the most part, to students in Grades 10 and 11. Moreover, other critical areas of inquiry such as 'Social Justice' are only offered on an elective basis—empowering students, to be sure, but doing little to develop a passion for meaningful political engagement (Ministry of Education, 2016). If the goal is to produce truly active and critically reflective citizens, then it might be time to make 'civics' a permanent, more specialized, and clearly defined part of the curriculum from Kindergarten to Grade 12; that is, make it a mandatory course of study that is not merely dispersed over two semesters and lumped into other broad areas of instruction that, though important, would tend to attenuate a genuine understanding and appreciation for statecraft and citizenship.

In the end, we need to concede that simply being labelled a knowledge based society does not guarantee participation or improvements in moral or instrumental competence. No amount of technology is likely to change this. Ultimately, modern democratic societies currently confronting a democratic deficit or widespread voter disengagement will have to go back to the basics, and this will mean investing in people—e.g., educational professionals—and the physical bedrocks—e.g., educational institutions—that make civic education work for citizens.

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Chapter 32
Multimedia Social Network Modeling Using Hypergraphs

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ABSTRACT

In this paper the authors define a novel data model for Multimedia Social Networks (MSNs), i.e. networks that combine information on users belonging to one or more social communities together with the multimedia content that is generated and used within the related environments. The proposed model relies on the hypergraph data structure to capture and to represent in a simple way all the different kinds of relationships that are typical of social networks and multimedia sharing systems, and in particular between multimedia contents, among users and multimedia content and among users themselves. Different applications (e.g. influence analysis, multimedia recommendation) can be then built on the top of the introduce data model thanks to the introduction of proper user and multimedia ranking functions. In addition, the authors provide a strategy for hypergraph learning from social data. Some preliminary experiments concerning efficiency and effectiveness of the proposed approach for analysis of Last.fm network are reported and discussed.

INTRODUCTION

Nowadays, *Multimedia Sharing Systems* (MSSs) and some *On-line Social Networks* (OSNs) provide users an interactive platform to create and share multimedia content (e.g. text, image, video, audio, etc.) of interest. As an example, each minute thousands of tweets are sent on Twitter, several hundreds

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of hours of videos are uploaded to YouTube, and a huge quantity of photos are shared on Instagram or uploaded to Flickr. In such "interest-based" social networks, each user interacts with the others through the multimedia content of interest and such interactions forming social links that well characterize the behaviors of involved users in the networks.

Social Network Analysis (SNA) methodologies have been recently introduced to study the properties of such kind of information networks with the aim of supporting a wide range of applications: information retrieval, influence analysis, recommendation, marketing, event recognition, user profiling, and so on.

In our vision, an additional challenge in the management of social networks derives from the presence of multimedia information and several questions arise, if we consider the important role that multimedia data can assume in a social network:

- Is it possible to exploit multimedia features and notion of *similarity* to discover more links? Are such links effectively useful for analytics purposes?
- Can the different types of user annotations (e.g. tag, comment, review, etc.) and interactions with multimedia objects provide a further support for an advanced network analysis?
- How is it possible to integrate and efficiently manage the information coming from OSNs and multimedia sharing systems (for example, a Facebook user has usually an account also on Instagram or Flickr) in a unique social network? How can we deal with very large volumes of data?
- In this context how is it possible to model all the various relationships among users and multimedia objects? Are the "graph-based" strategies still the most suitable solutions?

The preliminary step to provide an effective answer for the above questions lies in the introduction of a model for *Multimedia Social Networks* (MSNs): integrated networks that combine the information on users belonging to one or more social communities, with all the multimedia contents that can be generated and used within the related environments.

In the literature, the term MSN have been used over the last years together with *Social Multimedia Network* or *Social Media Network* to indicate information networks that leverage multimedia data in a social environment for different purposes: distributed resource allocation for multimedia content sharing in cloud-based systems (Nan, Zang, Dou, & Li, 2015), generation of personalized multimedia information recommendations in response to specific targets of interests (Liu, Ye, Chen, Yan, & Chang, 2012), evaluation of the trust relationship among users (Z. Zhang & Wang, 2013), high dimensional video data distribution in social multimedia applications (Ji et al., 2014), characterization of user behavior and information propagation on the base of multimedia sharing (O'Donovan et al., 2013), representation of a social collaboration network of archeologists for cultural heritage applications (Moscato, Picariello, & Subrahmanian, 2015), just to cite some of the most recent proposals. As we can notice such proposals face only in part the discussed problems, rather focusing their efforts on specific applications.

In this paper we define and implement a novel and general data model for MSNs. Such work represents an extension of a previous one that the authors have presented in a recent conference (Amato, Moscato, Picariello, & Sperlì, 2016). The model allows us to represent in a simple way all the different kinds of relationships that are typical of such environments (among multimedia contents, among users and multimedia content and among users themselves) and to support several kinds of analytics and applications by means of the introduction of some *ranking* functions. In addition, we provide a strategy for hypergraph learning from data coming from different OSNs (e.g. Facebook, Twitter) and MSSs (e.g Flickr, Last.fm, Youtube). Finally, some preliminary experiments concerning efficiency and effective-

ness of the proposed approach for analysis of Last.fm (a popular internet radio and social network) data are reported and discussed.

The paper is organized as the following. Section 2 presents the related work on different models that can be used for representing and managing a social information network, also detailing the supported applications. Section 3 describes the proposed model with its properties and foundations also showing several examples. Section 4 shows some experimental results using Last.fm, while Section 5 reports conclusions and the future work.

RELATED WORK

The huge amount of heterogeneous information produced by information networks makes the effort of their characterization a really challenging problem in the literature. The first proposals for OSNs modeling take into account only *user* as basic entity and her/his interactions. Exploiting this model, different approaches has been proposed for different applications, such as lurkers identification (Tagarelli & Interdonato, 2013), experts finding (J. Zhang, Tang, & Li, 2007), influence analysis (Kempe, Kleinberg, & Tardos, 2003). However, such approaches do not consider multimedia contents. Successively, more complex models for social information networks, embedding multimedia data, have been introduced and it is possible to classify them on the base of four main categories.

In the first one, a social network is defined as a *graph* composed by heterogeneous vertices, such as users, tags, multimedia objects. In (Qi, Aggarwal, Tian, Ji, & Huang, 2012), the authors propose an algorithm that combines both context and content network information for multimedia annotation purposes. In turn, Jin et al. (Jin et al., 2013) use network and content-based information to propose a new image similarity concept. The second type of approaches is in turn based on *bipartite graphs*. Zhu et al. (Zhu, Su, & Kong, 2015) propose a user-content bipartite graph model to compute the influence diffusion in a social network. Gao et al. (Gao, Liang, Fan, Sun, & Han, 2013) exploit a bipartite graph - composed by users' group and objects - in order to address a consensus maximization problem. The third category of approaches uses *tripartite graphs*. In (Lu, Hu, & Park, 2011), a strategy that exploits users, tags and resources for clustering goals is proposed. A similar approach is then proposed by Qui et al. (Qi, Aggarwal, & Huang, 2012), they leverage a tripartite graph in order to cluster multimedia objects. In (Chen, Wang, Huang, & Mei, 2012), the authors propose a different approach that allows to model the interaction existing between user, query and videos in order to define a personalized video recommendation. Eventually, the last group contains the approaches based on *hypergraph* theory. In (Bu et al., 2010) the authors propose an approach based on hypergraph network in order to develop a music recommendation exploiting both social and acoustic based information. In (Anandkumar & Sedghi, 2015), authors propose a tensor decomposition approach for guaranteed learning of communities in 3-uniform hypergraph. Finally, a news recommender system via hypergraph learning is described in (Li & Li, 2013), while (Fang, Sang, Xu, & Rui, 2014) propose a novel Topic-Sensitive Influencer Mining (TSIM) framework in interest-based social media networks.

Table 1 summarizes the described approaches.

The graph based approaches permit to model only binary relationships existing among two entities of a MSN, but they can be easily implemented by the most diffused graph database technologies. On the other hand, hypergraph based models allow to represent all the different types of relationships of

Table 1. Social networks modeling

Type	Ref	Entities	Application
Graph	(Qi, Aggarwal, Tian, et al., 2012)	Multimedia Objects, concepts	Multimedia annotation
	(Jin et al., 2013)	Images, users, tags	Link based Similarity
Bipartite	(Zhu et al., 2015)	Users and contents	Influence Diffusion
	(Gao et al., 2013)	Objects, users, groups	Consensus maximization
Tripartite	(Lu et al., 2011)	Users, resources, tags	Clustering
	(Qi, Aggarwal, & Huang, 2012)	Multimedia Objects, users, tags	Recommendation
	(Chen et al., 2012)	Users, videos, queries	Recommendation
Hypergraph	(Bu et al., 2010)	Users, tracks artists, tags, albums	Recommendation
	(Anandkumar & Sedghi, 2015)	Tags, users	Consensus maximization
	(Li & Li, 2013)	Users, topics, articles, named entities	Recommendation
	(Fang et al., 2014)	Users, topics, images	Influence mining

MSN, but they require a hypergraph based store engines or techniques to "map" hypergraph structures in an equivalent graph.

Inspirited by hypergraph based approaches, our model proposes a solution for representing MSNs sufficiently general with respect to: i) a particular social information network, ii) the different kinds of entities, iii) the different types of relationships, iv) the different applications.

THE MSN DATA MODEL

Preliminaries

In this section, we present our model for managing information within a *Multimedia Social Network* (MSN). In our vision, a MSN is basically composed by three different kinds of entities:

- **Users:** The set of persons and organizations constituting the particular social community: several information concerning their profile, interests, preferences, etc. can eventually be considered and exploited by our model;
- **Multimedia Objects:** The set of multimedia resources (i.e. images, video, audio, posts, documents, etc.) that can be shared within a MSN community: high level (*metadata*) and low level information (*features*) can be properly used in our model;
- **Annotation Assets:** Each set of symbols (e.g., keyword, label, tag, textual comment etc.) exploited by users to annotate multimedia resources within a MSN; we explicitly note that it is possible to relate a given asset with a specific *topic* (the most significant terms or named entities of a given domain) which definition can be found into dictionaries, ontologies and so on, thus formally providing the related semantics.

Several types of relationships can be established among the described entities: for example, a user can annotate an image or a song with a particular tag, two friends can comment the same post, a user can tag another user in a photo, a user can share some videos within a group and so on. Due to the variety and complexity of these relationships, we leverage the *hypergraph* formalism to model a MSN. Our model is quite general and allows modeling not only the main social networks for multimedia sharing (such as Panoramio, Flickr, YouTube, Instagram, Last.fm, etc.), but also the most diffused OSNs (such as Facebook, Twitter, etc.) and other kinds of networks used for specific purposes (e.g., LinkedIn, ResearchGate). In the following, we describe in details our proposal.

The Hypergraph-Based Modeling

Definition 1 (Multimedia Social Network): A Multimedia Social Network MSN is a triple $(V; E = \{e_i : i \in I\}; \omega)$, being V a finite set of vertices, E a set of hyperarcs (or hypredges) with a finite set of indexes I and $\omega : E \rightarrow [0,1]$ a weight function. The set of vertices is defined as $V = U \cup M \cup A$, U being the set of MSN users, M the set of multimedia objects and A the set of annotation assets. Each hyperarc $e_i \in E$ is in turn defined by a ordered pair $e_i = \left(e_i^+ = \left(V_{e_i}^+, i\right); e_i^- = \left(i, V_{e_i}^-\right)\right)$. The element e_i^+ is called the head of the hyperarc e_i whereas e_i^- is its tail, $V_{e_i}^+ \subseteq V$ being the set of vertices of e_i^+, $V_{e_i}^- \subseteq V$ the set of vertices of e_i^- and $V_{e_i} = V_{e_i}^+ \cup V_{e_i}^-$ the subset of vertices constituting the whole hyperarc. The degree of a hyperarc e is defined by the related number of vertices, while the degree of a vertex v is $\sum_{v \in e} \omega(e)$, $\omega(e)$ being the weight of the hyperarc e.

A MSN can be thus represented by a weighted and directed hypergraph, where vertices are the basic entities of our model and hyperarcs constitute the related relationships.

Actually, vertices and hyperarcs are particular *abstract data types* with a set of properties (attributes and methods) that permit to support several applications. In particular, in our model each hyperarc has to be characterized at least by the following attributes (common to all kinds of relationships):

- **Id:** A unique identifier for the hyperarc that is automatically assigned;
- **Name:** A generic name that can be assigned to the hyperarc to describe it;
- **Timestamp:** The given time in which the relationship has been instantiated;
- **Type:** The identifier of particular class which hyperarc belongs to.

We use the dot notation to identify the attributes of a given hyperarc: $e_k.\text{id}$, $e_k.\text{name}$, $e_i.\text{time}$ and $e_i.\text{type}$ represent the id, name, timestamp and type of the hyperarc e_k, respectively. In addition, the weight function can be used to define the confidence or uncertainty of a given relationship in terms of probability, fuzzy membership and so on.

In a similar manner, each vertex is an abstract data type that can be characterized by several attributes. As an example, a vertex of user type can be described through the related username, information about her/his profile, preferences, list of interests, etc. and identified by a system identifier. For multimedia

objects, we can exploit their high level and low level description, and eventually, for annotations assets we use the symbolic representation together with the possible URI of related concepts.

Analyzing the different types of relationships that can be established in the main multimedia social networks, we have identified three categories of relationships:

- *User to User* relationships, describing user actions towards other users;
- *Similarity* relationships, describing a relatedness between two multimedia objects, users or annotation assets;
- *User to Multimedia* relationships, describing user actions on multimedia objects, eventually involving some annotation assets or other users.

Another basic concept of our model is *social path*, which definition is reported in the following.

Definition 2 (Social path): A social path between vertices v_1 and v_k of a MSN is an alternative sequence of distinct vertices and hyperedges (hyperpath) $v_1, e_1, v_2, e_2, \ldots, e_{k-1}, v_k$ such that $\{v_i, v_{i+1}\} \subseteq V_{e_i}$ for $1 \leq i \leq k-1$. The length of the path is $\alpha * \sum_{i=1}^{k-1} \cdot \frac{1}{\omega(e_i)}$, where α is a normalizing factor. We say that a social path contains a vertex v_h if $\exists e_i : v_h \in e_i$. In turn, we define a constrained social path as an hyperpath containing a specific set of hyperedges.

In our model, social paths (hyperpaths) between two nodes leverage the different kinds of relationships. As an example, a given path can "directly" connect two user because they are friends or members of the same group, or "indirectly", as they have shared the same photo or commented the same song.

User to User Relationships

Definition 3 (User to User relationship): Let $\mathrm{U}' \subseteq U \subseteq V$ a set of users in a MSN, we define user to user relationship a hyperarc $e_k = (e_k^+ = (V_{e_k}^+, k); e_k^- = (k, V_{e_k}^-))$ with the following properties:

$V_{e_k}^+ = \{u_i\}$ such that $u_i \in \mathrm{U}'$

and:

$V_{e_k}^- = \mathrm{U}' - \{u_i\}$

The weight function for such relationship returns as value $\frac{H'_{ij}}{H_i}$, H'_{ij} being the average number of distinct social paths related to relationships between u_i and u_j for each $u_j \in \mathrm{U}' - \{u_i\}$, and H_i the number of user to user paths having as initial vertex u_i.

In the following, we report several examples of "user to user" relationships that characterize our model.

Example 1 (Friendship relationship): Let $u_i, u_j \in U \subseteq V (i \neq j)$ be two different users in a MSN, a friendship relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} = \{u_j\}$, iii) e_k. type equal to "Friendship".

In this case, u_i is the user sending the friendship request and u_j is the user accepting the request; e_k.time represents the given time in which user u_j accepted the friendship request.

We explicitly note that it is possible to introduce in our model other attributes that are specific for friendship relationships, such as the given time in which user u_i sent the friendship request.

Figure 1 shows as a friendship relationship (typical of the Facebook OSN) can be easily represented in our model.

Example 2 (Following relationship): Let $u_i, u_j \in U \subseteq V (i \neq j)$ be two different users in a MSN, a following relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} = \{u_j\}$, iii) e_k. type equal to "Following."

In this case, u_i is the follower user (a user who desires to follow activities of another user), u_j is the following user and e_k.time represents the given time in which the following relationship was created.

Figure 2 shows as a following relationship (typical of the Twitter OSN) can be easily represented in our model.

Example 3 (Membership relationship): Let $\mathrm{U}' = \{u_1, u_2, \ldots, u_n\} \subseteq U \subseteq V$ be a set of users in a MSN, a membership relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$ such that $u_i \in \mathrm{U}'$, ii) $V_{e_k}^{-} = \mathrm{U}' - \{u_i\}$, iii) e_k.type is equal to "Membership".

Figure 1. Friendship relationship

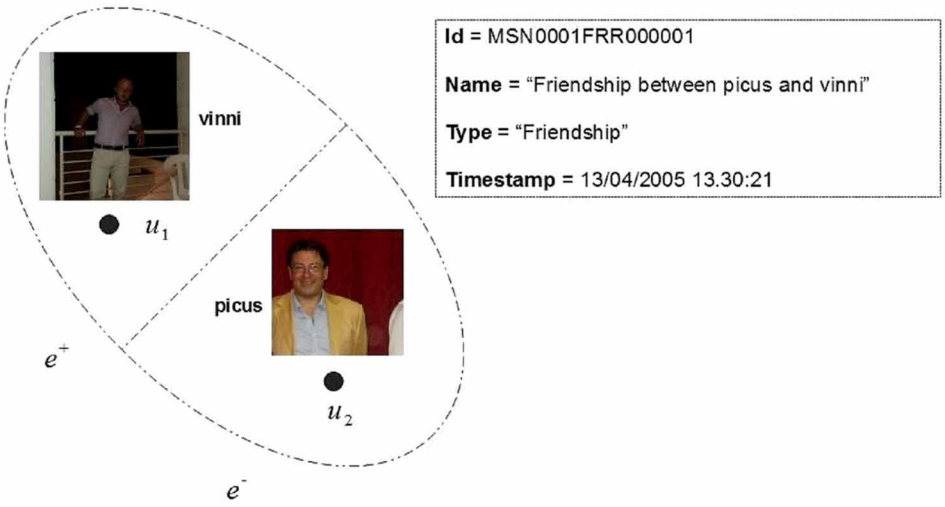
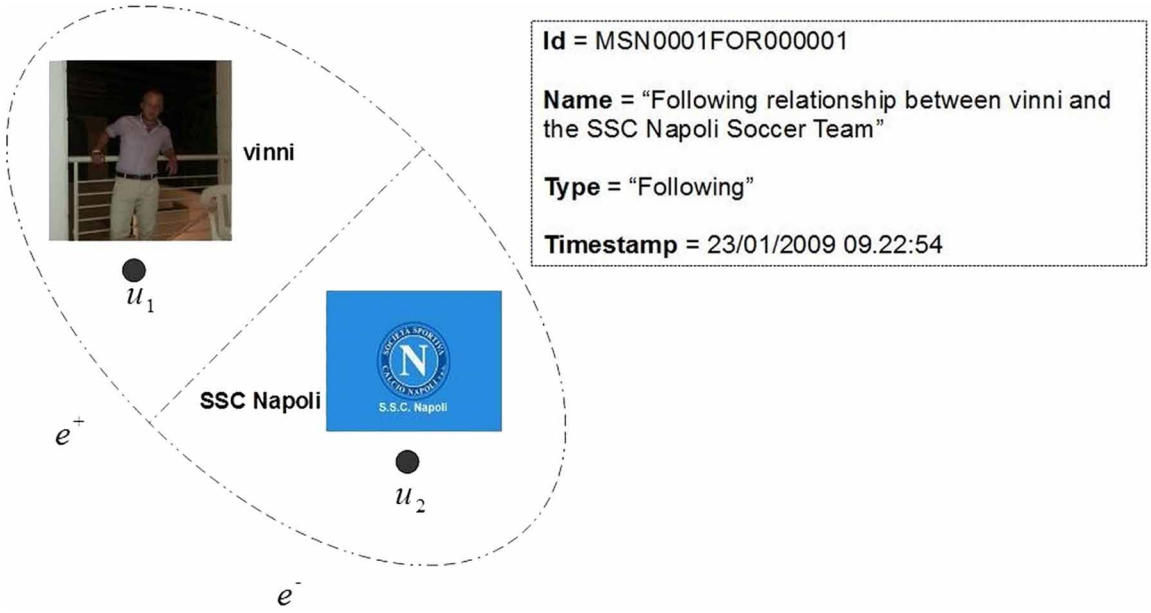


Figure 2. Following relationship



This kind of relationship allow users to "connect" themselves with one or more users belonging to the same organization, having similar interests, etc. within a given *group*.

In this case, u_i is the group creator, the remaining elements of U' are the participants to the group, e_k.time is the given time in which the group was created by the user u_i.

Facebook and Twitter allow to define users aggregation to share multimedia contents between group members, whereas Instagram does not have this kind of relationship.

Figure 3 shows as a membership relationship can be easily represented in our model.

Similarity Relationships

Definition 4 (Similarity relationship): Let $v_i, v_j \in V \ \left(i \neq j\right)$ two vertices of the same type of a MSN, we define similarity relationship a hyperarc e_k with the following properties:

$$V_{e_k}^{+} = \{v_i\}$$

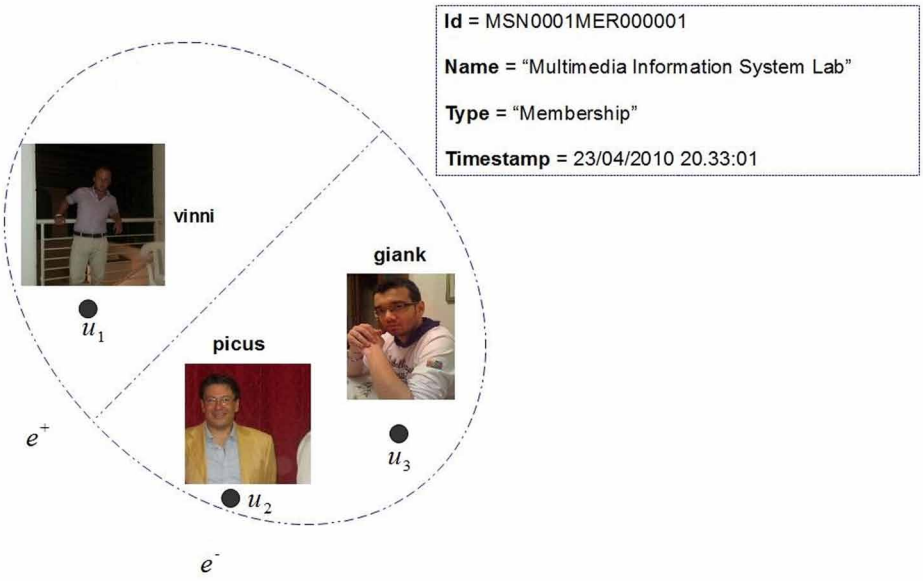
$$V_{e_k}^{-} = \{v_j\}$$

The weight function for this relationship returns similarity value between two vertices of hypergraph.

In our model, the similarity relationships are defined on the top of a *similarity function* $f_{sim} : V \times V \rightarrow R$.

This function can be applied to a pair of vertices of the same type, and in particular it is possible to compute a similarity value:

Figure 3. Membership relationship



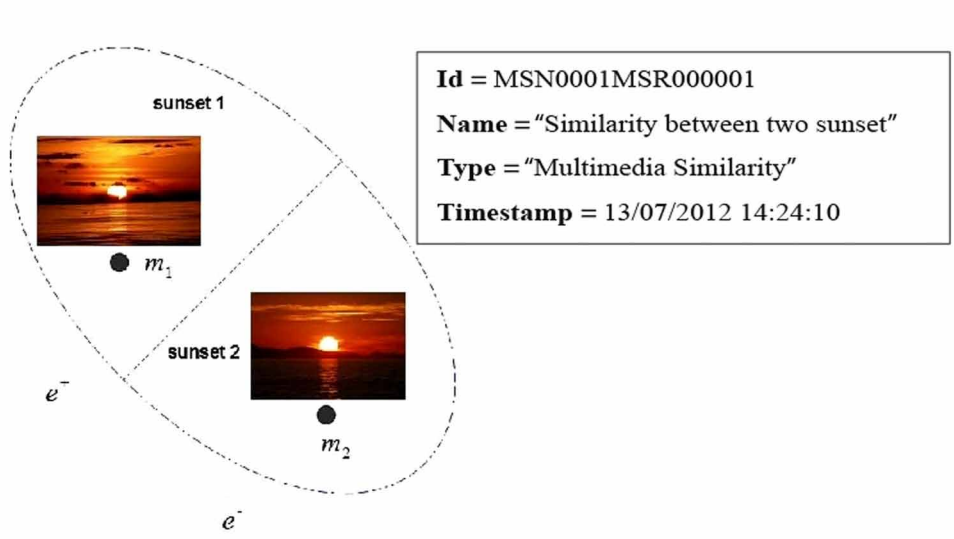
- Between two users by considering different types of features (interests, profile information, preferences, etc.);
- Between two multimedia objects using the well-known (high and low level) features and metrics proposed in the literature;
- Between two annotation assets exploiting the related concepts and the well-known metrics on vocabularies or ontologies.

In the following, we report some examples related to the similarity between two users, multimedia objects and concepts.

Example 4 (User Similarity relationship): Let $u_i, u_j \subseteq U \subseteq V \ \left(i \neq j\right)$ two users of a MSN, a user similarity relationship is any hyperarc e_k characterized by: i) $V_{e_k}^+ = \{u_i\}$, ii) $V_{e_k}^- = \{u_j\}$, iii) $\omega(e_k) \geq \gamma$, iii) e_k.type is equal to "User Similarity".

In this case u_i and u_j are two users, γ is a given threshold and e_k.time represents the given time in which the relationship was instantiated (e.g., through the application of user similarity metrics). In order to compute the similarity between two users, we define a feature-space based on information extracted from user profile and can exploit the well-known similarity metrics to compute the related relatedness. In Figure 4 it is shown an example of how *User Similarity* relationship existing between two users, called *vinni* and *giank*, can be modelled in easily way through our model.

Figure 4. User similarity relationship



Example 5 (Multimedia Similarity relationship): Let $m_i, m_j \subseteq M \subseteq V \ \ (i \neq j)$ two multimedia objects of a MSN, a multimedia similarity relationship is any hyperarc e_k characterized by: i) $V^+_{e_k} = \{m_i\}$, ii) $V^-_{e_k} = \{m_j\}$, iii) $\omega(e_k) \geq \gamma$, iv) e_k.type is equal to "Multimedia Similarity."

In this case m_i and m_j are two different multimedia objects, γ is a given threshold and e_k.time represents the given time in which the relationship was instantiated (e.g., through the application of particular computer vision algorithms).

As an example in the multimedia realm, two images can be considered "similar" if they have similar features (e.g., color, texture, shape, etc.) and/or metadata (e.g., title, keywords, description, etc.).

Figure 5 shows as the similarity between two images can be easily represented in our model.

Example 6 (Concept Similarity relationship): Let $a_i, a_j \subseteq M \subseteq V \ \ (i \neq j)$ two annotation assets of a MSN, a concept similarity relationship is any hyperarc e_k characterized by: i) $V^+_{e_k} = \{a_i\}$, ii) $V^-_{e_k} = \{a_j\}$, $\omega(e_k) \geq \gamma$, iv) e_k.type is equal to "Concept Similarity".

In this case, a_i and a_j are two different annotation assets (provided with the related concepts), γ is a given threshold and e_k.time represents the given time in which the relationship was instantiated (e.g., through the application of particular algorithms). As an example, shown in Figure 6, two tags can be considered "similar" if they have attached a similar semantics: similarity can be computed using a semantic distance (e.g., Wu & Palmer) between concepts on a given taxonomy.

Figure 5. Multimedia similarity relationship

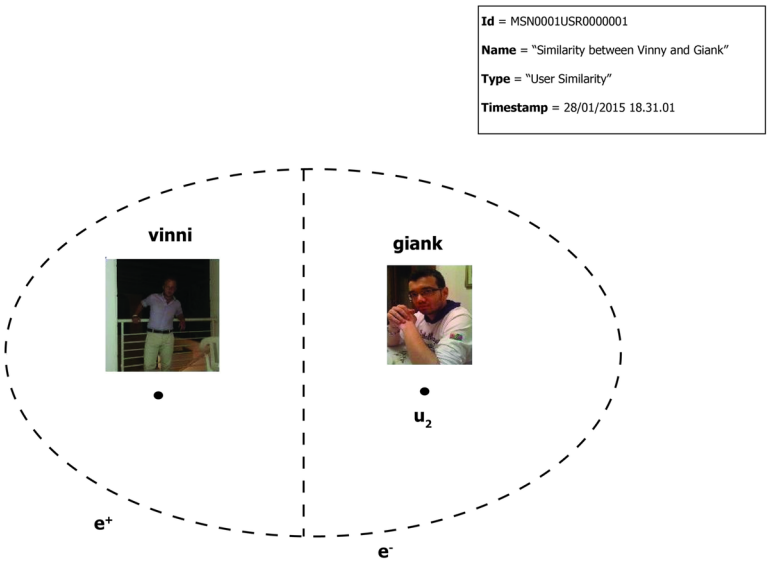
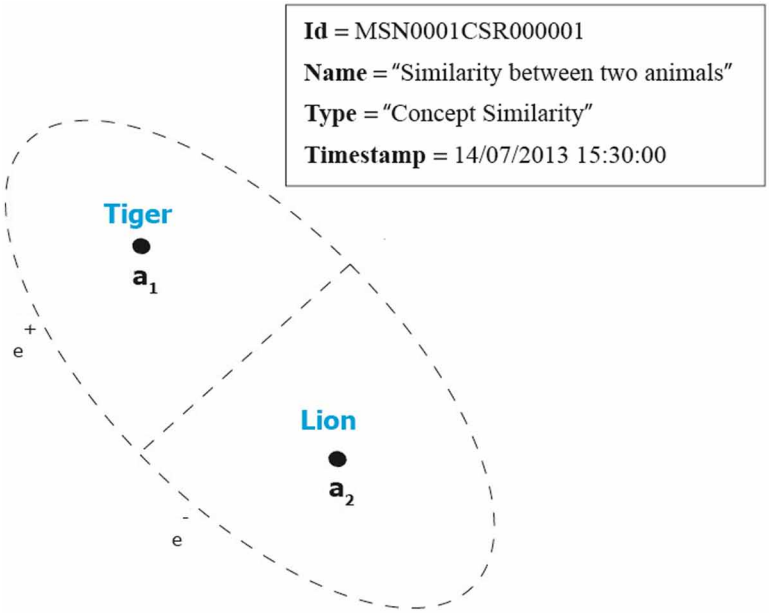


Figure 6. Concept similarity relationship



User to Multimedia Relationships

Definition 5 (User to Multimedia relationship): Let $U' \subseteq U \subseteq V$ a set of users in a MSN and $M' \subseteq M \subseteq V$ a set of multimedia objects, we define user to multimedia relationship an hyperarc $e_k = (e_k^+ = (V_{e_k}^+, k); e_k^- = (k, V_{e_k}^-))$ with the following properties:

$V_{e_k}^{+} = \{u_i\}$ such that $u_i \in \mathrm{U}'$

$V_{e_k}^{-} \supseteq M'$

The weight function for such relationship reurns as value $\frac{H'_{ij}}{H_i}$, H'_{ij} being the average number of distinct social paths related to relationships between u_i and m_j for each $m_j \in \mathrm{M}'$, and H_i the number of user to multimedia paths having as initial vertex u_i.

In the following, we report several examples of "user to multimedia" relationships that characterize our model.

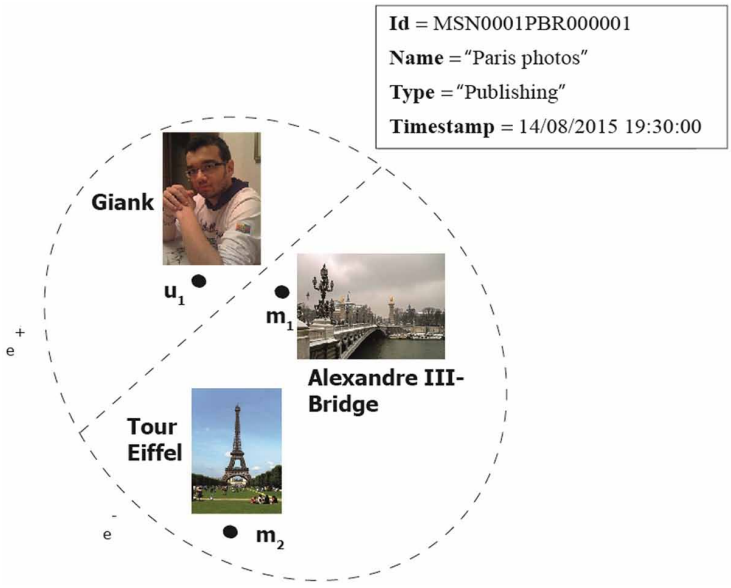
Example 7 (Publishing relationship): Let $u_i \in U \subseteq V$ be an user of a MSN and $M' = \{m_1, m_2, \ldots, m_n\} \subseteq M \subseteq V$ a set of multimedia objects, a publishing relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} = M'$, iii) e_k.type is equal to "Publishing."

In this case, u_i is the user who desires to publish a set of multimedia objects, whereas $m_1, \ldots, m_n$ are the published multimedia objects; e_k.time represents the given time in which user u_i performed the publishing operation.

As an example, this relationship takes place in a MSN when a user publishes several multimedia objects (e.g., those related to an album and the name of relationship could be the album title) in order to share them with other users or to remind a particular event.

Figure 7 shows how our model easily allows to represent the relationship established between a user and her/his shared photos.

Figure 7. Publishing relationship



Example 8 (Annotation relationship): Let $u_i \in U \subseteq V$ be a user of a MSN, $m_j \in M \subseteq V$ a multimedia object and $\mathrm{A}' = \{a_1, a_2, \ldots, a_m\} \subseteq A \subseteq V$ a set of annotation assets, an annotation relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} - = \{m_j\} \cup \mathrm{A}'$, iii) e_k.type is equal to "Annotation".

In this case, u_i is the user who describes a multimedia object m_j with a set of annotation assets (A'); e_k.time represents the given time in which this relationship occurs.

Figure 8 shows how our model easily allows to represent the relationship established when user annotates an image using some tags that is typical action supported by of the majority of MSNs.

Example 9 (User Tagging relationship): Let $m_i \in M \subseteq V$ be a multimedia object and $\mathrm{U}' = \{u_1, u_2, \ldots, u_m\} \subseteq U \subseteq V$ a set of users, a user tagging relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_j\}$ such that $u_j \in \mathrm{U}'$, ii) $V_{e_k}^{-} = \{m_i\} \cup \mathrm{U}' - \{u_j\}$, iii) e_k.type is equal to "User Tagging."

In this case, u_i is the user who "tags" other users (the remaining elements of U') within a multimedia object (m_j); e_k.time represents the given time in which this relationship occurs.

Figure 9 shows how our model easily allows to represent the relationship established when user tags another one in a given photo that is typical action supported by of the Facebook OSN.

Figure 8. Annotation relationship

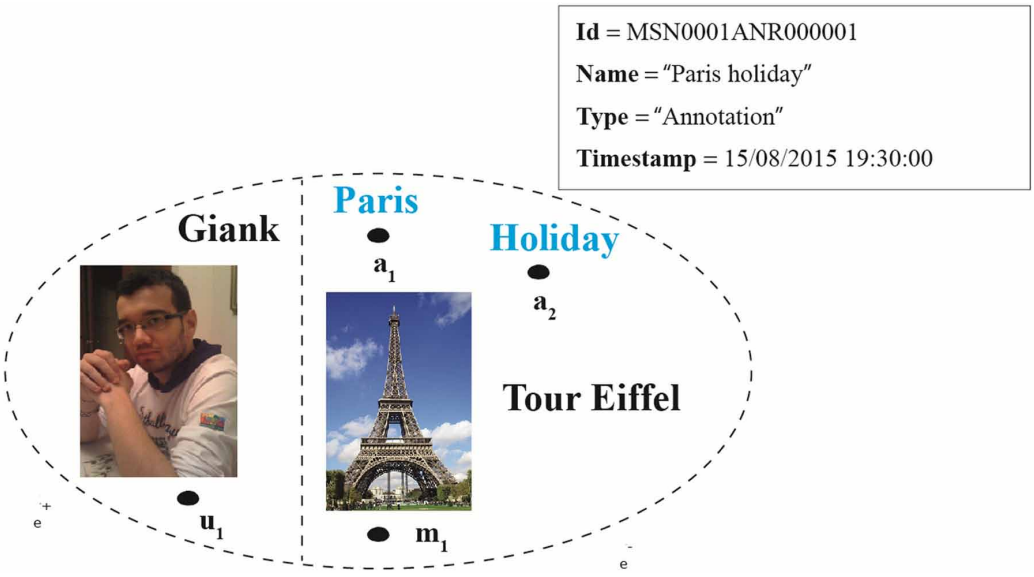
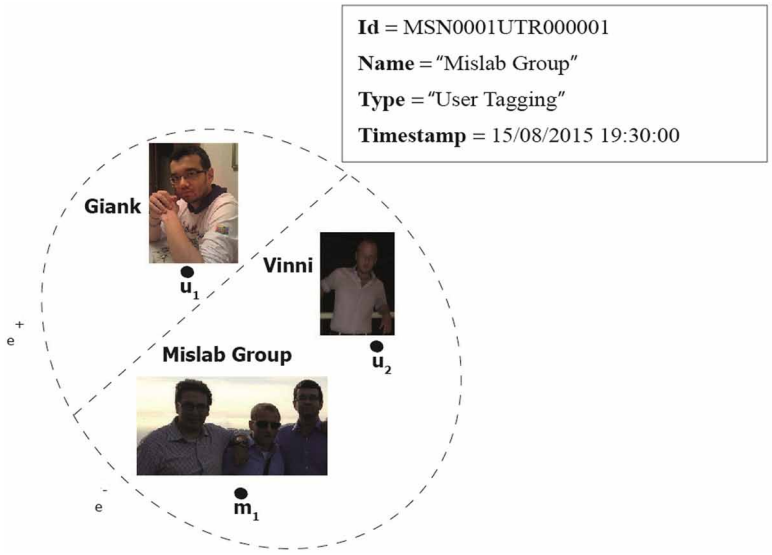


Figure 9. User tagging relationship



Example 10 (Endorsement Relationship): Let $u_i, u_j (i \neq j) \in U \subseteq V$ be two users in a MSN and a_k an annotation asset, an endorsement relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} = \{u_j, a_k\}$, iii) e_k.type is equal to "Endorsement".

In this case, u_i is the user who wants to make an endorsement related to a_k asset for u_j user in the e_k.time instant.

This kind of relationship is typical of several social networks as ResearchGate or LinkedIn.

Figure 10 shows how our model easily allows to represent the relationship established when user endorses another one for a particular job skill.

Example 11 (Reaction relationship): Let $u_i \in U \subseteq V$ be a user of a MSN and $m_j \in M$ a multimedia object, a Reaction relationship is any hyperarc e_k characterized by: i) $V_{e_k}^{+} = \{u_i\}$, ii) $V_{e_k}^{-} = \{m_i\}$, iii) e_k.type is equal to "Reaction" together with the related kind (like, sad, angry, etc.).

In this case, as shown in Figure 11, u_i is the user who likes the m_j multimedia object in the e_k.time instant. This kind of relationship is typical of Facebook OSN.

Ranking Functions

In this subsection, we introduce some functions can be profitably used to "rank" users or multimedia objects in a MSN.

First, we introduce some preliminary definitions.

Figure 10. Endorsement relationship

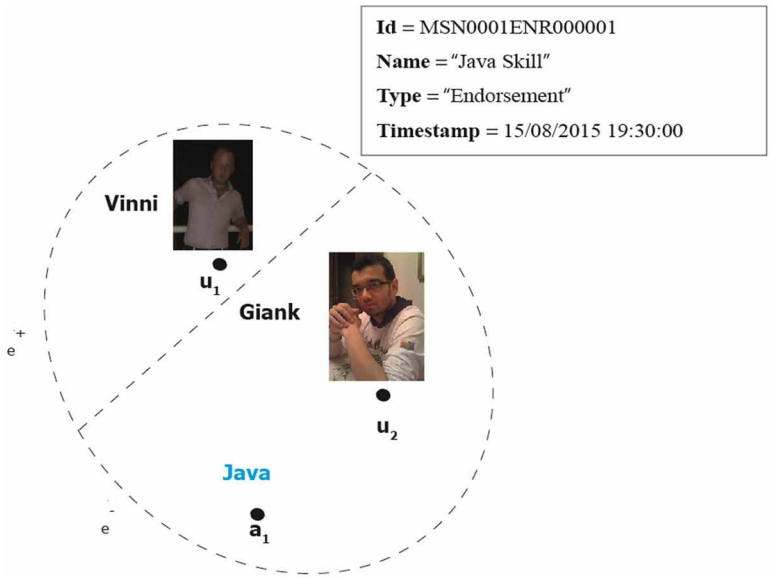
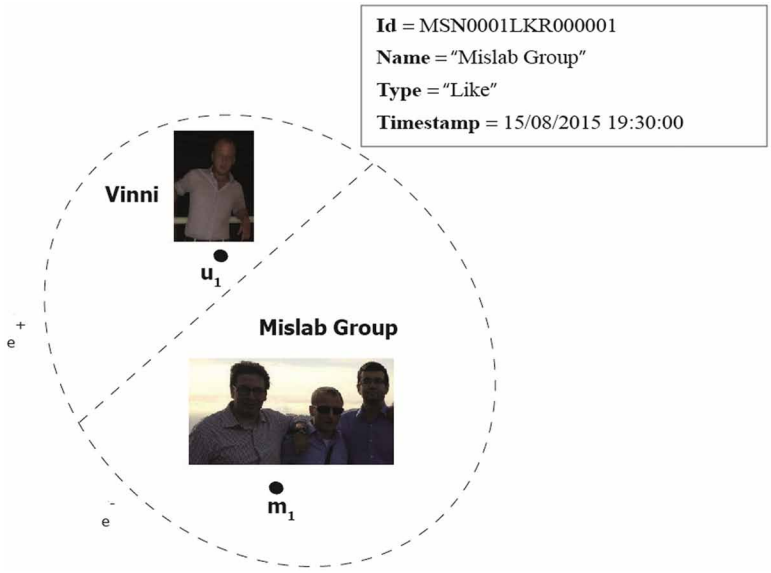


Figure 11. Reaction-like relationship



Definition 6 (Distances): We define minimum $v_j \in U$ distance $\left(d_{min}(v_i, v_j)\right)$, maximum distance $\left(d_{max}(v_i, v_j)\right)$ and average distance $\left(d_{avg}(v_i, v_j)\right)$ between two vertices of a MSN the length of the shortest hyperpath, the lenght of the longest hyperpath and the average length of the hyperpaths between v_i and v_j, respectively. In a similar manner, we define the minimum distance

$\left(d_{min}(v_i, v_j \mid v_k)\right)$, maximum distance $\left(d_{max}(v_i, v_j \mid v_k)\right)$ and average distance $\left(d_{avg}(v_i, v_j \mid v_k)\right)$ between two vertices v_i and v_j, for which there exists a hyperpath containing v_k.

Definition 7 (λ-Nearest Neighbors Set): Given a vertex $v_i \in V$ of a MSN, we define the λ-Nearest Neighbors Set of v_i the subset of vertices NN_i^{λ} such that $\forall v_j \in NN_i^{\lambda}$ we have $d_{min}(v_i, v_j) \leq \lambda$ with . Considering only the constrained hyperpaths containing a vertex v_k, we denote with NN_{ik}^{λ} the set of nearest neighbors of v_i such that $\forall v_j \in NN_{ik}^{\lambda}$ we have $d_{min}(v_i, v_j \mid v_k) \leq \lambda$

If as neighbors we consider only vertices of user type, the NN^{λ} set is called λ*-Nearest Users Set* and denoted as NNU^{λ}, similarly in case of multimedia objects we define the λ*-Nearest Objects Set* as NNO^{λ}.

On the top of such definitions, now we are able to introduce the *ranking* functions for our model. They allow to rank users or multimedia objects in a MSN in absolute way or with respect to a given topic of interest.

Definition 8 (User Ranking function): Given a user $u_i \in U \subseteq V$ and a subset of users $\mathrm{U}' \subseteq U \subseteq V (u_i \notin \mathrm{U}')$ of a MSN, a user ranking function is a particular function $\rho : U \rightarrow [0,1]$ able to associate a specific rank to the user u_i with respect to the community U' that is computed as in the following:

$$\rho_{u_i}(\mathrm{U}') = \frac{\left|NNU_i^{\lambda} \cap \mathrm{U}'\right|}{\left|\mathrm{U}'\right|} \tag{1}$$

NNU_i^{λ} being the λ-Nearest Users Set of u_i.

Definition 9 (Topic-User Ranking function): Let $u_i \in U \subseteq V$ a user, $\mathrm{U}' \subseteq U \subseteq V (u_i \notin \mathrm{U}')$ a subset of users and $a_j \in A \subseteq V$ an annotation asset of a MSN, a topic-user ranking function is a particular function $\rho : U \times A \rightarrow [0,1]$ able to associate a specific rank to the user u_i with respect to the community U' given the topic a_j that is computed as in the following:

$$\rho_{u_i}^{a_j}(\mathrm{U}') = \frac{\left|NNU_{ij}^{\lambda} \cap \mathrm{U}'\right|}{\left|\mathrm{U}'\right|} \tag{2}$$

NNU_{ij}^{λ} being the λ-Nearest Users Set of u_i with respect to the topic a_j.

Definition 10 (Multimedia Ranking function): Given a multimedia object $m_i \in M \subseteq V$ and a subset of users $\mathrm{U}' \subseteq U \subseteq V$ of a MSN, a multimedia ranking function is a particular function $\rho : M \rightarrow [0,1]$ able to associate a specific rank to the object m_i with respect to the community U' that is computed as in the following:

$$\rho_{m_i}\left(\mathrm{U}'\right)=\frac{\left|NNU_i^{\lambda}\cap \mathrm{U}'\right|}{\left|\mathrm{U}'\right|} \tag{3}$$

NNU_i^{λ} being the λ-Nearest Users Set of u_i.

Definition 11 (Topic-Multimedia Ranking function): Let $m_i \in M \subseteq V$ a multimedia object, $\mathrm{U}' \subseteq U \subseteq V$ a subset of users and $a_j \in A \subseteq V$ an annotation asset of a MSN, a topic-multimedia ranking function is a particular function $\rho : M \times A \rightarrow [0,1]$ able to associate a specific rank to the object m_i with respect to the community U' given the topic a_j that is computed as in the following:

$$\rho_{m_i}^{a_j}\left(\mathrm{U}'\right)=\frac{\left|NNU_{ij}^{\lambda}\cap \mathrm{U}'\right|}{\left|\mathrm{U}'\right|} \tag{4}$$

NNU_{ij}^{λ} being the λ-Nearest Users Set of u_i with respect to the topic a_j.

In our model the concept of *rank* of a given node is related to the concept of *influence*, and in our vision it can be measured by the number of user nodes that are "reachable" within a certain number of steps using any hyperpath, with respect to a social community of users, and eventually to a given topic of interest. By exploiting similarity relationships several paths can be "implicitly" instantiated: two users (that are not friend, do not belong to any group and do not share any multimedia object) have annotated two images that are very similar (e.g. two sunsets) on the base of their high and low level multimedia features, or they have commented two different posts which concern similar topics (e.g. sport or politics).

In a similar manner to most diffused influence diffusion models, the influence of a node decays with the path distance necessary to reach the other ones.

Thus, our ranking functions can be easily exploited to solve influence analysis problems or to support multimedia recommendation strategies.

Hypergrpah Learning

The proposed hypergraph learning approach is inspired by the methodology proposed in (Fang et al., 2014). It consists of three learning stages: hypergraph construction, topic distribution and similarity learning, and topic-based ranking.

First, extracted data related to relationships between multimedia contents, users and multimedia content and users themselves are initially used to construct the hypergraph structure in terms of nodes and hyperedges. For the annotation relationships, textual annotations are then analyzed by the LDA approach - proposed by some of the authors in (Colace et al., 2014) - to learn the most important topics and to infer relations between topics and annotation assets. From the other hand, similarity values between users, multimedia objects and topics are eventually determined using proper strategies (Boccignone, Chianese, Moscato, & Picariello, 2008). Eventually, the hypergraph global and topic sensitive ranking is performed with respect to the discovered topics.

EXPERIMENTAL RESULTS

In this section, we show some experimental results obtained through the implementation of the proposed model using different types of *graph databases*. As well-known, many of them do not natively support the hypergraph data structure, thus proper mapping techniques are necessary to transform the hypergraph into an equivalent graph, such as *clique expansion* (Zien, Schlag, & Chan, 1996) or *clique average* (Agrawal, Gehrke, Gunopulos, & Raghavan, 2005).

For our experiments, we decided to adopt two different graph databases: *HypergraphDB*[1] (supporting the hypergraph data structure) and *Neo4J*[2] (together with the clique expansion technique).

We performed two kinds of evaluation: firstly we analyze the scalability of the two databases for hypergraph management with respect to the graph size, and successively we show an application of our ranking functions on music domain using Last.fm data[3] to identify the related more "important" objects.

Scalability

In the first stage of our experimental evaluation, we compared the hypergraph construction and shortest hyperpath computation times varying the related topology and size. To this goal, we automatically generated three different types of connected graphs (see Table 2):

- **Low-degree connection:** The graph is connected and each node has a number of incident edges varying from 5 to 8;
- **Medium-degree connection:** The graph is connected and each node has a number of incident edges varying from 9 to 12;
- **High-degree connection:** The graph is connected and each node has a number of incident edges varying from 13 to 16.

Figures 12, 13, and 14 show the comparison between HypergraphDB and Neo4J concerning the average construction times with respect to the three different types of dataset. It is possible to note that the use of a graph database technology based on the hypergraph data structure has comparable perfor-

Table 2. Artificial datasets

Type	Nodes	Hyperedges	Edges
Low-degree connection	20000	120,875	582,284
	50000	302150	1,447,267
	100000	603.263	2,900,547
Medium-degree connection	20000	200,756	741,125
	50000	502201	1,849,976
	100000	1,004,047	3,680,928
High-degree connection	20000	280,831	894,389
	50000	702100	2243848
	100000	1,404,247	4,508,468

Figure 12. MSN construction times: Low-degree connection

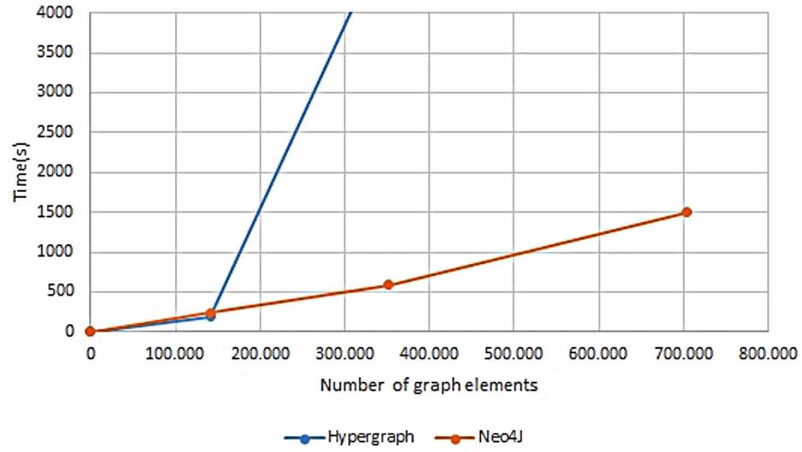


Figure 13. MSN construction times: Medium-degree connection

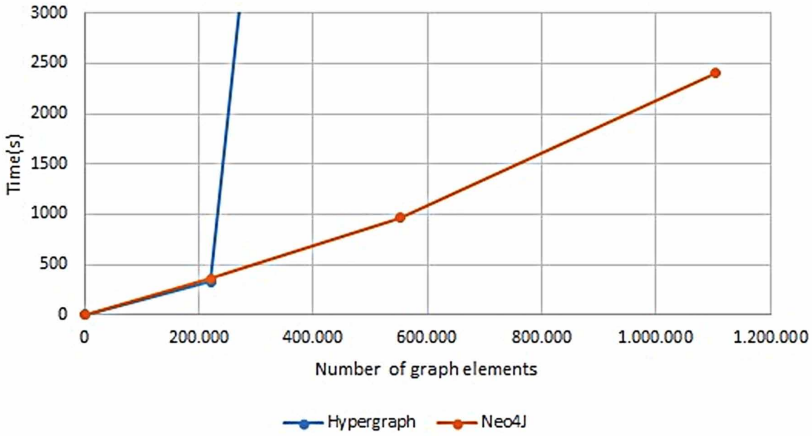
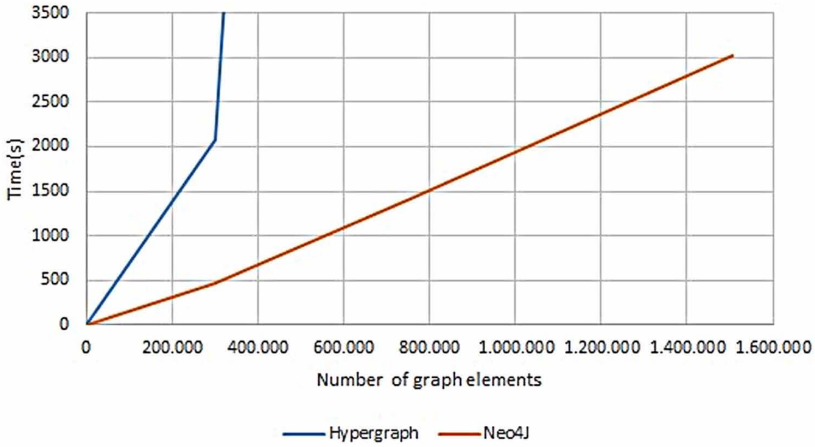


Figure 14. MSN construction times: High-degree connection



mances with a classical graphdb only for small graphs. From the other hand, Figure 15 reports the comparison in terms of shortest hyperpath computation times for a graph with a medium degree of connection of about 400000 elements, varying the λ (The hypergraph-based modeling) value. Also in this case, HypergraphDB exhibit worse performances than Neo4j database.

Last.fm

In the second stage of our experiments, we want to show a possible application of our model and of the related ranking functions in the music domain.

In particular, we used as dataset a music collection[4] containing a set of data extracted from the Last.fm multimedia social network in the first half of 2009. Table 3 reports all the information related to

Figure 15. Shortest hyperpath computation times

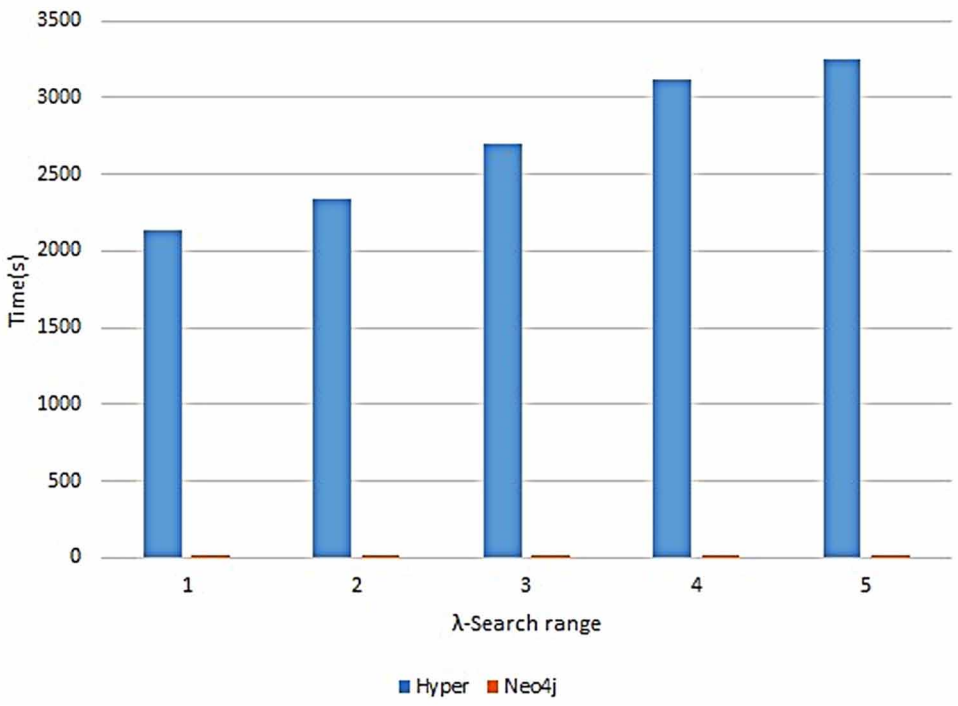


Table 3. Last.fm dataset

Element	Number
Crawled users	99,405
Annotations	10,936,545
Items	1,393,559
Tags	281,818
Groups	66,429

adopted dataset. In addition, through the help of some domain experts, we preliminary classified the songs belonging to the dataset with respect to the related musical genre (e.g. rap, pop, rock, etc.).

We selected as nodes of our hypergraph *users*, *topics* discovered by the analysis of tags used in the annotation, and *items* (songs eventually with the related raw data and multimedia description). In addition, we considered the following relationships: friendship, membership, annotation, user and multimedia similarities. We computed the similarity between two users leveraging the *neighborhood* values provided by the Last.fm API and between two songs using Spotalike [5] facilities (based on the low-level features) together with Last.fm *similarity score*.

Then, we computed the ranking functions for two specific users' communities: *rap* and *pop*.

Figure 16 shows the average values of users' ranking for each community varying λ. We can note that these communities have a strong degree of interconnection among users: using low values of λ, we rapidly obtain that each node assumes the highest ranking value.

From the other hand, we report in Figure 17 the average values of multimedia ranking. In this second case, we can observe that for smaller communities as rap the multimedia ranking values rapidly grow up to the maximum value with λ (each user have in some way interacted with all the musical items), in the opposite for larger communities as pop ranking values exhibit a more slow trend.

Finally, we show in Table 4 the Top-5 songs with respect to the computed ranking values for each examined community. In addition, Table 5 reports the most important users (id) for the considered communities. We can notice that the most important songs for our ranking are effectively those with the higher number of global "scrobbles".

Figure 16. User ranking

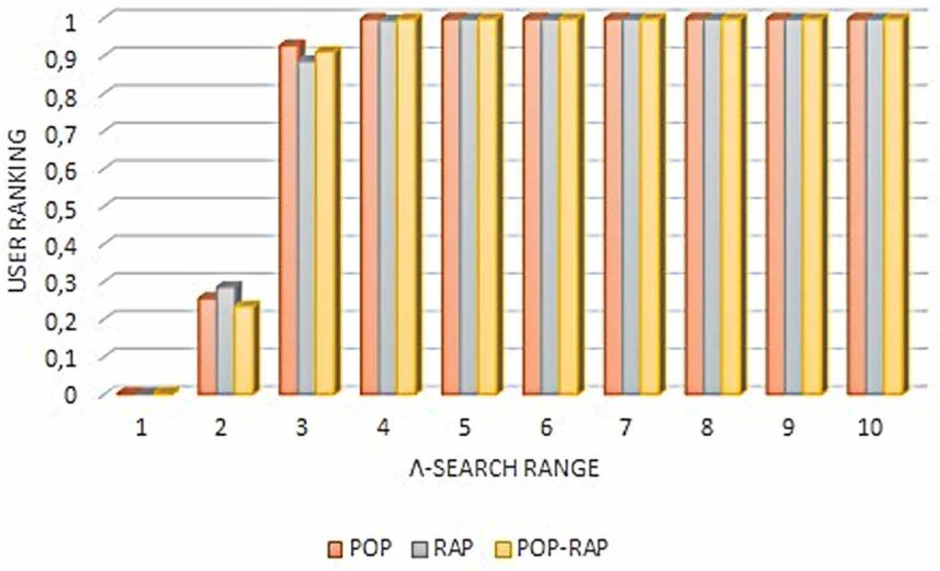


Figure 17. Multimedia ranking

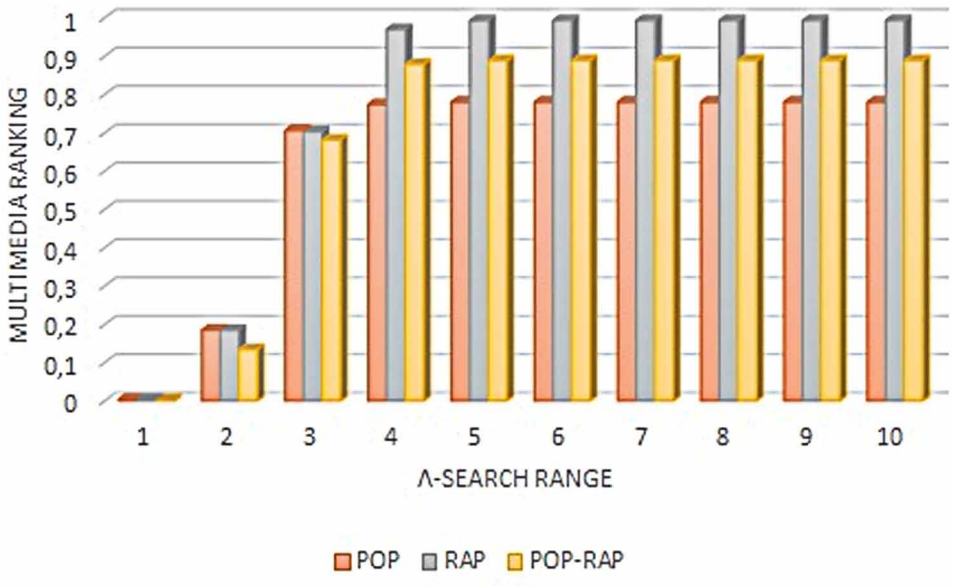


Table 4. Multimedia Top-5 for pop, rap and pop-rap communities

Pop	Rap	Pop-Rap
Lady Gaga – I like it rough	Eminem – We made you	Madonna – Hung up
Klimt 1918 - Snow of ’85	Jay-z – U dont know	Britney spears - Piece of me
Rihanna – Umbrella [feat. jay-z]	Dr. dre - Big,ego’s	Mariah carey - Reflections
Estelle feat. Kanye West - American boy	Eminem – Forgot about dre	Eminem - Mockingbird
Michael Jackson - Don’t stop ’til you get enough	Snoop dogg - Pass it pass it	Eminem - My fault

Table 5. Users Top-5 for pop, rap and pop-rap communities

Pop	Rap	Pop-Rap
342,1147,1166, 1993,2387	813,1427,1963, 2004, 2007	342, 1140, 2741, 4566, 7384

CONCLUSION AND FUTURE WORKS

In this paper we described a novel data model for *Multimedia Social Networks*, combining information on users together with the multimedia content, with several applications.

Using hypergraphs, the model allows us to represent in a simple way all the different kinds of relationships that are typical of a MSN (among multimedia contents, among users and multimedia content

and among users themselves) and to enable several kinds of analytics and applications by means of the introduction of some ranking functions.

In addition, we provided a strategy for hypergraph learning from data coming from different OSNs (e.g. Facebook, Twitter) and MSSs (e.g Flickr, Instagram, Last.fm, Youtube) and presented some preliminary experimental results using Last.fm data.

Future work will be devoted to extend experimentation of our system prototype (in the current version it allows the hypergraph browsing and the computation of rankings) to other multimedia social networks. Successively, we are planning to exploit the introduced ranking functions to support multimedia recommendation and influence analysis applications, in order to perform an experimental evaluation of the proposed model for the cited problems.

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ENDNOTES

1 https://code.google.com/archive/p/hypergraphdb/

2 http://neo4j.com

3 We realize all the experiments using a single machine equipped with 1 processor Intel(R) Core(TM) i5 M430@ 2.27 GHz and 4 GB of RAM.

4 http://carl.cs.indiana.edu/data/last.fm/

5 http://www.spotalike.com/

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Chapter 33
The Use of Eye-Gaze to Understand Multimedia Learning

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ABSTRACT

There is great interest in how learners construct knowledge when presented with multimedia. Although information has been gained from evaluating recall performance across multimedia conditions, the use of eye-gaze indices for understanding multimedia learning is becoming increasingly popular. Within the multimedia learning literature, researchers have used duration, frequency and sequence of fixations as well as shifts in eye-gaze to identify differences regarding the selection, organization, and integration of information among learners. The current chapter provides a discussion of eye-gaze measures that have been employed in multimedia research and their related interpretations for the attentional process that takes place during the learning phase. In addition, considerations for using eye-gaze measures to understand multimedia learning are presented.

INTRODUCTION

Educators and researchers have long been interested in how learners construct knowledge. Relatively recently, attention has been devoted to information processing when learners are presented with multimedia. Multimedia presents learners with information consisting of verbal (spoken and/or written text) and pictorial (static and/or dynamic visualizations including drawings, photos, animations, graphics, and videos) representations which may or may not be relevant to the individual's learning goals. Multimedia presentations are increasingly being used to present information in both formal and informal learning contexts. These contexts, include but are not limited to the traditional classroom, online during distance learning courses, slideshows, Internet websites, educational-focused apps on smartphones and tablets, and during work presentations. Much empirical research supports that people learn better from multimedia, when the presentation is designed effectively, than from words alone (Fletcher & Tobias, 2005).

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In effect, there has been a call for investigations of information processing during multimedia learning and the variables that influence knowledge acquisition.

Although information has been gained from evaluating recall performance across multimedia conditions (see Mayer, 2005 for a review), the use of eye-movement indices for understanding multimedia learning is becoming increasingly popular. Indeed, area journals have devoted special issues to eye-gaze research regarding multimedia learning (e.g., ACM Transactions on Multimedia Computing, Communication & Applications, 2007, vol. 3; Learning & Instruction, 2010, vol. 20). To highlight the unique knowledge eye-gaze recordings have contributed to the understanding of learning from multimedia, the current chapter is structured as follows: background to eye-gaze research is provided for readers not familiar with the methodology, followed by a discussion of information processing during multimedia learning based on eye-gaze measures. The objective of the current chapter is not to provide a comprehensive review of the multimedia literature, but rather to provide a discussion of the eye-gaze measures that have been employed in multimedia research and their related interpretations for cognitive processing during the learning phase.

BACKGROUND ON EYE-GAZE RESEARCH

According to the eye-mind hypothesis (Just & Carpenter, 1980) and the assumption of the eye-mind link (Reichle, Pollatsek, & Rayner, 2006), there is a close association between the element of the visual field a person is fixating on (aka overt attention) and his/her cognitive attention (aka covert attention). It is assumed that individuals are attending to the element of the visual field which their eyes are fixated (Anderson, 2000; Wang, 2011). When people attend to information they make a sequence of fixations separated by fast eye movements known as saccades. Fixations capture the motionless gaze or pauses that typically last about 200-500ms when visual information enters the information processing system; on the other hand, vision is suppressed during saccades (Rayner, 1998; Viviani, 1990). Therefore, information abstracted from learners' fixations - including duration, frequency, location, or sequence - has been considered the most meaningful for understanding attentional processes during multimedia learning.

According to Lai et al. (2013), popular eye-gaze measures can be categorized into the following three different scales of measurement: temporal, count, and spatial. Temporal eye-gaze measures involve the length of time a person is fixated on a particular element of the visual field, either on average, in entirety, or relative to other fixation locations; whereas, count measures involve frequency counts of fixations in particular areas of the visual field. While the most popular method for assessing differences in frequency and duration of fixations has been quantitative, some researchers have compared heat maps to assess temporal differences among learners. Heat maps show the overall visual distribution using color codes to differentiate the time spent fixating on each location of the visual field. This visual display enables researchers to identify at a quick glance which elements were attended to most and least often for either individuals or on average when collapsed across participants in a particular group/condition. Often the number and length of fixations have been used to answer questions related to how learners process information and which elements in the visual field receive greater attention.

Generally, it is agreed upon that fixation frequency and duration indicate attention (Wang, 2011) and the amount of cognitive processing engaged with fixated information (Anderson, Bothell, & Douglass, 2004; Graesser, Lu, Olde, Cooper-Pye, & Whitten, 2005; Just & Carpenter, 1980; Rayner, 1998). However, it is ambiguous as to whether extensive processing of a particular element is due to perceived impor-

tance or to difficulty (Rayner, 1998). In his review, Rayner (1998) describes that increased processing difficulty is related to longer fixations, suggesting that learners would need to attend to more difficult information for longer periods of time in order for cognitive processing to be successful. Given that attention to relevant information is often positively related to performance on learning tests in multimedia literature (Desjarlais, 2013; Hannus & Hyönä, 1999; O'Keefe, Letourneau, Homer, Schwartz, & Plass, 2014; She & Chen, 2009), researchers typically conclude that more and longer fixations are indicators of successful information processing even if fixations are a product of increased cognitive load. It should be noted, however, that some multimedia researchers have reported negative correlations between mean fixation duration for relevant information and test performance (e.g., Ozcelik, Arslan-Ari, & Cagiltay, 2010). Ozcelik and colleagues (2010) suggested that higher average fixation durations occurred when information was harder to understand.

Since learners can exhibit the same fixations for similar lengths of time but in a different sequence, spatial measures of eye-gaze have been used in attempt to account for individual differences in learning. Researchers record fixations in a space dimension such as location, sequence, and transitions. Transitions refer to shifts between one element of the visual field to another, with a greater number of shifts implying greater interplay or integration between elements (Schmidt-Weigand, Kohnert, & Glowalla, 2010). The sequence of eye-gaze, also referred to as saccades or scan paths, show the location of the learner's fixations and their connections in order. Scan paths provide a visual representation of the distribution of fixations using circles in which the size of the circle is directly related to the fixation time for that position in the visual field before eye gaze shifted. The fixation circles are connected by a line and are identified according to their sequence in the learning session. Thus, scan paths provide information regarding both the selection of information and sequencing of attention. Another method to assess differences in locations attended to along with their sequences include the Levenshteins' distance measure. When using the Levenshteins' distance measure, the sequence of fixations are determined for each participant and considered as the input data. Similarity scores for each possible pair of participants in a group/condition are calculated, and the mean similarity scores for the groups of learners are then typically compared. Similarity scores are based on the number of insertions or deletions needed to transform the sequence for one learner into that of another learner, where a smaller value represents a greater similarity between the scan paths (Jarodzka, Scheiter, Gerjets, & van Gog, 2010).

Similar to temporal and count measures, the interpretation of spatial measures are not straightforward. Although differences in fixation sequences and transitions reveal differences in the learning process, multiple sequences may be associated with similar levels of learning gains and thus it is questionable what differences in eye-gaze patterns actually mean. More attempts to integrate information may represent either success of readers' construction of referential connections between sources or problems when integrating information (Holsanova, Holmberg, & Holmqvist, 2009; Johnson & Mayer, 2012). Given that an increase in recall performance is typically associated with a greater number shifts between conceptually related information (Mason, Trornatora, & Pluchino, 2013; O'Keefe et al., 2014), multimedia researchers often consider the presence of transitions as an indicator of successful information processing. However, some studies have shown that while the number of transitions changed due to certain features within the multimedia, such as the inclusion of signals, an increase in transitions was not related to learning outcomes (Scheiter & Eitel, 2015). Therefore, the interpretation of changes in eye-gaze behavior is still debatable.

It should be noted that analyzing fixations during multimedia learning, whether the measures are based on duration, frequency, or sequence, typically require researchers to first separate the elements

of multimedia into what is referred to as areas of interest (AOIs). AOIs are precise researcher-specified areas in the visual display, such as introductory text, glossary items, relevant components of text or images, or interesting but irrelevant segments. Researchers can then determine the total or mean frequency, the amount of time, or the order in which learners attended to a particular AOI or groups of AOIs (e.g., all relevant information).

EYE-GAZE MEASURES IN MULTIMEDIA RESEARCH

Based on the dual-coding theory (Paivio, 1986) and theories of working memory (Baddeley, 1986; Chandler & Sweller, 1991), the cognitive theory of multimedia learning postulates that meaningful learning occurs when learners engage in the following three kinds of cognitive processes: selecting, organizing, and integrating (Mayer, 2005; Mayer & Moreno, 1998; Mautone & Mayer, 2001). Sensory information in the form of verbal (spoken/written text) and pictorial (static/dynamic visualizations) representations enter the information processing system through separate visual (eyes) and auditory (ears) channels. Learners then actively attend to or *select* the elements of the multimedia presentation for further processing. Information that is selected from sensory memory is moved into working memory where learners *organize* words into a coherent verbal representation and pictures into a pictorial representation. Next, learners *integrate* or merge the verbal and pictorial models with relevant prior knowledge to construct a coherent mental model. Selecting, organizing and integrating are active mental processes that are constrained by the limited cognitive capacity of the information processing system. That is, only a limited amount of cognitive processing can take place in either the visual or auditory channels at any one time (Baddeley, 1986; Chandler & Sweller, 1991).

There has been great attention devoted to guiding learning from multimedia, including identifying design features of multimedia and learner characteristics that impact instructional efficacy (Crooks, Cheon, Inan, Ari, & Flores, 2012; Kalyuga, Ayres, Chandler, & Sweller, 2003; Leslie, Low, Jin, & Sweller, 2012; Mayer, Heiser, & Lonn, 2001; Tabbers & van der Spoel, 2015). Although there currently is an understanding of how to design effective multimedia and the individual differences that need to be considered, the reasons driving the relations with performance have been largely speculative; that is, until the recent popularity of eye-gaze research in multimedia learning. Eye-tracking methodology has provided valuable insights into the encoding and attentional processes carried out during the learning phase (Hyönä, 2010). The general questions that have been addressed by examining eye-gaze in multimedia learning research include: Where is attention distributed during the learning phase? Why does a particular instructional design feature work to promote learning? And, how do learner characteristics facilitate learning? The following sections in this chapter provide an overview of the contributions of eye-gaze research for addressing the aforementioned three questions, while highlighting the three categories of eye-gaze indices and their relation to the three cognitive processes. Table 1 (Appendix) presents a summary of findings from multimedia learning research involving eye-gaze recordings organized by the cognitive process (i.e., selection, organization, and integration) that was assessed as well as whether the findings address visual distribution in general or as a function of contextual or learner characteristics.

How Do Learners Distribute Their Attention During Multimedia Learning?

Researchers have used eye-gaze measures to understand the way in which learners distribute their attention during a multimedia presentation that facilitates learning. First, the length of fixations has been commonly used to assess differences in learners' attention to multimedia elements. Using AOIs researchers differentiate relevant from irrelevant (or less relevant) information as well text from picture content. Overall and average fixation duration is greater for task-relevant over irrelevant segments (Hannus & Hyönä, 1999; Kaakinen, Hyönä, & Keenan, 2003; Slykhuis, Wiebe, & Annetta, 2005) and for text compared to pictures (Ho, Tsai, Wang, & Tsai, 2014; Johnson & Mayer, 2012; Liu & Chuang, 2011; Schmidt-Weigand et al., 2010; Stone & Glock, 1981). Based on the above findings, researchers have suggested that learners are able to adequately identify and select relevant information and that the processing of pictorial material was mainly driven by the text. Moreover, Desjarlais (2013) examined differences in study behaviours between learners with high levels of attention to relevant information (which was computed as a total proportion of time fixated on relevant information) compared to low levels of attention when learning from Internet websites containing text and pictures. Learners with high levels of sustained attention more frequently deployed context-effective navigational patterns and reading strategies and explored information in a more linear fashion, suggesting that sustained attention may be impacted by the monitoring of one's progress towards the learning goal.

Sequences and transitions of eye-gaze have been used to understand the order of elements attended to and the interplay between text and illustrations. Order of attention has been explored by examining the location of learners' initial fixations (Ozcelik, Karakus, Kursun, & Cagiltay, 2009; Schmidt-Weigand et al., 2010; Stone & Glock, 1981), and the location of the AOI when a switch in visual attention to another modality occurred (Hegarty & Just, 1993; Liu & Chuang, 2011). Schmidt-Weigand and colleagues (2010) found that 91% of the first five fixations were associated with the text among all scene changes during the dynamic multimedia. They suggested that learners construct an initial understanding of the material based on the text before elaborating on their mental models with information from the picture. Similarly, Hegarty and Just (1993) presented learners with text and a static image and found that an average of 55.6% of the diagram inspections occurred following the completion of reading a clause or sentence. The researchers argued that the content of the text guides attention to the parts of the picture that are necessary/complementary for understanding the material. In either case, learners often selected and started reading text before shifting attention to accompanying pictures in order to supplement the mental model formulated from the text. In contrast, others have reported an alternative learning process. For example, Stone and Glock (1981) examined participants' initial fixations and found that within the first 1 to 2 seconds of viewing a multimedia consisting of text paired with an illustration, participants tended to inspect the picture first and then shifted gaze to the text. The researchers presumed that by using this strategy learners were able to obtain a first impression or gist of overall theme which they then could use as a base for formulating the mental model from the text-based content.

The integration of text and corresponding illustration elements during multimedia learning has been examined using spatial eye-gaze measures. For example, Hegarty and Just (1993) examined the number of shifts in overt attention from text to pictures. There was an average of 6.07 shifts, which given the

short nature of the multimedia presentation indicates relatively high interplay between the modalities. Hegarty (1992) made similar observations when examining the scan paths of participants. Hannus and Hyönä (1999) also examined the interplay between text and illustrations during the learning phase of their fourth-grade participants. In lieu of using the number of transitions, the researchers coded the amount of time children looked back and forth between the relevant illustration and the target text segment using a 5-point scale. A score of 5 represented extensive interplay and was obtained when a participant made at least 3 relatively long fixations on the relevant illustration following the text segment. A score of 3 was assigned for one to two short fixations on the relevant illustration following the text segment and finally a score of 1, which represented no interplay, was assigned when a participant did not make any fixations on the relevant illustration. The overall average was 2.3 indicating limited interplay for the younger learners.

Researchers have also used eye-gaze measures to explore the learning process as it evolves over time. For instance, Hegarty and Just (1993) reported that the total number and duration of fixations corresponding to a diagram increased over time. They attributed the increase in the inspection of the diagram to an increase in complexity of the text-based content, and thus learners progressively relied on the diagram to aid in their understanding of the text. In addition, Ozcelik et al. (2009) compared fixations for the technical terms presented in the text with those for illustration materials corresponding to each 10 sec interval that occurred during the initial 40 sec of the multimedia presentation. A duration of 40 sec was chosen given that 49 sec was the minimum length of the learning phase for the self-guided presentation. During the first two 10-sec intervals the total fixation time was longer for the technical terms within the illustration than the text; however, this difference disappeared during the subsequent two 10 second intervals. Supporting Stone and Glock (1981), Ozcelik et al. (2009) suggested that learners initiate their studying of the material by looking at the illustration and then shift their attention to the text.

Overall, eye-gaze measures have contributed to an understanding of multimedia learning. Learners exhibit little difficulty identifying and sustaining attention on relevant information and often select text-based information over illustrations to form their mental models. There are differences across the research in terms of what learners typically attended to during the initial stage of the learning phase, which may be attributed to differences in multimedia formats; however, within studies there was consistency regarding where learners looked first when considering attention to text and illustrations. Therefore, differences in learning may not be attributable to the selection of information but rather result from differences that occur during the organization and/or integration processes when building a mental model. Regardless of the modality learners attend to first or for the longest, learners seem to move back and forth between verbal and pictorial information, even slightly, in attempt to integrate information into a single mental model. Moreover, attentional patterns change throughout the learning phase, possibly as learners monitor their own learning to ensure that the mental model is meeting their learning goals.

Why Does a Particular Design Feature Work to Promote Multimedia Learning?

Knowing that multimedia can aid learning compared to text alone, attention has been devoted to identifying design features for multimedia that further promote learning. Research based on performance measures has led to the establishment of multiple principles regarding instructional efficiency (see Mayer, 2005 for an overview). The principles of multimedia design that are pertinent to the current chapter include:

1. The spatial contiguity principle, which states that placing corresponding text and pictures physically close to one another on the screen rather than at a distance facilitates learning (Ayres & Sweller, 2005);
2. The signaling principle, which states that the inclusion of signals/cues promote learning by identifying for the learner the relevant information (Mautone & Mayer, 2001);
3. The coherence principle, which postulates that eliminating unnecessary verbal or pictorial information from the presentation facilitates learning (Ayres & Sweller, 2005; Kalyuga, Chandler, & Sweller, 1999); and,
4. The modality principle, which indicates that learning is facilitated when animation is paired with narration rather than text (Moreno & Mayer, 2002).

By understanding how individuals process information from multimedia under various conditions, design of these materials can be optimized to further enhance learning (Mayer & Moreno, 2002). Eye-gaze research has shed light on why the aforementioned multimedia designs guide learning, and a discussion of this research is provided below.

First, according to the spatial contiguity principle, when multimedia presents integrative information physically distant on screen learners must split their attention between the conceptually related sources of information that are essential for understanding the material (Ayres & Sweller, 2005). It is presumed that having to scan back and forth to mentally integrate the multiple sources of information places extraneous cognitive load on the learner, hindering learning compared to multimedia that presents conceptually related information in close proximity. In order to investigate the mediating factors involved in the contiguity effect, three studies included temporal and spatial eye-gaze measures. Holsanova and colleagues (2009) presented learners with newspaper articles consisting of words and graphics either within close or far proximity from one another and assessed the proportion of integrative transitions between conceptually related text and picture segments made by participants. In addition to comparing integrative transitions, Johnson and Mayer (2012) examined the proportion and total fixation duration for text between groups presented with multimedia where text was either separated or integrated with a conceptually related illustration. Bayram and Bayraktar (2012) assessed the number and duration of fixations along with comparing heat maps among learners studying from integrated versus separated dynamic multimedia.

Johnson and Mayer (2012) reported no difference in the number or total duration of fixations with text between the integrated and separated multimedia designs. They concluded that the selection of information within the cognitive learning process is not impacted by proximity. In contrast, Bayram and Bayraktar (2012) did find that learners fixated on target areas more and for longer overall when studying from an integrated compared to separated multimedia design. As such, they concluded that learners in the integrated group were more focused on the instructional material. Regarding the shifts between sources, Johnson and Mayer (2012) as well as Holsanova et al. (2009) reported that readers did make more integrative transitions overall and more transitions between text and corresponding elements in a picture when learning from the integrated format as compared to the separated format. A greater number of integrative transitions may result because the corresponding information is easier to find between sources when material is integrated, whereas learners treat the text and picture as two separate units when separated. Therefore, Johnson and Mayer (2012) claim that integrated presentations encourage learners to make successful connections between words and pictures. Overall, while the integration of information may not improve attention to relevant content, integrated multimedia does seem to guide

learners to successfully organize verbal and pictorial representations and integrate these into a successful mental model.

Chuang and Liu (2012) also compared integrated and separated multimedia presentations, but did so using a different format. Instead of manipulating the physical distance between pictures and text on a single screen, Chuang and Liu (2012) asked learners to study information from a multimedia presentation consisting of either five successive pages or a single page detailing the formation of lightning. They assessed the total number and duration of fixations as well as the scan paths. Therefore, the conceptually related text and images were presented physically close together on screen throughout the presentation, but all information was available at once during the integrated presentation whereas the separated presentation required learners to hold information from previous steps in the process in their working memory while attending to successive material. The number and duration of fixations for pictures was greater for the segmented design than the single page multimedia, suggesting that segregated sources heightened interest for the learner (based on frequency data) but decreased learning efficiency for the images (based on duration data). This is one study in which longer fixations were regarded negatively in terms of information processing. On the other hand, the number of fixations on text was the same between the conditions indicating that information processing efficiency was the same for text areas regardless of the design. Chuang and Liu (2012) used a qualitative approach to examine the scan paths. Specifically, they described individual differences observed in sample students' scan paths between the two conditions. For example, in the single page condition, one participant fixated predominantly on the text with only one fixation appearing on the image. Another participant's eye fixations were distributed across the text and image, with the movements within the image primarily occurring as shifts to and from the text. In contrast, one participant in the multiple page condition fixated predominately on text for the first page but then showed more integration between text and image for the second page. Based on the examples provided, the researchers concluded that students appear to be more cognitively engaged with the pictorial information when the material was presented in segments rather than in a single page.

Second, signaling or cueing learners involves visually highlighting specific passages or image segments in the multimedia to guide learners' attention to relevant information in a particular order. A variety of signals have been compared for their effectiveness, such as spotlights, highlighting, arrows, and changing colors (Boucheix & Lowe, 2010; Harp & Mayer, 1998; Jamet, 2014; Sung & Mayer, 2012). Although performance is enhanced with the presence of cues, it is less clear whether signals actually result in increased attention to relevant sources and consequently decreased attention to irrelevant information. The purpose of the present discussion is not to compare cues, but rather to explore what information eye-gaze measures have provided when researchers have compared cued to non-cued designs.

Not surprisingly, differences in learner attention patterns between experimental conditions have been found. The total as well as mean number of fixations and the total fixation time for relevant (signaled) information were greater for groups who received cues versus no cues (Boucheix & Lowe, 2010; Jamet, 2014; Ozcelik et al., 2009; Ozcelik et al., 2010; Scheiter & Eitel, 2015). Signaled areas were also fixated on longer (when considering fixation duration overall, Lowe & Boucheix, 2011; Ozcelik et al., 2010; mean fixation duration, de Koning, Tabbers, Rikers, & Paas, 2010; proportion of time fixating, Kriz & Hegarty, 2007) as well as more frequently (i.e., greater mean number of eye fixations; Scheiter & Eitel, 2015) compared to non-signaled elements. Students who were not presented with cues took longer to fixate on target elements compared to students for whom those elements were signaled (Scheiter & Eitel, 2015). Researchers claim that the increased fixation data supports the idea that the comprehension improvement associated with the cued format was a result of the cue redirecting attention to relevant elements of the

multimedia for essential processing (e.g., Boucheix & Lowe, 2010; Jamet, 2014; Ozcelik et al., 2009). Indeed, Scheiter and Eitel (2015) show that even when the signals within a diagram do not correspond to the text, attention is still guided to the signaled information. Specifically, during the initial pages of a multimedia presentation the mean fixation count was higher on signaled (but non-corresponding) elements for those who were presented with signals versus students without signals. The effect of signaling vanishes, however, as students learn that the signals are not helpful for learning. Approximately half way through the presentation, there was an evident shift in mean fixations (and attention) away from signaled information and toward relevant (non-signaled) information.

Jamet (2014) expanded on such analyses above by examining when the shift in gaze to cued information occurred. The percentage of time in which the gaze shifted to the cued information prior to, as well as 2 sec following, the conceptually related information being shared in the narration were calculated. While no differences in attention were observed between the groups following the evocation in the narration, gaze shifted to the target element of the image just prior to being discussed in the narration more often when the cue was present. The cue, therefore, seemed to be helpful for directing gaze more quickly but not necessarily in entirety. Furthermore, to consider how the learning process evolved over time, de Koning et al. (2010) separated the learning phase of their participants into five segments of 22 sec each. They then examined the proportion of time fixated on target information for participants who received a cued versus non-cued multimedia. Cueing resulted in more visual attention initially, but differences in attention between cued and non-cued multimedia disappeared over time, suggesting that cueing may be helpful to guide attention only initially. Overall, eye-gaze data supports the presumption that cues/signals guide attention, at least during the initial stages of the learning phase. Taking into account the facilitative effect of cues for learning, learners exposed to multimedia with cues may start off with a more successful mental model to build on during the latter stages of the learning phase.

Third, seductive details include emotionally interesting verbal statements and attention-grabbing images added to a presentation in order to increase reader interest and capture learner attention, and thus are presumed to promote learning (Chang & Choi, 2014). However, according to the coherence principle, learning is facilitated by the elimination of such unnecessary information. Indeed, the relative amount of gaze duration on (or attention to) seductive text segments is negatively related to test performance (Chang & Choi, 2014). The inclusion of seductive details may hinder learning because of distraction, disruption or diversion (Harp & Mayer, 1998; Rey, 2012). According to the distraction hypothesis, seductive details may seduce selective attention away from relevant information. Then, because seductive details require little attentional effort and are easily understood, learners may remember seductive details in lieu of the target information. According to the disruption hypothesis, learning of a causal chain of events requires steps to be integrated and when seductive details are presented they interrupt the connections being made between main ideas. Each step in the causal chain is then cognitively processed as an independent event making it difficult to organize information into a single coherent mental model. However, in Rey's (2012) meta-analysis, support for all the hypotheses were provided, as well as contradictory support for whether or not there is an effect on learning when seductive details are included. Rey (2012), therefore, made a call for more eye-tracking studies to understand the seductive details effect.

In one eye-gaze study of the seductive details effect, Rey (2014) compared overt attention among learners who studied from one of the following four multimedia: consisting of only relevant text and images, added seductive images, added seductive text, or added seductive text plus images. Although those who did not receive any seductive text passages or illustrations performed better on learning tests than those who received one or both types of seductive details, Rey (2014) reported a significantly shorter

total fixation time on relevant material when seductive details were excluded as compared to students who received seductive images only. There were no differences in fixation duration for the relevant material between the group with no seductive information and either those with seductive text or both seductive text and images. Students with seductive text passages fixated longer in total on relevant information (marginally significant) compared to those with seductive text and images. Rey (2014) regarded the fixation duration as a measure of positive performance and thus suggested that the inclusion of seductive details, to a certain extent, served to increase arousal to an optimal level which then sustained attention on relevant information. Although the presence of seductive details appeared to hinder learning, Rey's (2014) findings support the assumption that seductive details increase interest in the material, leading to higher persistence during learning (Park, Kim, Lee, Son & Lee, 2005; Schnotz, Fries, & Horz, 2009).

Last, according to the modality effect, pictorial information presented with spoken rather than written text leads to better learning outcomes. The underlying principle of this relates to the dual-channel assumption of information processing. When information is presented simultaneously in the same sensory channel (visual or auditory), it is presumed that learners need to split their attention in order to incorporate the information from the sources into their mental model. Alternatively, attention does not need to be spilt when one source is visual and the other is auditory, and thus the representations enter the information processing system through two different sensory channels (Mayer & Moreno, 2002). To test this principle, Schmidt-Weigand et al. (2010) presented learners with an animation accompanied by written text or a narration. The total viewing time of the animation was greater among learners who received the narration than the written text, although there was no difference in learning outcomes. She and Chen (2009) found similar findings with 7th graders learning science regarding the number of fixations and mean fixation duration. Therefore, attention is diverted away from the picture when learners need to read text, supporting the underlying principle of the modality effect.

In summary, performance measures have shown that different instructional designs optimize multimedia learning. A comparison of attention between particular AOIs (e.g., integrated vs. separated sources, signaled vs. non-signaled information, relevant information with vs. without seductive details included) and exploration of transitions in attention between designs (e.g., integrated compared to segmented text and illustrations) has confirmed presumptions regarding mediating factors associated with different multimedia principles. It should be noted that only a selection of the multimedia features investigated have been presented in this chapter. Eye-gaze measures have also been used to explore changes in information processing depending on the pace of presentation (Meyer, Rasch, & Schnotz, 2010; Schmidt-Weigand et al., 2010), the inclusion of narration in general (Slykhuis et al., 2005; Wiebe & Annetta, 2008), as well as the presence of redundant information (Liu, Lai, & Chuang, 2011). Eye-gaze measures have provided insight into what is attended to and when; however, they still fall short in identifying specifically what cognitive processes (selection, organization or integration) are facilitated or hindered by the different design features.

How Do Learner Characteristics Facilitate Learning?

Multiple individual differences account for variation in information processing. Three of the popular learner characteristics considered in multimedia learning that have been explored using eye-gaze measures include expertise, intellectual ability, and working memory capacity. First, differences in the learning phase as a function of expertise have been examined using temporal and spatial measures. For example, there is evidence that learners with higher domain knowledge fixate faster (Gegenfurtner, Lehtinen, &

Säljö, 2011; Liu et al., 2007) as well as fixate longer and more (Canham & Hegarty, 2010; Ho et al., 2014; Jarodzka et al., 2010; van Gog et al., 2005) on relevant/target areas as compared to when learners have low domain knowledge. In terms of spatial measures, a variety of methods have been used to examine transitions. Based on frequency counts, a greater number of transitions between elements were reported for participants with greater levels of prior knowledge (Yang, Chang, Chien, Chien, & Tseng, 2013). Similarly, although differences in prior knowledge were not observed between three patterns of visual behaviors based on a fixation times with a variety of elements, prior knowledge was positively associated with specific behaviors including total number of integrative transitions and total duration of fixations on text that occurred after a shift from the illustration (Mason et al., 2013). Ho and colleagues (2014), on the other hand, examined differences in experts' and novices' attention using heat maps. Learners with high domain knowledge typically read both the text and picture, whereas learners with low domain knowledge focused on the text and rarely inspected the picture. In addition, Jarodzka and colleagues (2010) used the Levenshteins' distance measure to compare the scan paths between experts and novices. They found that scan paths were more heterogeneous between experts than novices, concluding that either experts employed more individualized strategies or novices did not use any strategies to guide their learning. Across the research, expertise appears to facilitate the selection of relevant information while easily ignoring irrelevant material, and also encourages successful integration. However, since expertise has been investigated as a between-groups variable (Liu, Gale, & Song, 2007; van Gog, Paas, & Van Merriënboer, 2005) more often than involving manipulation of prior knowledge as a within-groups variable in pre-posttest designs (e.g., Canham & Hegarty, 2010), one cannot conclude with certainty that the differences between groups is specifically due to an increase in knowledge. Other individual differences associated with prior knowledge, such as experience with similar multimedia environments when acquiring their knowledge and intrinsic motivation, may be responsible for variation in cognitive processing.

Regarding intellectual ability, Hannus and Hyönä (1999) examined differences in the learning process between fourth-grade students with high and low intellectual ability. Accompanying the traditional measures of fixation frequency and duration, the researchers also coded participants' attentional processes on two 5-point scales for attention to relevant segments and interplay between text and illustrations. Regarding attention to relevant information, high and low ability students fixated on target information the same amount of time and just as often. However, low ability students fixated more often on irrelevant blank spaces between and around the text and illustrations than high ability students, indicating that low ability students were more likely to become momentarily distracted during the learning phase. For the coding, a score of 5 was assigned when a participant spent at least 80% of his/her inspection time with the illustration or text on pertinent segments. A score of 3 represented an equal distribution of time with pertinent and less pertinent segments, and a score of 1 was assigned if a participant spent at least 80% of his/her time with less pertinent segments. Based on their coding, high ability students showed greater attention to relevant information than low ability learners. The researchers also coded the transitions between text and corresponding segments of the illustrations on a 5-point scale, with a 5 denoting extensive interplay and a 1 denoting no interplay. A score of 5 was assigned when a participant made at least 3 relatively long fixations on the relevant illustration following the text segment, and a score of 1 was assigned when a participant did not make any fixations on the relevant illustration. Although there was relatively little interplay overall, high ability students did exhibit greater integration of text and illustration information than low ability students. Overall, Hannus and Hyönä (1999) suggested that high-ability students use more effective learning strategies, including concentration on pertinent information and integrative processing.

Third, Sanchez and Wiley (2006) evaluated the learning process of individuals with varying levels of working memory capacity when multimedia included seductive illustrations. Learners with low working memory capacity spent more time in total viewing irrelevant illustrations, viewed significantly more of the irrelevant diagrams, and exhibited less backward fixations (fixations that move from the current text position backward to text segments that were beyond text included in the same line) than learners with high working memory capacity. There was no difference between learner groups for the time spent reading the text. They concluded that learners with higher working memory capacity were better able to control their attention and integrate information from the various sources and modalities.

Overall, heightened levels of prior knowledge, intellectual ability and working memory capacity were each associated with more efficient interactions with multimedia. These learner characteristics were positively related to the selection of and attention to important information as well as longer attempts at integrating sources.

CONSIDERATIONS FOR USING EYE-GAZE MEASURES TO UNDERSTAND MULTIMEDIA LEARNING

In general, eye-gaze data has the potential to provide insight into cognitive processing that is not available through assessing learning outcome data alone. However, as evidenced in this chapter, interpretations of specific visual behaviours vary across learning contexts and researchers. For example, more fixations or longer fixation duration in one context may represent heightened interest for the material whereas in another context this may represent greater difficulty with the information (Rayner, 1998). As such, differences in the number of fixations for certain elements may not be observed between learners, such as novices and experts, not because they are mentally processing the information in a similar fashion, but rather because their visual attention is driven by different factors that ultimately do have implications for how information is organized and integrated. The use of eye-gaze data to understand cognitive processing is further complicated in that the relation between eye-gaze measures and learning outcomes has not been consistent.

In addition, although there is evidence of a strong link between overt and covert attention, it is possible that gaze is not reflective of the mind's activity. A reader could be staring at the words in this chapter right now but thinking about something else. The fixations that would be recorded then are not representative of the individual's momentary cognitive processing. When learners experience high levels of cognitive difficulty or memory load over time, the ability to sustain attention deteriorates (Parasuraman, 1979). Similarly, instances of task-unrelated mind wandering may be associated with boredom (Eastwood, Frischen, Fenske, & Smilek, 2012). This may be a concern when the multimedia content is relatively uninteresting or too challenging. Moreover, eye-gaze measures are unable to capture attention that occurs in the peripheral field of vision. Learners may attend to elements in the periphery without specifically directing their gaze (i.e., overt attention); thus, claims that learners did not attend to elements that were not fixed on may be erroneous. Although eye movement measures provide researchers with knowledge regarding what learners are looking at on screen, they still have to make presumptions about learners' mental activities.

Eye-gaze measures do not explain *why* a learner was looking at selected representations for a particular amount of time and in a certain order (Mayer, 2010). The conclusions made about the learning process based on the selection of information and the sequence of that selection discussed in the current

chapter involve assumptions about the learners' strategies when studying from multimedia. For example, researchers have assumed that learners purposely read text before inspecting a picture (Schmidt-Weigand et al., 2010) and that learners with high domain knowledge employed a variety of learning strategies in comparison to less knowledgeable peers (Jarodzka et al., 2010). However, in addition to being guided by task-related goals, eyes are also guided by perceptually salient stimuli such as the abrupt onset of a stimulus, stimulus brightness, and stimulus movement (Schreij, Los, Theeuwes, Enns, & Olivers, 2014). When learning from multimedia, movement during animations, sudden onset of cues, brighter colours in the illustration and so on, could draw the eye automatically. Since both stimulus-driven and goal-driven attention can be automatic and learners can exhibit involuntary shifts in attention due to features of the visual field (Folk & Remington, 1998), it makes it difficult to distinguish these eye-movements. Furthermore, even if the learner is actively attending to the information on screen, the learner can spend time attending to the information without adequately comprehending its relevance (de Koning et al., 2010).

Taking into account the challenges associated with interpreting eye-gaze data, some researchers have included complementary measures beyond learning outcomes, such as retrospective reporting (de Koning et al., 2010; Jarodzka et al., 2010; van Gog et al., 2005). During retrospective cued reporting, participants are shown their eye-movement patterns to serve as an aid when verbally reporting their thoughts at the time of the recording. Verbalizations are then assessed for consistencies between overt and covert attention. For example, de Koning and colleagues (2010) counted the number of idea units expressed in the verbalizations that corresponded to the idea units contained in the multimedia presentation. Similarly, Jarodzka et al. (2010) assessed the content of utterances for reference to relevant and irrelevant features. In both studies the verbalizations supported the findings from the eye-gaze measures, confirming that learners' gaze corresponded to what they were attending to during the learning phase. However, it would also be valuable to ask learners to recall the strategies they employed. Azevedo and Cromley (2004), for instance, asked participants to detail their thoughts while completing the learning phase specific to how they were regulating their own learning. They obtained information then on the learners' momentary motivation, learning strategies, effort, and the reasons behind their behaviours. Such verbal protocols would be extremely valuable to pair with eye-gaze data for understanding and confirming attentional processes.

With advancements in technology, eye-gaze recording is becoming easier and more accessible to conduct, and thus attracting many new users to this methodology. However, background knowledge is essential for such research for the selection and understanding of eye-movement indices. Familiarity with the limitations of eye-gaze research pertaining to the mental processes that eye-gaze data can in fact capture will evade misinterpretation of eye-gaze measures and facilitate the selection of measures based on theory.

CONCLUSION

Among the studies presented in the current chapter, researchers predominantly analyzed eye-gaze data, including duration and number of fixations, and number of transitions, for the learning phase overall. Eye-gaze research of multimedia learning has provided an understanding of the global differences between learners' attention as well as supported various multimedia design principles, including the spatial contiguity, signaling, modality, and redundancy principles. Nonetheless, the variability in specific eye-gaze measures incorporated into multimedia research has made it challenging to compare results across

studies. In addition, the commonly used total, average, or proportion measures do not provide insight into momentary information processing and how processing evolves over time. A handful of studies were presented in the current chapter that attempted to capture the learning process as it unfolded by examining changes in fixations across intervals of time. Overall, eye-gaze data has contributed much to the understanding of multimedia learning and the impact of various design features for information processing. However, the conclusions obtained from eye-gaze measures still require assumptions about learners' cognitive activities on the part of the researcher. Therefore, not only is there a call for more investigations of momentary attentional processes, but also the pairing of eye-gaze measures with verbal protocols focusing on learners' self-regulatory processes.

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KEY TERMS AND DEFINITIONS

Areas of Interest (AOIs): The researcher-specified areas or regions in the visual display.

Covert Attention: What the mind is attending to at a particular moment.

Eye Fixations: The motionless gaze or pause of the eye to attend to information in the visual display. Fixations typically last 200-500 ms.

Multimedia: The presentation of information using a variety of verbal and/or pictorial representations.

Overt Attention: The area of the visual field one's eyes are fixating on at a particular moment.

Pictorial Information: Static and dynamic visualizations, such as illustrations, diagrams, graphics, images, animations and videos.

Scan Path: The sequence of eye fixations and saccades.

Transitions: The shift in eye fixations between areas of interest in the visual display.

Verbal Information: Spoken (aka narration) and written text.

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APPENDIX

Table 1. Sample studies using eye-gaze measures to examine cognitive processing during multimedia learning

Cognitive Process	Findings
1. Selection and Organization: How Long Are Elements Inspected and What Elements Are First Detected?	
a. General observations	• Attention was greater for relevant than irrelevant content (fixation duration: Kaakinen et al., 2002). • Attention was greater for text than pictures (fixation duration & count: Johnson & Mayer, 2012; Liu, 2010). The element receiving attention at the outset of the presentation varied: • Initial fixations focused on the picture (Stone & Glock, 1981). • 91% of the first five fixations focused on the text (Schmidt-Weigand et al., 2010).
b. Multimedia design considerations	Support for the spatial contiguity principle: • Attention was greater for target areas during integrated versus separated multimedia (fixation duration & count: Bayram & Bayraktar, 2012; heat maps: Bayram & Bayraktar, 2012). Support for the signaling principle: • Attention was greater for relevant than irrelevant information for cued versus non-cued multimedia (fixation duration & count: Boucheix & Lowe, 2010; Chuang & Lui, 2012; Jamet, 2014; Ozcelik et al., 2010). • Attention was directed more quickly to target information for cued versus non-cued multimedia (Jamet, 2004; Scheiter & Eitel, 2015). • Attention was greater for signaled versus non-signaled elements (fixation duration & count: de Koning et al., 2010). Opposing observations for the coherence principle: • Attention was greater for relevant than irrelevant content when multimedia contained rather than omitted seductive images (fixation duration: Rey, 2014). Support for the modality principle: • Attention was greater for an animation when verbal information was presented as narration rather than as text (fixation duration & count: Schmidt-Weigand et al., 2010; She & Chen, 2009).
c. Learner characteristics	More effective cognitive processes were exhibited by learners with high prior knowledge, intellectual ability, and working memory capacity: • Attention was greater and faster for target information among experts (fixation duration & count: Canham & Hegarty, 2010; van Gog et al., 2005; latency to fixations: Gegenfurtner et al., 2011; Liu et al., 2007). • Experts attended to the picture and text, whereas novices focused on the text with seldom inspection of the picture (heat map: Ho et al., 2014). • Experts exhibited more heterogeneous eye-gaze sequences (Levenshteins' distance measure: Jarosdzka et al., 2010). • Learners with low intellectual ability attended to blank spaces longer (fixation duration: Hannus & Hyönä, 1999). • Learners with high working memory capacity attended less to seductive details (fixation duration: Sanchez & Wiley, 2006).
2. Integration: What and When Do Transitions Occur?	
a. General observations	Occurrence of transitions: • 55.6% of picture inspections occurred at the end of sentences (Hegarty & Just, 1993). Amount of interplay: • Extensive: Learners exhibited an average of 6.07 shifts from text to an illustration (Hegarty & Just, 1993). • Limited: Learners scored an average of 2.3 (on a rating scale of 1-5) regarding the amount of interplay (Hannus & Hyönä, 1999).
b. Multimedia design considerations	Support for the spatial contiguity principle: • The number of shifts between text and conceptually-related pictorial information was greater when the modalities were integrated rather than separate (Holsanova et al., 2009; Johnson & Mayer, 2012).
c. Learner characteristics	More effective cognitive processes were exhibited by learners with high prior knowledge, intellectual ability, and working memory capacity: • Experts exhibited a greater number of transitions between elements (Yang et al., 2013). • Learners with high working memory capacity exhibited more backward fixations (Sanchez & Wiley, 2006). • Learners with high intellectual ability showed greater interplay between text and illustrations (Hannus & Hyönä, 1999).
3. Time Course of Processing: Does Information Processing Change over Time?	
a. General observations	• Attention to illustrations decreased over time (fixation duration & count: Hegarty & Just, 1993). • Attention to technical terms presented within the picture was greater than the text during the first two 10 sec intervals, but differences disappeared during the remaining two 10 sec intervals (fixation duration: Ozcelik et al., 2009).
b. Multimedia design considerations	Attention was greater for target information during the initial 22 sec for cued over non-cued multimedia, whereas no differences were observed for the remaining four 22 sec intervals (fixation duration: de Koning et al, 2010).
c. Learner characteristics	High ability students exhibited greater integration of information than low ability students, although there was relatively little interplay overall (Hannus & Hyönä, 1999).

Note. Studies presented in the table represent a sample of the eye-gaze measures used. Only statistically significant findings are presented.

Chapter 34
Agent-Based Modelling of Emotional Goals in Digital Media Design Projects

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ABSTRACT

The authors promote agent-oriented models to identify, represent and evaluate high-level abstractions of digital media design projects. A major aspect is the introduction of emotional goals, in addition to functional goals and quality goals to describe feelings such as having fun, being engaged and feeling cared for. To establish emotional goals, digital media design methods and processes were employed including the development of emotional scripts, user profiles, mood boards and following an iterative participatory design process. This approach proved to be highly successful, not only to represent emotional goals such as fun, tension and empathy, but also to facilitate the ideation, creation and progressive evaluation of projects. The process supports communication between designers, developers and other stakeholders in large multidisciplinary development teams by providing a shared language and common artefact. The process is demonstrated in the development of a Multiplayer Online Role Play Game (MORPG) called Aspergion that promotes respect for people with Asperger's Syndrome.

1. INTRODUCTION

Human interaction with technology is ubiquitous and the objectives of software are widening from the utilitarian, to the facilitation of rich and engaging human interactions. *"Interaction with technology is now as much about what people feel as it is about what people do."* (McCarthy & Wright, 2004). Computing and software is increasingly pervasive and integrated throughout our lives making the consideration of human factors fundamental to the development of successful products and systems. "We do not just admire technology; we live with it. Whether we are charmed by it or indifferent, technology is deeply embedded in our ordinary everyday experience." (Pacey, 1999).

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Computing and software has moved from the workplace, into our personal lives rendering socio-cultural aspects increasingly influential (Iacucci & Kuutti, 2003). Meta-issues outside of the technical system, such as lifestyle and social structures, have become more important and need to be considered in design (Dourish, 2001b; Randall Harper & Rouncefield, 2004; Rheingold, 2003).

Realising emotional factors is fundamental to design disciplines, from industrial and communication design to architecture and fashion design. In each case, collaboration with manufacturing, science and engineering experts is required. The current challenge for the emerging field of digital media design is to develop mutually beneficial partnerships with software engineering, as architecture has with civil engineering and industrial design has with materials science.

As digital technologies increase in complexity and collaboration with other disciplines is necessary, a trans-disciplinary approach for developing sociotechnical systems is required, where digital media design practices may be incorporated into software engineering. Agent-oriented models show potential, not only to identify and realise emotional goals, but also to provide an overall progressive evaluation of these goals as we will demonstrate in this paper.

The overall objective of this research is to facilitate the creation of digital media design outcomes including sociotechnical systems that positively affect people's emotional state or wellbeing. We claim that this can be achieved by incorporating creative design processes that explicitly identify emotions as high-level goals into existing agent-oriented models (AOM) to provide a shared language between stakeholders and support project design, development and evaluation. We also propose a colour-coded evaluation system to easily communicate the progress of projects to all stakeholders and serve as a form of acceptance testing.

2. EMOTIONAL GOALS IN DESIGN

Sociotechnical systems are complex interactions between people and technology. They can be defined as a system that includes hardware and software, has defined operational processes and offers an interface, implemented in software, to humans.

Sociotechnical systems exist to support human activities, such as guarding of a building, trading, planning a route, and flirting. (Sterling & Taveter, 2009)

The consideration of emotions is important in the development of many sociotechnical systems. If a computer game does not feel fun, we will not play it; if an ecommerce website does not feel trustworthy (irrespective of the actual security) we will not purchase from it; and if a social networking application does not feel engaging we will not use it. We describe these as the *emotional goals* of the system, which we define as goals that aim to affect people's emotional state or wellbeing. These include basic emotions such as happiness, sadness, fear, anger, surprise and disgust, human factors like engagement and more abstract descriptions of feelings such as fresh, cool, wicked and fun.

Emotional goals, often described by designers as the *look and feel* or *values* of a product, have always played an important role in design considerations (Desmet & Hekkert, 2009). The industrial designer Hartmut Esslinger who worked on Apple product lines from 1984 to 90 expresses the importance of

considering emotions, saying that; "even if a design is elegant and functional, it will not have a place in our lives unless it can appeal at a deeper level, to our emotions […] form follows emotion" (Esslinger quoted in Demirbilek & Sener, 2003).

Apple's commitment to achieving emotional goals is expressed in its recent advertising campaign, launched in June 2013. The Apple campaign presents a manifesto that reflects Esslinger's design philosophy "form follows emotion" in the television commercial "Our Signature" and in the motion graphic "Our Intention" quoted here:

The first thing we ask is what do we want people to feel? Delight, surprise, love, connection? Then we begin to craft around our intention. It takes time. There are a thousand no's for every yes. We simplify, we perfect, we start over, until everything we touch enhances each life it touches. Only then do we sign our work. Designed by Apple in California. (Apple Inc, 2013)

Apple exemplifies a design-led approach to developing products and services, including software, where the "feel" precedes the functional and quality goals. By identifying, valuing and satisfying the emotional goals of its customers, Apple's products and services have revolutionised the Personal Computer, Desktop Publishing, Mobile Phone, Tablet PC, Retail Space and Music Industries. For some part of 2012 it was the world's most valuable company. We cite Apple to demonstrate how the consideration of emotional goals may facilitate the creation of successful products and services.

As a system requirement it is admittedly difficult, perhaps impossible, to quantify whether an emotional goal has been fully satisfied. Emotional goals depend on context, individual experiences and attitudes and are constantly changing, so even if we could quantify an emotional response at one moment in time, we could not apply it at all times. However whilst emotional goals are qualitative and temporal they are none the less important and in sociotechnical systems are often the primary system requirement. For example, a computer game must be engaging enough that people will play it. Making a game that is fun trumps other system requirements, irrespective of whether the goal of fun is clearly definable or measurable. If no one wants to play the game, no matter how robust the code is, it has not met the primary system requirement.

Digital media design methodologies have a tradition in realising emotional goals (often referred to by designers as the look, feel, values or brand values) by using tools and processes such as: emotional colour scripts, flowcharts, rich pictures and mood boards, where "the mood board takes all structure and explicit message out […] leaving only colour type and innuendo […] to capture a feeling." (Daniel & Brown; 2007). Designers model emotion and communicate the feel to clients and to each other using this visual and in some cases audio and textural language.

However, digital media design lacks the modelling techniques, ontology and domain expertise required to represent and build large sociotechnical systems. A trans-disciplinary approach that encourages digital media designers and software engineers to co-create sociotechnical systems is needed. Current software engineering modelling techniques are inadequate to provide for such integration. This is recognised by Baxter and Sommerville (2011): "The abstractions currently used in technical system modelling (e.g., use-cases, objects, etc.) do not seem to us to be sufficient to represent sociotechnical considerations." Our main thinking was that if emotional goals could be incorporated into agent-oriented models complemented with digital media design process then we could realise emotional goals in sociotechnical system design.

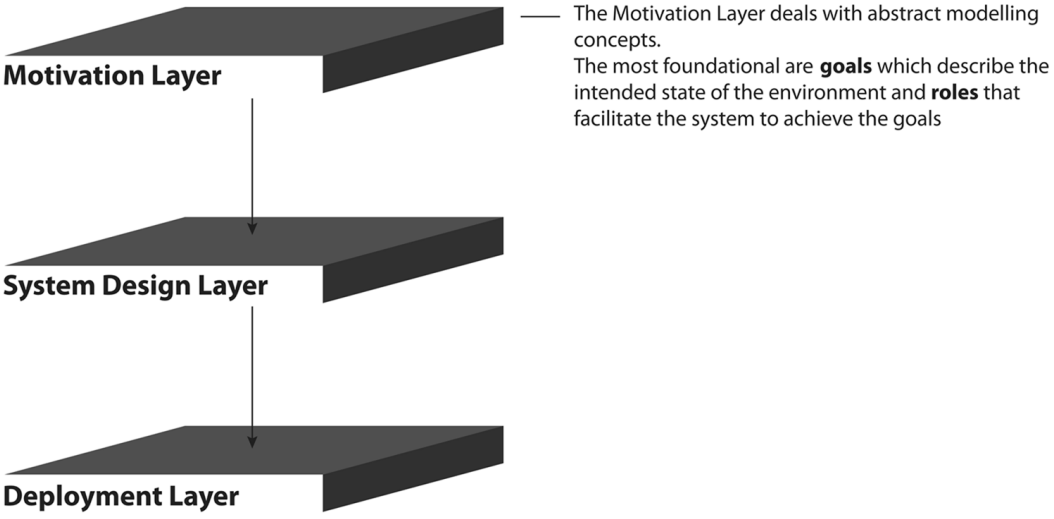
3. EMOTIONAL GOALS IN AGENT-ORIENTED MODELS

Agent-oriented models provide a promising direction forward as the characteristics of agents can be equated to human actors. They are highly suitable for understanding complex topics because the concepts used in these models are suitable for expressing the behavioural aspects of individuals and their interactions (Pavon, 2008). Agents may exhibit human-like behaviours such as autonomy, flexibility, intelligence, learning, and dynamic adaptability to the surrounding environment, increasing their suitability for socially oriented software facilitating people's social interactions. Figure 1 illustrates the agent-oriented modelling conceptual space according to Sterling and Taveter (2009), where on the motivation layer, goal models describe high-level abstractions. Current software engineering practices specify two types of goals. Functional goals, which describe a specific function such as performing a calculation and quality goals that describe the systems attributes, such as the system being stable, scalable or safe.

Focusing on quality is well established within software and systems engineering. Software engineers are aware of the need to express quality attributes of software as well as functional capabilities of software. These quality attributes are referred to using a variety of terms including: non-functional requirements, constraints, quality attributes, quality goals, or quality of service requirements (Gross, 2005; Kirikova et al., 2002; Reekie & McAdam, 2006; Sommerville, 2007; van Lamsweerde & Letier, 2003). However, goal models are often perceived as useful only at the early stages of requirements analysis to arrive at a shared understanding between stakeholders (Guizzardi & Perini, 2005; Jureta & Faulkner, 2007). Following this they are usually discarded and the quality goals deprioritised. Furthermore quality goals do not generally have a direct relationship with functional goals (Chung et al., 2000). This makes it more difficult to carry them through the whole development process and often quality considerations get lost during development. Consequently quality goals have been neglected, as they are difficult to specify, implement, and measure during development (Paay et al., 2009).

However, Sterling and Taveter (2009) use the construct of quality goals attached to functional goals to represent quality attributes of social interactions. Quality goals are formulated to encapsulate social

Figure 1. Agent-oriented modelling conceptual space (Sterling and Taveter, 2009)



aspects of the context into the software requirement model, thus providing a mechanism to carry subtle nuances of those social aspects through to the implementation phase. The direct pairing between system goals and quality goals opens up a variety of possible interpretations both in the design and use of the system.

In agent-oriented models, real people may be included in goal models and emotional factors may be expressed as quality goals. "We believe that agent-oriented concepts enhance the handling of quality requirements in open, distributed sociotechnical systems." (Sterling & Taveter, 2009).

Importantly, the agent-oriented models do not require that the implemented system be agent-based, instead, the agent paradigm is used to understand a domain and the activities of its people. This approach is again well described by Sommerville:

Agent-oriented technology is an effective way to construct sociotechnical systems, which take into account organisational and human issues as well as technical issues. Agents are a useful abstraction that helps us think about how sociotechnical systems deliver the services required by their users. We should think about this without regard to whether the agents that deliver these services are people or automated systems… (Ian Sommerville 2008 foreword page xii, in Sterling and Taveter)

Sterling and Taveter (2009) focus on how to make high-level agent-oriented models palatable to design discussions. This is achieved using goal models with a straightforward and easy syntax and semantics. Functional goals are represented as parallelograms, quality goals are clouds and roles are stick figures. These constructs can be connected using arcs, which indicate relationships between them (See Figure 5). They use the construct of quality goals attached to functional goals to represent quality attributes of social interaction as abstract, ambiguous and unresolved concepts in the models.

3.1. Proposed Method for Considering Emotional Goals

To promote the consideration of human factors we propose a new category of goal, called an *emotional goal*, to be modelled with equal hierarchy to functional and quality goals. By incorporating emotional goals into agent-oriented models the aim is to signal that the goal may be best realised by a trans-disciplinary approach. When these goals are encountered by software engineers they should seek a domain knowledge expert to apply digital media design methodologies and processes.

An icon set was developed for these goals as illustrated in Figure 2. This includes the conventional parallelogram and cloud to signify functional and quality goals with the introduction of a heart symbol to signify emotional goals.

Figure 2. Icon set for functional, quality and emotional goals

To help categorise system requirements, they can be thought of as 'doing', 'being', and 'feeling' goals. For example we can consider a university as a sociotechnical system and model its high-level goals as shown in Table 1.

For most universities the functional and quality goals will be similar, however the emotional goals will differ depending on the university's market position. We have described the type of emotional goals that a small, mid ranking university may aspire to. An Ivy League university may have emotional goals such as feeling elite, traditional, influential, distinguished and preeminent. Emotional goals are central to design and are treated with the highest consideration. The emotional goals (brand values) of sociotechnical systems like universities should permeate though every aspect of the system, from the physical and virtual spaces to the smallest interactions such as answering the phone. This includes systems like the university's website and student management system and is therefore highly relevant to software engineers.

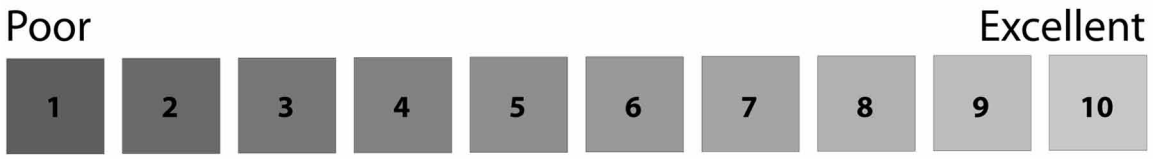
We further adapted agent-oriented models to include a colour-based rating scale. The aim was to provide a method of communicating project progress to each of the stakeholders in a quick and easily understood way. A ten steps colour chart, from red to green was developed to indicate whether the project goals were being met, where 1 (red) indicated no progress and 10 (green) indicated excellent progress (See Figure 3). The colour brightness and saturation of the red and green colours used in the scale are similar to ensure that text can remain single colour (black). Alternatively if the colour brightness varied for example from white to black, the text colour would also have to change inversely to remain readable. A consequence of this is that the colour scale must be viewed in colour. For viewing in black and white a numbering scale may be added to each goal.

To explore the feasibly of incorporating emotional goals into agent-oriented models and rate project progress using a colour-based scale, we applied them in the development of a sociotechnical system called Aspergion.

Table 1. Example of the goals of a university

Functional goals (do)	Quality goal (be)	Emotional goal (feel)
Teach students	Equitable	Dynamic
Promote wisdom	Credible	Cool
Conduct research	Accessible	Inspiring
Engage with society	Accountable	Cutting edge
Archive knowledge	Financially Sustainable	Flexible

Figure 3. Colour rating scale for project goals



4. CASE STUDY: THE ASPERGION PROJECT

Aspergion is a learning resource for secondary school students, which promotes 'respect' for people with Asperger's Syndrome. Asperger's Syndrome is an autism spectrum disorder at the least severe, or high-functioning end of the autism spectrum. To generalise, people diagnosed with an autism spectrum disorder have behavioural, social and communication impairments. Typically, people with Asperger's Syndrome will have a special interest that they focus on in detail. These are often rule-based such as mathematics, music, computer programing and science. Some famous people diagnosed with high-functioning autism / Asperger's Syndrome include abattoir designer Temple Grandin and actress Daryl Hannah. Albert Einstein, Wolfgang Amadeus Mozart, Thomas Edison and others that have hyper-focus in specific interests display traits of Asperger's Syndrome. However this alone is not sufficient to be diagnosed with an autism spectrum disorder.

Ten people with Asperger's Syndrome (further referred to as Asperger participants) were heavily involved in the development of the Aspergion project to give creative direction, provide domain knowledge, act as representative users, give user feedback and set the project goals. In setting the high-level project goals it was clearly stated that they did not want to create a project that provided therapy for people with Asperger's Syndrome, rather they wanted to create awareness and change of attitude in Neurotypicals (non-autistic or 'normal' people). They collectively set the primary project goal, which was to promote "respect" for people.

Approximately 160 students developed the Aspergion project in the 3rd year of the Digital Media Design Program at Swinburne University of Technology. Aspergion was delivered as a capstone (finishing) project in the Group Research Project and Advanced Technology units, each of which had three contact and nine non-contact hours per week over a 12-week semester. There were two separate cohorts of students (approximately equal in size) that created the project over two semesters with each student working approximately 250 hours. In addition university lecturers and domain specialists contributed to the Aspergion bringing the total project development time to 42,550 hours as detailed in Table 2. As a digital media design university project, this is extremely large, both in the time commitment and complexity.

4.1. Incorporating Emotional Goals into Agent-Oriented Models

The Aspergion project provided a unique opportunity to explore the feasibility of incorporating emotional goals into agent-oriented models, because the high-level system requirement was to affect a real world

Table 2. Participants in the Aspergion project (approximate numbers)

Participants	Quantity	Semester Delivery	Hours
Student Developers	160	1&2	40,000
Lecturing Team	12	1&2	1,800
Aspergers Participants	10	1	300
Psychologists	4	1&2	200
Documentary Maker	1	2	200
Script writer	1	2	50

behavioural change of respect by evoking feelings of empathy and responsibility in the player. Additionally the system was a Multiplayer Online Role Play Game (MORPG), requiring a range of emotions to be realised throughout the gameplay. The game was developed in two phases by separate development teams providing an opportunity to collect systematic data on whether or not agent-oriented models affected the quality of the outcome.

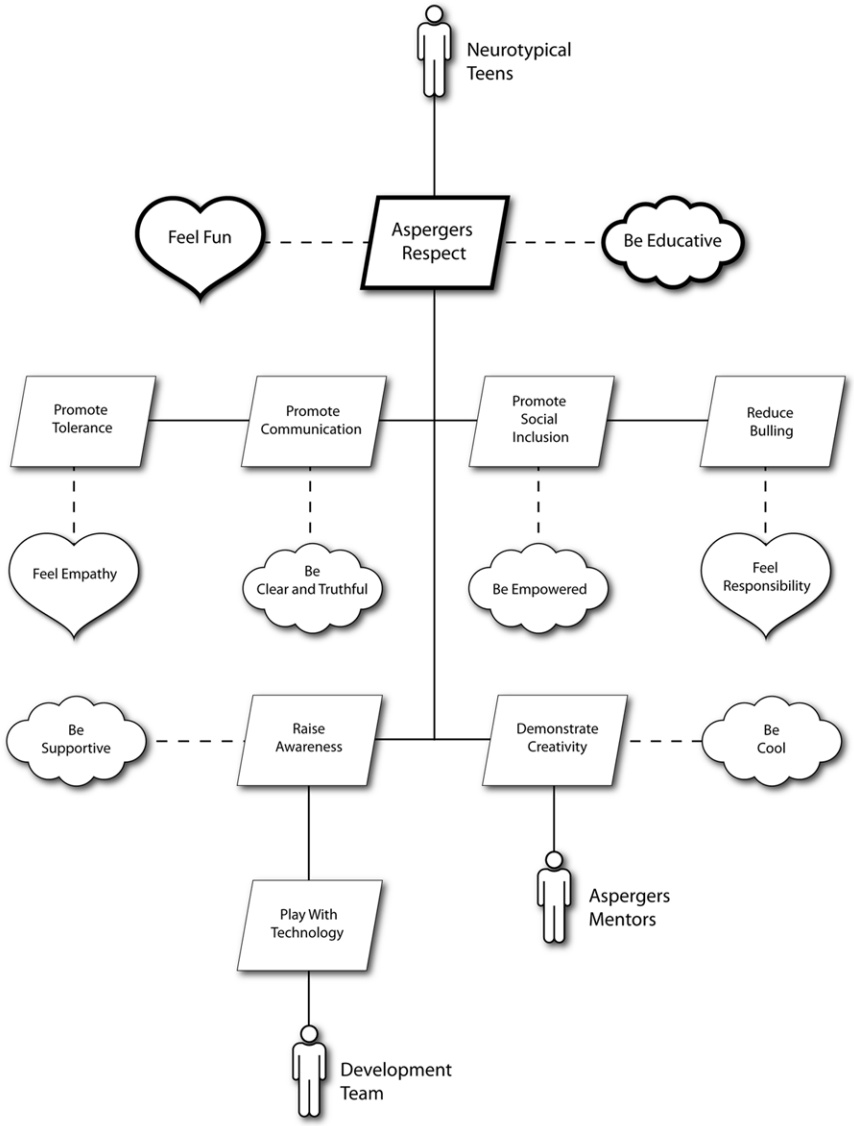
The primary target market for Aspergion was Neurotypical secondary school students. To achieve the functional goal of respect, we aimed to demonstrate that people with Aspergers could be cool and creative, through the creation of a MORPG. The game was developed in Unity 3D and has similar functions to the popular MORPG, World of Warcraft. All of the code, characters, animations, environments, attacks, spells and interface design, were develop by the digital media design students, rather than modifying an existing game. Playing the game takes approximately 40 hours to complete and the game is currently in Beta stage. A screenshot of the game can be seen in Figure 4.

Aspergion is a space adventure containing ten planets that may be explored. Each of these planets was designed and developed by a team of six students and specified by one of the ten Aspergers participants. The specification included the planets name, inhabitants, flag, environment, laws, manifesto, activities, friends and enemies, obstacles, objects, currency etc. The majority of Aspergers participants used their special interest as a foundation for the planet specification. For example the planet "Scientifica" reflects the participants interest in science, planet "AncesTree" in genealogy, planet "Cadenza" in music and planet "Dilemmacon" reflects the participant's interest in moral dilemmas. Backstories were developed for each planet such as the following:

Dilemmacon is a planet of mystery and contradiction. Once having unrivalled biodiversity, the planets energy source, known as Mana, has now been plundered. In the past, this opulent planet thrived with dramatic mountain vistas, magical flowering fields and valleys of treasure. However greed and overconsumption has resulted in a dystopia. With a lack of resources for daily survival, distrust festers on Dilemmacon and caution is advised.

Figure 4. Aspergion game play

Figure 5. Aspergion game project level agent-oriented model



Students met with the Aspergers participants and communicated via email. Each week the students would send an updated design document detailing the progress of the planet development and receive feedback from the Aspergers participants. At the conclusion of the first semester delivery of Aspergion a design document approximately 40 pages in length specified each planet.

4.2. How Agent-Oriented Models Were Used

Aspergion was developed by two separate groups of students over two semesters, each covering a different phase. In the first delivery an agent-oriented model was developed that was derived from interviews with the ten Aspergers participants to set the high-level project goals (See Figure 5). This was an early

exploration of using agent-oriented models to support digital media projects and the intention was to investigate the feasibility of incorporating emotional goals into agent-oriented models.

The agent-oriented model shown in Figure 5 was posted in the main development lab and the lecturers reinforced the goals to the student developers on a weekly basis. The model proved useful as a communication tool to ensure that all 80 students were aligned and working to achieve the primary functional, quality and emotional goals. In post interviews with the Aspergers participants it was clear that these goals had been addressed in the development process. This was also evident in self and peer assessment conducted by the students and in the context of a capstone university project it was successful. However in the first semester delivery the Aspergion game was not successful. Whilst an interesting concept the game lacked an overall narrative and purpose and was not fun to play.

The Aspergion project was delivered again the following semester and to make the game fun to play a professional games scriptwriter was employed to provide expert advice. An overarching plot was developed that included the necessary conflict and character arcs that make games engaging. The plot is to save the Aspergion galaxy from being pulled into a black hole, by bringing balance to the 'VIBE'. The planets of Aspergion are out of harmony due to their inhabitants displaying intolerance, exclusion and poor communication resulting in conflicts. The character arc enacted by solving these conflicts is to grow your avatar from being a rogue space traveller, to "Aspinaut Admiral, Grand Master in the VIBE." The game introduction script provides the backstory:

In a parallel universe much like our own the Aspergion Space Architects developed the universe's ultimate energy source. By focusing their positive emotions they harnessed the virtually infinite potential of black holes. They used this power to create new and utopian worlds. As the planets grew, three space stations were constructed to focus the collective emotions of the galaxy's inhabitants. Known as VIBE, this Virtually Infinite Behavioural Energy keeps the delicate system in balance. It requires Behavioural Tolerance, Social Inclusion and Clear Communication. The VIBE is the life force on which everything depends.

On entering the game the player finds that the 'VIBE' is critically low and the Aspergion Galaxy is on the brink of annihilation. To complete the game the player must visit all ten planets and resolve a societal conflict by demonstrating tolerance, inclusion and clear communication. As previously mentioned Asperger's Syndrome is characterised by behavioural, social and communication impairments and the goals of the game encourage the user to recognise, accommodate and tolerate these.

In the first semester delivery an agent-oriented model described the entire Aspergion sociotechnical system, including the game, documentary, social network and website. The model proved useful in focusing the student developers on the project goals. In the second semester delivery of Aspergion the use of agent-oriented models was greatly extended to facilitate a coherent narrative for the game and to model the emotional goals that we were aiming for the player to feel. Three levels of agent-oriented models were developed, a high-level project model (See Figure 5) a game level model and a planet level model (See Figure 6), with a breakdown of goals being detailed in Table 3.

The high-level project model remained similar to the first delivery model, but was updated to focus more on achieving goals related to the Aspergion game. The game level model described the overall game goals and detailed which planets had the role of achieving these goals. Thirdly, a planet level goal model (See Figure 6) described the overall conflict, the quest chains required to resolve the conflict, the

Figure 6. Planet level agent-oriented model (Planet Dilemmacon)

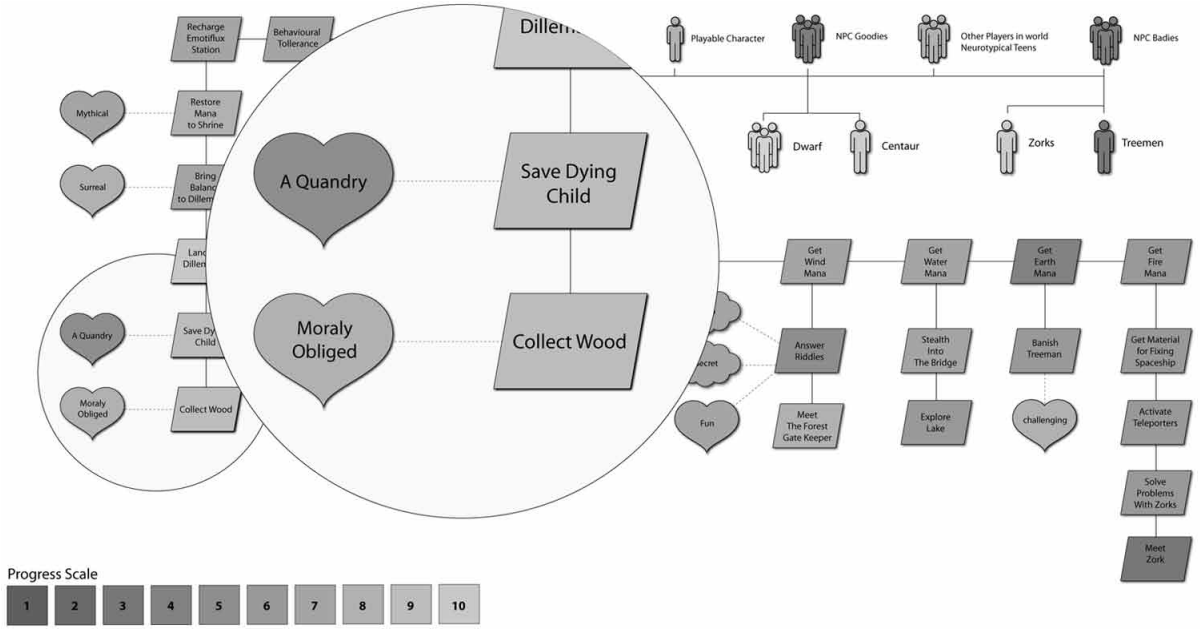


Table 3. The granularity of goals and roles across three levels of goal model

Level	Model	Roles	Functional goals	Quality goals	Emotional Goals
Level 1	Project	3	8	5	3
Level 2	Game	3	18	3	2
Level 3	Planet	219	363	115	97

characters (roles) involved and the associated emotional story and character arcs. Each level of agent-oriented model increased in complexity as illustrated in Table 3.

Emotional goals were derived from the story elements. For example, on planet Dilemmacon the overarching conflict is between the native inhabitants and an alien race that are stealing the planet's precious minerals. In working to resolve this conflict the player is exposed to a series of quest chains to complete. As the name suggests Dilemmacon is a world of moral dilemmas. When playing the game, in the first task you encounter on Dilemmacon is a mother who is nursing her sick child and requires wood for the fire to keep him warm. She cannot leave the child and fears that he will surely die that night of exposure if the fire goes out. You are asked to collect wood from the neighbouring houses, but the neighbours aren't home to grant you permission to take it. The moral dilemma is that to take the wood without permission is stealing. What should you do, is it morally correct to steal sometimes and if so when? The functional goal of this task is to "save dying child" by doing "collect wood". These functional goals are linked to the emotional goals of feeling "a quandary" and of feeling "morally obliged". The narrative elements and tasks, known as quests, were developed in collaboration with a professional game scriptwriter to create emotional arcs that supported the higher-level project goal of feeling "respect" and "responsibility".

Quests are game interactions that the player undertakes to complete a larger game objective, or mission called a quest chain. For example to complete the quest chain "Save Dying Child" the player must complete a conversation quest with the child's mother, a multi-choice question quest to resolve a moral dilemma, a search quest to collect wood and a return quest to take the wood to the child. To build emotional goals into quest chains, in addition to the environmental and character design, game patterns are used, for example battling an enemy will make the player feel *tension* and *accomplishment.*

In order to incorporate digital media design processes into the agent-oriented models, each time an emotional goal was specified it was supported with a mood board and game pattern. The emotional goals for the Dying Child quest chain were for the player to feel both "a quandary" but ultimately "morally obliged". The mood boards provided art direction for the designers by translating the emotion into a visual from. From this, the dialogue, character design, objects, environment, ambience and colour palette could be derived. By sequencing the mood boards the emotional flow was developed and refined. A similar process is used in the animation industry by companies such as Pixar, where a movie will be broken down into type of storyboard called a colour script from which the emotional arc of the movie is visible. The happy, scary, exciting and dramatic sections of the movie are evident in colour palette.

The three levels of agent-oriented models provided a common language and shared artefact between the lecturing staff and student developers and the granularity of the models allowed for sufficient detail to be expressed at different levels. For example the planet level model directly described the storyline as a series of quest chains allowing for the story and character arcs to be identified and realised.

4.4. How AOM Supported Progressive Appraisal and Evaluation

Rotating teams of approximately 20 student testers would evaluate the project goals on each project build, which occurred weekly in the last six weeks of both semester one and semester 2 project deliveries. The students would assess aspects of the game that they hadn't worked on, which usually meant playing an Aspergion planet other than the one that they were developing. Lectures also provided an expert evaluation. The evaluation involved giving each of the 614 project goals a ranking from 1 to 100, which was then translated to an absolute score out of ten and given a colour coding on the agent–oriented model. Figure 7 shows the assessment of the high-level project goals, as modelled in Figure 5, by student developers at the completion of the Aspergion project, where the rows are individual student evaluations of each goal. An average of these provides an empirical project evaluation by the students of 76.7%. It is important to note that Figure 7 only details the data for the 16 high-level goals and this process was repeated across all 614 goals on a weekly basis and updated and displayed (See Figure 8).

The majority of the testing occurred at the planet level, where the agent-oriented models described the quest chains that the player would be required to complete such as the Save Dying Child quest. The project lecturers provided a rubric of the criteria for assessing functional goals. Firstly, did the quest chain break the game? If so it received a rating from 1-10 indicating that it required critical attention. Secondly, if the functional goal (quest chain) broke but was non-critical to the game progression, it would score 11-20. Thirdly were there major errors in continuity (21-30), fourthly spelling mistakes (31-40) etc. The majority of user testing and evaluation of functional goals was bug fixing, primarily ensuring that the game didn't break. It was relatively easy to develop the rubric criteria and to rate the progress of achieving the goals from 1 - 100.

The evaluation of emotional goals was more subjective than that of functional goals. Firstly this was due to the fact that emotional goals are subjective by nature and it is difficult do develop a rubric

Figure 7. Assessment of the high-level project goals by student developers at the completion of the Aspergion project

Aspergers Respect	Fun	Educative	Promoting Communication	Promoting Tollerance	Promoting Social Inclusion	Reduce Bulling	Feel Empathy	Be Clear and Truthful	Be Empowered	Feel Responsibility	Be Supportive	Raise Awareness	Demonstrate Creativity	Be Cool	Play with Technology	Project Goals Total
85	85	80	85	80	80	80	100	80	75	80	80	75	90	85	80	82.5
70	80	65	7	60	60	50	70	80	70	80	70	60	70	70	90	65.75
70	80	80	80	70	60	60	70	90	90	80	70	65	80	75	70	74.375
70	60	70	70	60	50	40	50	50	80	80	60	90	10	80	90	63.125
80	60	60	80	75	90	60	60	70	85	80	95	90	90	60	70	75.3125
75	62	65	70	72	81	65	87	82	76	84	79	69	70	83	72	74.5
60	65	70	70	60	60	45	50	60	60	60	60	70	80	60	80	63.125
95	75	80	85	80	80	75	70	75	70	80	80	80	80	75	80	78.75
60	85	60	40	40	40	30	30	30	65	85	85	75	85	50	85	59.0625
90	75	75	90	80	90	75	90	80	85	90	80	90	90	85	90	84.6875
93	88	92	89	90	87	89	88	90	91	94	95	88	92	94	90	90.625
85	83	82	86	84	88	85	84	83	82	85	88	85	84	88	85	84.8125
82	80	80	82	80	79	78	80	80	79	80	80	79	85	85	81	80.625
50	75	50	75	75	75	75	75	75	75	75	75	75	75	75	75	71.875
85	80	85	85	50	90	80	90	70	90	75	80	85	90	85	90	81.875
80	85	80	85	85	85	80	85	85	80	80	85	85	80	85	80	82.8125
60	75	85	70	75	75	80	65	65	60	75	75	75	60	85	95	73.4375
70	80	60	80	75	90	50	50	80	40	50	70	20	20	60	80	60.9375
80	75	90	80	80	85	85	75	90	90	85	85	90	95	80	95	85
80	70	70	80	70	74	70	63	70	80	75	60	80	65	70	70	71.6875
70	80	80	70	70	70	50	50	90	90	90	80	90	90	80	90	77.5
85	85	75	60	60	60	75	85	80	60	75	75	90	90	70	90	75.9375
75	65	75	65	76	60	60	65	60	54	55	70	70	70	50	60	64.375
70	75	70	80	80	80	75	70	60	65	60	60	75	75	60	70	70.3125
35	40	35	50	35	40	35	40	35	50	70	60	35	80	60	80	48.75
90	50	10	80	80	80	90	70	60	50	20	30	80	40	10	70	56.875
40	60	45	65	40	40	50	40	60	35	60	50	40	80	60	80	52.8125
70	70	65	60	80	80	60	69	70	60	90	90	65	60	80	90	72.4375
70	75	70	90	80	85	70	80	90	90	80	80	70	85	85	90	80.625
85	86	90	88	80	90	75	76	85	81	90	90	86	88	85	90	85.3125
65	80	70	90	90	90	60	70	70	65	60	80	90	100	90	90	78.75
70	70	80	70	80	70	70	70	80	70	80	70	80	80	80	100	76.25
80	80	70	80	75	80	80	80	80	70	80	80	70	70	80	70	76.5625
85	85	85	85	80	75	85	85	85	80	80	80	85	85	85	85	83.125
70	80	70	85	85	85	80	75	70	80	85	80	75	75	77	80	78.25
90	90	80	90	100	100	100	100	90	100	100	100	80	100	100	100	95
90	90	70	80	80	70	85	80	90	90	80	70	90	80	70	80	80.9375
85	70	90	90	90	90	75	77	84	70	70	85	90	95	70	85	82.25
80	87	80	82	78	82	86	82	83	83	80	79	78	79	85	80	81.5
80	80	78	81	79	84	87	83	87	85	87	84	85	90	97	80	84.1875
80	90	99	90	85	87	87	70	99	80	99	95	90	90	99	100	90
75	80	60	75	60	60	50	80	60	50	75	80	50	90	75	100	70
80	75	90	89	80	85	90	98	100	85	100	90	85	85	100	80	88.25
75	80	70	76	74	70	76	72	69	72	79	68	73	80	72	75	73.8125
83	78	80	80	78	78	78	80	80	77	78	78	80	79	81	80	79.25
85	88	85	78	77	75	75	80	80	75	80	80	80	75	78	80	79.4375
80	85	85	85	80	85	80	85	85	85	80	85	85	85	85	85	83.75
95	85	75	90	90	95	95	95	85	70	75	85	90	95	80	90	86.875
90	90	100	100	80	90	90	100	80	80	80	90	100	90	80	90	89.375
90	80	80	85	90	75	80	80	86	85	87	85	85	90	90	95	85.1875
80	70	70	88	90	90	90	70	70	80	90	80	85	78	70	80	80.0625
76.824	**76.804**	**73.745**	**77.765**	**75.353**	**76.863**	**72.373**	**74.294**	**76.235**	**74.314**	**78.196**	**77.667**	**77.51**	**79.216**	**76.745**	**83.588**	**76.718**
8	**8**	**8**	**8**	**8**	**8**	**7**	**7**	**8**	**7**	**8**	**8**	**8**	**8**	**8**	**8**	**8**

to empirically measure goals such as fun, respect and moral obligation in a consistent way. Secondly, within the scope of the project, the vast majority of the 12-week production time was spent in development and to assess the emotional goals requires a minimum level of development for example the game must be playable, should not crash and ideally should be conducted with the target market. Thirdly the scale of the project was prohibitive. It was possible to measure whether sections of the game achieved the specified emotional goal. For example did the Save Dying Child quest chain make you feel morally obliged and how this could be improved? The higher-level emotional goals such as, was the game "fun" and did it "promote respect" for people with Asperger's Syndrome required that the game be played to

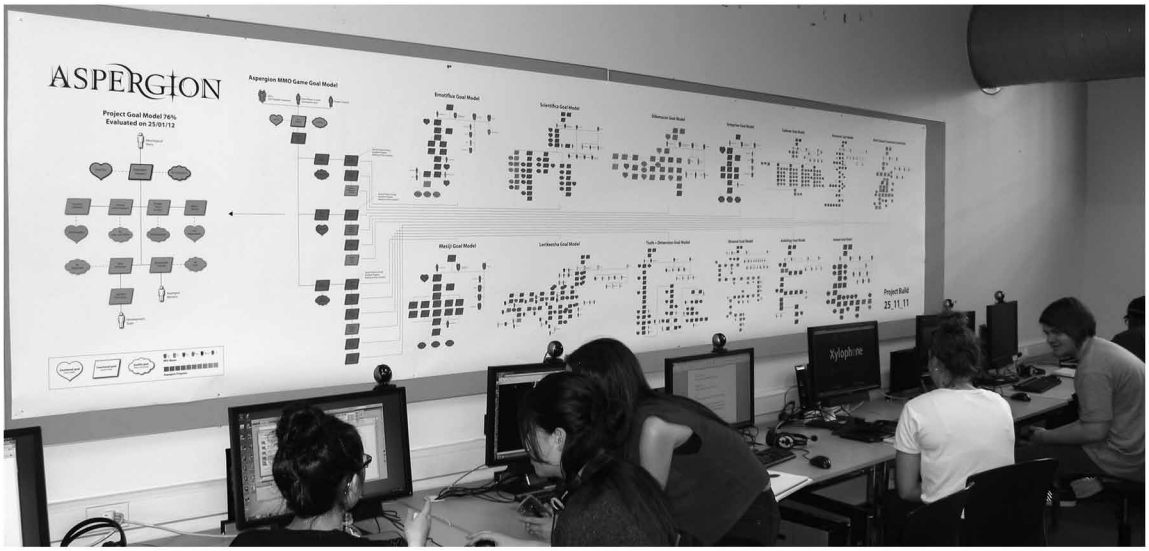
completion. This takes approximately 40 hours and requires at least 2 people, a player and a facilitator to record the player's feedback on the 614 goals being assessed.

To evaluate emotional goals student testers provided a numerical rating based on their own feeling as they played sections of the game and from this assessment valuable data was gained. Where numerous tests consistently ranked an emotional goal like "moral obligation" poorly, this provided an indication that the game section required investigation and usually further work. In addition by declaring and modelling high-level emotional goals such as "fun" "cool" and "respect" with the same hierarchy as functional and quality goals, ensured that they were continuously being considered throughout the development process.

The data collected from student and lecturer evaluation was averaged and transferred into colours on the project agent-oriented model. In this way the student developers, lecturers and other stakeholders such as financial backers could get a fast overview of the project progress. A large print of the model (See Figure 8) containing the 614 goals of the project was displayed in the main production lab and was updated after each testing phase. This also encouraged peer feedback and support where team members from successful production teams would voluntarily help the teams who were falling behind. The agent-oriented model shown describes the state of the goals at approximately three quarters of the way through the project build.

The assessment conducted gave a good overview of the overall state of the project. Whilst in the first delivery we had specified fun as a high-level emotional goal, insufficient tools, processes and focus were employed to realise the goal of fun sufficiently. Rather we relied on the tacit knowledge of students and lecturers, which is often the case in digital media design projects and can be successful in projects of a smaller scale. By expanding the use of agent-oriented models to include the planet level goals (the game play) the user interaction was evaluated at regular intervals, between 30 seconds and 5 minutes, depending on the length of the quest chain. This granularity ensured that the users didn't get bored and that the developers gave appropriate attention to the emotional goals, rather than focusing solely on the programming. Importantly the process of defining, modelling and evaluating goals and was repeatable, both in the two development phases of the project and throughout the project, game and planet level goals.

Figure 8. Agent-oriented model of the 2011 Aspergion project



The assessment detailed in Figure 7 demonstrates that from the student developer's perspective all high-level project goals were addressed, ranging from 74% to 84% completion. The consistency of results for each goal indicates that an appropriate level of attention was given to realising the functional, quality and emotional goals and shows the value of modelling them with the same hierarchy. By using a colour-coded system any of the stakeholders could rapidly see the state of the project.

5. BENEFITS FOR THE DESIGN AND AGENT COMMUNITES

Agent-oriented models used in the development of Aspergion demonstrated that emotional goals could be effectively incorporated into agent-oriented models to support the development of digital media design projects and sociotechnical systems. By providing high-level abstractions that were easily interpretable, the agent-oriented models served as a common language between student developers, lecturing staff and other stakeholders. Modelling emotional goals in addition to and with the same hierarchy as functional and quality goals provided an appropriate focus and acted as a signalling point for digital media design processes to be employed. In this way the process supports a trans-disciplinary approach to the development of sociotechnical systems that engage people by appealing to their emotional goals. By explicitly identifying emotions using creative design processes, and incorporating them into agent-oriented models that were available throughout the design, development and evaluation phases of the large cross-discipline team project, we went a long way to achieving our objectives.

An important development step of Aspergion was that the game was conceptualised by people with Asperger's Syndrome, each designing a planet to be included in the game. Having asked the participants to specify planet designs, agent-oriented models were created to clearly communicate the planet goals, inhabitants, character arcs and overall narrative. In the second delivery of the project three levels of agent-oriented models were developed to communicate goals at the project level, the MORPG game level and the planet level. This significantly contributed to the development and evaluation of the project, which in past digital media projects had been tacit.

The colour-coded evaluation system that was developed ensured that all stakeholders could get an instant snapshot of the projects progress and served as a form of acceptance testing. Over 600 project goals were defined, modelled and progressive evaluated. The process was repeated to support the realisation of high-level project goals, game level goals and more granular planet level (narrative) goals. This approach of using emotional goals to model narrative introduces a new method for incorporating emotional goals into agent-oriented models. 614 project goals, 102 of which were emotional goals, were being evaluated on a weekly basis by teams of student user testers. Explicitly modelling emotional goals ensured a coherent narrative and also signalled when design processes should be employed to support the development.

The process described in this paper of incorporating emotional goals into agent-oriented models and using a colour scale to evaluate project progress, has become a standard in the design process taught in the Digital Media Design Program at Swinburne University of Technology. The process has been repeated in over 120 projects, each representing approximately 150 hours of development time. In these projects agent-oriented models that include emotional goals have been applied to the development of software, computer games, websites and animations, with projects ranging in scale from 1 to over 160 developers and at academic levels including 3rd year, Honours, Masters, Doctoral and Post Doctoral.

Further research in this area would involve developing a rigorous method of categorising and evaluating emotional goals and using the process detailed in this paper to investigate whether agent-oriented models may be used to describe how game patterns elicit emotional goals.

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Chapter 35
The Use of Eye Tracking as a Research and Instructional Tool in Multimedia Learning

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ABSTRACT

The present chapter summarizes the state of the art of using eye tracking in research on multimedia learning. It first provides an overview the various eye tracking parameters that have been used in this field before describing its various functions as a research tool. As a research tool eye tracking serves to test and refine assumptions regarding the process of learning with multimedia, explain the origin of individual differences in learning outcomes, gives insight into the effects of instructional interventions at a process level, and enriches other forms of assessment. In addition, more recently eye tracking has also been used to develop materials aimed at supporting multimedia learning. Thus, it also serves as an instructional tool when it used to design adaptive instruction or to model cognitive processes relevant to multimedia learning. The chapter concludes with a description of some of the challenges in using eye tracking in multimedia research.

INTRODUCTION

Learning from multimedia has become one of the major areas of research in learning and instruction especially since digital technology is increasingly used in education, thereby allowing not only static instructional materials, but also dynamic formats. Despite the fact that many people think of multimedia involving the use of advanced digital technology, its definition in research is far more traditional. Here the term multimedia refers to any combination of words (spoken or written) and pictures (e.g., photographs, diagrams, videos, animation). More generally speaking, multimedia environments are multirepresen-

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tational systems (Ainsworth, 1999) where different representational formats are combined in a way to best convey an instructional message.

The case for multimedia is made by comparing it to monomedia formats, mostly to text-only instruction. There is abundant empirical evidence showing that multimedia yields better learning than text (Mayer, 2014a). This multimedia effect is dependent on a variety of conditions: In particular, pictures that serve to augment the text should be relevant to the learning objective and not only serve decorative purposes. Moreover, the materials should be designed in a way that they enable and facilitate certain cognitive processes that have been determined as essential for effective multimedia learning by respective theories in this research area. Accordingly, the majority of current multimedia research is focused on identifying possible boundary conditions for the multimedia effect and the cognitive processes underlying multimedia learning. This is where eye tracking comes into play (cf. Scheiter & Van Gog, 2009; Van Gog & Scheiter, 2010). For instance, as will be discussed later in more detail, eye tracking research has shown that successful learning from multimedia requires that learners will pay sufficient attention to pictures rather than predominantly reading the text and that they will make connections between both representations (e.g., Hannus & Hyönä, 1999; Hegarty & Just, 1993; cf. Renkl & Scheiter, in press, for a review on further boundary conditions).

According to cognitive theories of multimedia learning such as the Cognitive Theory of Multimedia Learning by Mayer (CTML; Mayer, 2014b) or the Integrated Model of Text and Picture Processing by Schnotz (ITPC; Schnotz, 2014), a set of distinct cognitive processes contributes to the construction of a mental model and thus learning from multimedia. Both theories agree upon the fact that learners first need to identify and attend to relevant information contained in both the text and the picture and select it for further processing. Once the relevant information is selected, it needs to be organized in memory into coherent, mode-specific mental representations. Finally, information from both representational formats are then related to each other with the help of prior knowledge and integrated into one mental coherent mental model. This mental model composed of verbal and pictorial information is seen as the major reason for why learning from text and pictures is more effective than learning from text only.

The objective of the present chapter is to illustrate how eye tracking can serve as a valuable tool to study and potentially also to support the aforementioned cognitive processes of selection, organization, and integration while learning from multimedia. In the following, we will first discuss which eye tracking parameters are typically used in multimedia studies and how they relate to the theoretical assumptions outlined above. Second, we will review studies in which eye tracking was used as a research tool to study cognitive processes underlying learning with multimedia, before turning our attention to more advanced uses of eye tracking for designing instruction in the third section. The fourth section deals with the various methodological challenges of using eye tracking in multimedia research before concluding with some suggestions for future research.

EYE TRACKING PARAMETERS USED IN MULTIMEDIA LEARNING STUDIES

When describing a person's gaze behavior, two major event categories can be distinguished, namely, fixations and saccades. During a fixation, the eyes remain relatively still, thereby allowing intake of information from the part of the stimulus that is being attended. On average, fixations last between 200 and 300 milliseconds. Their duration is affected by a number of factors such as the type of activity performed

(e.g., silent reading: 225 ms vs. scene perception: 330 ms), a person's interest, or the complexity of the materials, with longer fixations signaling higher interest and complexity, respectively (e.g., Rayner, 2009). In order to comprehensively process a stimulus, multiple fixations are required. This is the case because the area in which we see with high acuity is very limited; acuity degrades rather quickly the further away from this foveal region a visual element is placed (i.e., the more it is placed in the periphery). The high-velocity movements between multiple fixations are called saccades. During saccades information intake is suppressed. Together, fixations and saccades make up a scanpath, which provides a trace of how a person processes a text or a picture on a moment-to-moment basis (cf. Holmqvist et al., 2011 for a more detailed description of the basic characteristics of eye movements).

The use of eye tracking in multimedia research is to a large extent inspired by its use in reading research (cf. for an overview Rayner, 2009), which is likely due to the fact that multimedia is often conceptualized as an augmentation of (written) text with pictures. In reading and likewise in multimedia research, eye tracking is seen as providing insights into the moment-to-moment processes that occur during comprehending an external stimulus such as expository text or text-picture combinations (Rayner, Chace, Slattery, & Ashby, 2006). This interpretation is nourished by the eye-mind assumption (Just & Carpenter, 1980). That is, eye tracking parameters are not only used to make statements about students' distribution of visual attention or their perceptual processing (Mayer, 2010); rather, they are seen as evidence for when, how long, and in which order externally presented information is processed at the cognitive level, that is, in the person's mind. This link between visual attention and cognitive processing occurs without delay, so that once information is perceived it is also immediately processed at the cognitive level (immediacy assumption).

There are a variety of measures that can be derived from eye tracking and linked to cognitive processes. In reading research, it is typical to distinguish between first-pass and second-pass indicators since these are linked to different cognitive processes (Hyönä, Lorch, & Rinck, 2003; Hyönä & Nurminen, 2006). First-pass indicators describe processes that occur when first encountering a target area (i.e., area of interest, AOI) until leaving it. They are often linked to basic attentional phenomena such as differences in salience in visual stimuli or reflect basic reading processes. On the other hand, second-pass indicators refer to revisits of AOIs. They are linked to more intentional processes such as attempts to resolve comprehension problems and to integrate information across target areas. Only very few studies in the field of multimedia learning distinguish between first-pass and second-pass indicators; rather, they use aggregated values irrespective of when they occurred. The studies by Lucia Mason reviewed later in this chapter build a notable exception in this regard.

From a theoretical perspective, it is useful to subdivide eye tracking applications in multimedia learning studies into two major categories, which are also associated with different eye movement indicators: First, eye tracking is used to study selection and organization processes during learning, and second it serves to investigate the integration of text and pictures. To this end, those parts of a multimedia message that are seen as relevant to answer a research question are defined as AOIs for which parameters such as the fixation time or the number of fixations are determined. AOIs may range from a very coarse level (i.e., the text or picture as a whole) to a very-fine grained level (e.g., a word that corresponds to a visual detail shown in the picture).

In studies with a focus on selection and organization processes, eye tracking serves to determine when parts of the multimedia message are first detected and for how long they are attended during the course of learning. To determine how long it takes a person to attend to some part of the multimedia

message, the time it takes for the first fixation to land on that region (time to first fixation) or the number of fixations that occurred before the AOI was attended can be used as indicators. They may tell researchers something about the amount of visual search that was required to identify the AOI (e.g., De Koning, Tabbers, Rikers, & Paas, 2010; Ozcelik, Arslan-Ari & Cagiltay, 2009; Scheiter & Eitel, 2015), the salience of the element in question, or its relevance from the perspective of the learner – with earlier attention being an indicator of less visual search as well as higher salience and relevance, respectively.

To determine the amount of attention devoted to a certain AOI, both, the overall number of fixations and total fixation time can be used as indicators. Higher values are seen as indicating more intense processing with the reasons underlying this being manifold. That is, learners may decide to process a certain part of the stimuli for longer, because it appears more interesting or relevant to them in the context of the learning task, or because they find this part more difficult to understand than others. In order to disambiguate the first two reasons from the last one it may be worthwhile to further relate the number of fixations and total fixation time to each other. Mean fixation duration (i.e., total fixation time divided by the number of fixations) is often seen as an indicator for students' processing difficulties at least when reading text (e.g., Rayner, 2009).

In addition, eye tracking is frequently used in multimedia research to study the process of integrating text and pictures. To this end, look-froms and the number of saccades between text and pictures (i.e., text-picture transitions) have been used. Look-froms are indicators related to second-pass processing (Mason, Pluchino, & Tornatora, 2013; 2015). They describe the duration (fixation times) for re-reading text while re-inspecting the picture (i.e., look-froms picture to text) and vice versa (i.e., look-froms text to picture: re-inspection of the picture while re-reading the text). Text-picture transitions can be obtained at a global level by counting the number of times a person moved his/her eyes between any location within the text to any location within the picture. Moreover, researchers have investigated whether these transitions reflect an accurate understanding of the relations between text and pictures by counting only the number of transitions between corresponding (i.e., semantically related) text-picture elements (e.g., Johnson & Mayer, 2012).

So far, multimedia research has mostly used aggregate measures such as total fixation times or overall number of saccades. These measures can be assessed and analyzed relatively easy; however, they provide rather little insight into the temporal dynamics of processing illustrated text (Hyönä, 2010). There have been only very few studies that have deployed measures reflecting the time course of processing such as scanpath analysis. For instance, Jarodzka, Scheiter, Gerjets, and Van Gog (2010) determined Levinshtein's distance to determine the similarity among scanpaths both within and across different expertise levels of participants. To do so, each individual scanpath is represented as a string of events (i.e., fixations on different AOIs); typically, individuals will differ in whether certain events occur (e.g., whether an AOI has been attended at all), in the order of events, and in the number of events making up a scanpath. Levinshtein's distance reflects how many transformations, that is, deletions and insertions of events, are needed to convert one scanpath into another. Skuballa, Fortunski, and Renkl (2015) used Levinsthein's distance to test whether a pre-training that was assumed to direct students' attention while learning from a visual display would lead to a more homogenous gaze behavior compared with a no-training control group, but they found no such effects.

Similarly, time-locked analyses are rarely used. In time-locked analyses, eye tracking data are studied relative to the onset of some event such as the appearance of an object in an animation or the highlighting of information when using signals or cues in multimedia presentations (Hyönä, 2010).

EYE TRACKING AS A RESEARCH TOOL

As a research tool in multimedia learning, eye tracking can serve various functions with respect to studying the attentional and cognitive processes taking place. In particular, it may serve to test and refine certain assumptions regarding the processing of multimedia materials, explain why there is individual variability in learning outcomes, explain how instructional interventions work, and enrich other forms of assessments.

Testing and Refining Processing Assumptions

Cognitive theories of multimedia learning suggest that students conduct multiple steps when learning with illustrated text that range from constructing locally coherent mental representations involving the processing of a limited number of text and picture elements to establishing a globally coherent mental model of all relevant elements. Hegarty and Just (1993) provided first evidence favoring this assumption in their seminal study on how learners comprehend the functioning of a pulley system. Their students received a text describing how a pulley system works together with a corresponding picture of a pulley system and their eye movements were recorded. The results showed that learners proceeded in an incremental fashion and alternated between text and pictures when constructing a mental model in a highly interleaved fashion. That is, they read the text, upon reaching the end of a semantic unit (typically composed of 1-2 sentences) moved their eyes to the picture to investigate the part of the picture corresponding to that unit, and then continued reading the text. The fact that learners interrupted their reading to inspect the picture was interpreted as first evidence that learners mentally integrate information from both external representations rather than constructing two separate mental representations. This process appears to be largely guided by the text in that learners search the diagram for information corresponding to the text that they just read.

Since then, a number of eye tracking studies have confirmed that integrative processing of text and pictures is highly predictive for learning (e.g., Hannus & Hyönä, 1999; Mason, Pluchino, & Tornatora, 2013, 2015; O'Keefe, Letourneau, Homer, Schwartz, & Plass, 2014), thereby confirming one of the major assumptions of theories of multimedia learning, namely, that integration is pivotal to mental model construction. For instance, O'Keefe et al. (2014) studied learners' eye movements while they learnt about the Ideal Gas Laws with a multimedia simulation composed of multiple representations (i.e., a container filled with gas particles, sliders to control temperature, pressure, and the container's volume, a graph showing the relationship between two variables). Students who made more transitions between the control sliders and the graph and between the gas container and the graph scored better in a comprehension and transfer test, respectively (after controlling for pre-test scores). On the other hand, neither the number of fixations nor overall fixation time on any of the representations was related to learning outcomes. Thus, it is not the mere intensity of selecting and organizing information from each representation, but their integration that is related to better understanding during multimedia learning.

Not only does eye tracking confirm already existing theoretical assumptions, it also allows refining these assumptions. For instance, cognitive theories of multimedia learning assume that at least to some extent text and pictures are first processed independently from each other before being integrated. However, recent research has shown that integration of pictorial information with text occurs already very early during learning with multimedia, that is, after pictorial information has been studied for a short time only. Eitel and colleagues (Eitel, Scheiter, & Schüler, 2013; Eitel, Scheiter, Schüler, Nyström, &

Holmqvist, 2013) have suggested that a quick glance towards a picture will already allow extracting its global spatial structure, which in turn serves as a mental scaffold for further processing. This mental scaffold is reactivated during text processing and facilitates mental model construction from the text, thereby yielding a coherent mental model from both information sources. This assumption was tested regarding learning outcomes as well as via eye tracking data from students who saw a blank screen while listening to spoken text explaining the structure and functioning of a pulley system. Some students just received a blank screen while listening to the spoken text whereas others were exposed to a picture of the pulley system for a short time (600ms, 2s) before this. The spoken text described the spatial structure of the pulley system; however, it did not mention that the three pulleys were oriented diagonally from bottom-left to top-right (i.e., global spatial structure). This information could be extracted only from the picture. Students in the conditions with brief initial picture presentation (for 600ms, 2s) had better comprehension scores and made more eye movements in line with the pulley system's diagonal orientation of the pulleys than students in the condition without the picture. This indicates that students reactivated the global spatial structure constructed from briefly processing the picture while subsequently processing text about the system, hence suggesting early integration. The (early) integration of pictorial information with text facilitated the construction of a mental model as reflected in better comprehension.

Finally, eye tracking can reveal aspects of learning from multimedia that so far have not yet been addressed by the respective theories. For instance, cognitive theories of multimedia learning leave open the question whether text and pictures are given equal attention or whether one representation is favored over the other. However, eye tracking studies suggest that learners will often attend predominantly to the text at the expense of sufficient processing of the picture (Hegarty & Just, 1993; Rayner, Rotello, Stewart, Keir, & Duffy, 2001; Schmidt-Weigand, Kohnert, & Glowalla, 2010), which can explain why in some cases no multimedia effect occurs.

Explaining Individual Differences in Learning Outcomes

Eye tracking can provide explanations for why students differ in their learning outcomes. There are at least two types of studies addressing this question: One group of studies looks at the relationship between learner characteristics that can be considered relevant for multimedia learning and gaze parameters recorded during learning. The idea underlying these studies is that variability in learner characteristics will be associated with variability in gaze parameters, with the causal direction, however, being unclear. For instance, a low level of prior knowledge may cause inadequate online processing of text and pictures; however, it may also be the case that students' inadequate processing during past learning episodes may have caused them to acquire little prior knowledge. Another group of studies takes the interindividual variability of students' eye movement behavior as a starting point and seeks to identify groups of learners showing similar behavior (e.g., by applying multivariate statistical methods such as cluster analysis). Then it is tested whether the group membership, which reflects a certain pattern of eye movement behavior, can predict learning outcomes. What is interesting about this approach is that multiple eye tracking parameters are analyzed simultaneously rather than looking at the relationship between single eye tracking parameters and learning outcomes in isolation. It might well be that when analyzed in isolation, single parameters are unrelated to learning outcomes suggesting that these parameters are irrelevant for better learning. However, in the multivariate approach patterns composed of a specific configuration of multiple parameters (e.g., long fixation *and* early attention towards pictures) can be identified as being relevant for learning.

Prior knowledge and cognitive abilities have been shown to be linked to eye movements in a number of studies: Mason, Pluchino, and Tornatora (2013) found that prior knowledge was positively related to both, the number of integrative transitions and the look-from text-to-picture fixation time, which in turn were indicative for better learning outcomes. Hannus and Hyönä (1999) studied how 10-year old elementary school children processed illustrated passages from a biology textbook. Prior to learning, students were tested for their cognitive ability and divided into high and low ability groups. High ability students had better learning outcomes than low ability students; moreover, the prior paid more attention processing pertinent information in text and pictures and showed more transitions between the two. Ozcelik et al. (2010) showed that longer mean fixation durations on highlighted information elements in a multimedia message were related to lower prior knowledge and lower transfer performance. Moreover, there a number of studies on expertise differences suggesting that more expert persons are more likely to attend to relevant information (Canham & Hegarty, 2010; Haider & Frensch, 2001; Jarodzka et al., 2010). On the other hand, visual attention of persons with less expertise is often drawn towards salient, but irrelevant information (Lowe, 2003). Madsen, Larson, Loschky, and Rebello (2012) showed that students who were able to correctly solve a number of physics problems consisting of text and graphics attended longer to areas of the problem display that were thematically relevant to its solution than did those students who did not solve the problems. What is particularly interesting about the study by Madsen et al. (2012) is that they showed that at least in the case of solving physics problems it is not so much saliency that guides unsuccessful problem solvers' attention; rather, they attend to information that aligns with novicelike misconceptions, which explains their failure in solving the problems.

Nevertheless, there are also studies showing no relationship between prior knowledge and students' gaze behavior: For instance, O'Keefe et al. (2014) found no correlation between prior knowledge and the frequency of transitions between multiple representations in a chemistry simulation, with the latter, however, being related to better comprehension and transfer performance. Moreover, the results by Schwonke, Berthold, and Renkl (2009) suggest that the relationship between prior knowledge, gaze behavior, and learning outcomes may be more complicated than suggested by the previous studies. In their study on learning probability calculations in a multirepresentational environment, attention to diagrams was positively correlated to learning outcomes for high prior knowledge students, whereas there was a negative relationship for low prior knowledge students. Thus, the interpretation of a certain eye movement behavior as helpful or harmful for learning may change when prior knowledge increases or decreases.

Mason, Tornatora, and Pluchino (2015) studied the eye movements of 7th graders in a multimedia lesson on the food chain. They ran cluster analyses using first-pass and second-pass parameters, respectively, as input variables. Two clusters emerged: With respect to first-pass processing, one group of students showed longer text fixation times than the other; there were no further differences among the two groups. With regard to second-pass processing, the groups differed in their integrative processing of text and pictures. That is, one group showed more transitions between corresponding text and picture elements and vice versa as well as longer look-froms from text to pictures and vice versa than the other group. These differences in integrative processing predicted better verbal and pictorial recall, as well as transfer performance, whereas differences in first-pass processing were unrelated to learning outcomes. Students' integrative processing was predictive for learning outcomes beyond individual differences such as their reading comprehension, prior knowledge, and academic self-concept in science. This study replicates findings from an earlier study of the same research group (Mason, Pluchino, & Tornatora, 2013). In this study 4th graders were presented with a single slide explaining the concept of air using text and a picture. A cluster analysis was run using first- and second-pass processing indicators. It revealed

three clusters of learners different in the intensity of their integrative processing: low, intermediate, and high integrators. High integrators outperformed low integrators with regard to answering factual knowledge and transfer questions, suggesting that individual variation in eye movement behavior can explain individual variation in learning outcomes.

Explaining How Instructional Interventions Work

Eye tracking allows testing assumptions on how instructional design manipulations cause better learning by altering the way students will process the materials. Various instructional design measures have been investigated using eye tracking.

One way to improve the design of multimedia material is to highlight correspondences between text and pictures by means of signals or cues to facilitate text-picture integration. Signaling has been shown to yield better learning rather consistently and is associated with a small to medium effect for measures of deeper learning (see Richter, Scheiter, & Eitel, 2016 for a meta-analysis). The signaling effect is typically traced back by referring to two, non-exclusive explanations: First, signals reduce visual search for corresponding text-picture elements, thereby rendering the processing of multimedia materials more efficient by speeding up the selection of relevant information. Second, signals provide visual guidance towards relevant information so that learners will spend more time processing this information, possibly allowing for improved organization of information. As a consequence of both explanations, learners should be better able to integrate information from text and pictures. There are several eye tracking studies that have investigated the effects of signaling in closer detail by testing one or both of these explanations.

Ozcelik, Karakus, Kursun, and Cagiltay (2009) compared an unsignaled multimedia lesson on the nervous system composed of written text and a labeled picture to a version, in which terminology from the text and the corresponding labels in the picture were shown in the same color. As expected, color coding led to better transfer performance. Moreover, students in the color coding condition took less time fixating the corresponding label in the picture after having read about it in the text, suggesting that visual search demands were reduced due to color coding. Also, color coding yielded longer mean fixation durations for text and pictures, which were positively related to transfer performance. However, color coding did not cause an increase in total fixation times for highlighted terms. The latter finding may, however, be explained by the fact that spending additional time on a single word after it has served to identify a text-picture correspondence does have little functional relevance as compared with, for instance, processing the corresponding pictorial element. The latter interpretation is corroborated by the fact that visual search was negatively correlated with transfer performance, while there was no correlation between total fixation time and transfer performance. Thus, identifying correspondences between text and pictures quickly apparently facilitates integration and, as a consequence, supports comprehension, but further processing of corresponding labels does not yield better learning.

Ozcelik et al. (2010) compared an unsignaled multimedia lesson explaining the functioning of a turbofan jet engine using narration and a labeled static picture with a signaled variant, in which labels changed their color upon being mentioned in the narration. Students in a signaled group performed better in a transfer test than those learning without signals. Moreover, signals led to more frequent fixations and longer fixation times on relevant labels and picture elements as well as to a more efficient visual search. The latter was measured as the proportion of labels attended while listening to the corresponding narration as well as the time between mentioning a relevant item and attending it. Results furthermore showed

that longer search times were related to worse retention of the multimedia content, while longer mean fixation durations were associated with lower transfer performance (cf. Jamet, 2014, for a similar study).

Similarly, Mason, Pluchino, and Tornatora (2013) studied the effects of improving multimedia instruction by means of introducing labels into a diagram accompanying a science text. Labels improved transfer performance; moreover, students in the labeling condition spent more time refixating the text while reinspecting the illustration. These look-forms can be interpreted as an indication of integrative processing and were correlated with better transfer performance.

Taken together, these studies consistently show that signaling improves learning and changes visual attention processes, with the two aspects being correlated with each other. However, even though these two effects co-occur, it is still not clear from these studies whether changes in visual attention can explain the positive effect that signaling has on learning outcomes. To address this limitation, Scheiter and Eitel (2015) deployed mediation analyses to test whether the relationship among signaling, visual attention, and learning outcomes can be interpreted this way. In their study, students learnt either with unsignaled multimedia materials explaining how the heart works or with a signaled version using a variety of signals (e.g., deixis, labels, color coding) to highlight text-picture correspondences. Across two experiments, mediation analyses revealed that attending earlier towards relevant (highlighted) pictorial information and more frequently fully explained the positive effects that signals had on comprehension.

Johnson and Mayer (2012) studied the effects of another way of supporting integration of text and pictures, namely, the physical integration of text into the picture. According to the spatial contiguity principle, physical integration of text into the picture reduces the need to search for corresponding text-picture elements; moreover, the fact the text is segmented into smaller, meaningful units highlights its semantic structure. Accordingly, it has been shown to yield better learning rather consistently (for a meta-analysis see Ginns, 2006). Johnson and Mayer (2012) used eye tracking to test three alternative explanations for the spatial contiguity effect: First, when text is physically integrated into the picture, learners might be more inclined to attempt to integrate both representations, which should be visible in a higher number of transitions from text to diagram (integrative transitions). Second, physical integration might provide guidance for successfully identifying text-picture correspondences as reflected in a higher number of transitions between corresponding text and picture elements (corresponding transitions). Finally, it might guide learners' attention towards the graphic more generally, thereby increasing the proportion of time spent processing the diagram. In two out of three experiments students showed better transfer after having learnt with an integrated illustrated text; moreover, across all three experiments students had more integrative and/or more corresponding transitions, but did not show increased attention towards the diagram. It was concluded from the occurrence of differences in transfer performance and in integrative processing that the latter must be the reason for the former, but no mediation analyses were conducted.

Both, signaling and spatial contiguity, are based on simultaneously manipulating the layout of text and pictures. Thus, they improve text-picture integration by communicating meta-information to learners regarding the correspondences between the two representations. Mason, Pluchino, Tornatora, and Ariasi (2014) showed that also changes regarding the concreteness of the pictorial representation affect text-picture integration. In their study, they varied the instructional format by giving learners text only or text augmented with either an abstract or concrete visualization. The eye tracking data showed that students learning from text and abstract visualization processed the text more efficiently and made more frequent attempts to integrate the text with the picture.

Finally, also verbal instructions that commit students to the use of specific multimedia learning strategies during studying text and pictures can improve learning outcomes via supporting integrative processing. Stalbovs, Scheiter, and Gerjets (2015) used implementation intentions to improve students' processing of text and pictures. Implementation intentions are if-then plans that link an action aimed at reaching a specific goal to a favorable opportunity to perform this action; they have been shown to be a highly effective means to support goal accomplishment (Gollwitzer & Sheeran, 2006). Stalbovs et al. (2015) applied implementations intentions to foster different multimedia learning strategies (e.g., "If I have finished reading a paragraph, then I will search for corresponding information in the picture"). Multiple implementation intentions that addressed text processing, picture processing, and the integration of text and pictures led to a higher number of transitions between text and pictures, which in turn was linked to improved learning outcomes.

Enriching Other Forms of Assessment

Eye tracking can serve to enrich and improve other types of assessments regarding learning processes. For instance, eye tracking can be used to complement verbal reports and triangulated with students' introspections in order to arrive at a more meaningful interpretation of the data than what can be achieved by using only one process assessment in isolation. In particular, eye tracking provides objective information on whether a certain piece of information was attended or not, whereas verbal reports leave it open whether some information was not processed or whether the person simply forgot to mention this information in her/his report. On the other hand, eye tracking does not allow for any conclusions regarding why a person attended to a piece of information, which is, however, an insight that may be derived from a verbal report. What has to be kept in mind though is that there may be technical barriers when assessing eye tracking and verbal reports concurrently. In particular, letting people talk while recording their eye movements will inevitably lead to head movements that will reduce the accuracy of the eye tracking data. To circumvent this problem, eye tracking can be combined with retrospective verbal reports, which are assessed once a person has finished learning. Unfortunately, retrospective reports are more error-prone than concurrent reports (Brinkman, 1993) in that learners may be unable to retrieve memories regarding their learning behavior from long-term memory, fabricate reasons for their behavior, or make statements to comply with the experimental situation (e.g., by taking into account alleged expectations of the experimenter; cf. Van Gog, Paas, van Merriënboer, & Witte, 2005).

To improve the validity of retrospective verbal reports, Van Gog et al. (2005) have suggested using cued retrospective reporting as a technique. In cued retrospective reporting, gaze replays of students recorded during learning or problem solving are shown to students afterwards and they are asked to comment on their gaze behavior. Thus, the gaze replays act as cues that remind the students of the learning task and the behavior that they actually displayed during learning, making it more likely that the verbal reports are a true reflection of what students did. Jarodzka et al. (2010) used cued retrospective reporting to investigate expertise differences. The data from the eye tracking and the cued retrospective reporting provided converging evidence for expertise-dependent differences regarding the way the participants approached the task: Experts mentioned task-relevant information more often during their initial utterances than did novices; similar, their visual attention was more often focused on this information. In addition, the cued retrospective reports for the entire task duration showed that the experts remained focused on processing and interpreting task-relevant information, even though their visual attention was also drawn to less relevant aspects of the visual display.

To summarize, the use of eye tracking as a research tool has become quite popular in the field of learning and instruction and more and more researchers use it to complement their research in one (or more) of the aforementioned functions. In addition, there is a growing interest in using eye tracking to not just study, but to design instruction that aims at improving multimedia learning. Importantly, research that is based on the idea of using eye tracking as an instructional tool is still in its infancy; nevertheless, there have been first promising results that justify its review in the present chapter.

EYE TRACKING AS AN INSTRUCTIONAL TOOL

Research in which eye tracking is used to design interventions whose goal it is to improve multimedia learning is also conducted against the backdrop of the cognitive theories of multimedia learning introduced earlier. These theories serve to state which cognitive processes, namely, selection, organization, and integration of information from text and pictures, should be addressed in an intervention. Furthermore, self-regulated learning theories are used to reason why learners will often fail to learn if not guided, namely, because they will not adequately monitor and regulate their learning process, which in turn will lead to an insufficient use of effective cognitive (multimedia learning) processes (cf. Nelson & Narens, 1990). Finally, intervention studies that model effective processing of multimedia materials using eye tracking often refer to socio-cognitive learning theory (Bandura, 1977) to argue why observing another learner's processing behavior (i.e., his or her eye movements) should improve one's own learning. In the following, we will refer to two types of innovative interventions, both of which have only recently been introduced in the literature.

Designing Adaptive Instruction

Eye tracking can serve to assess and evaluate students' learning processes online and provide instruction that is adapted to their behavior. In a recent study by Leber and others (Leber, Skuballa, & Renkl, 2014) eye tracking was used to identify a potentially dysfunctional processing of text and pictures (e.g., insufficient reading of text), in which case the system provided rapid assessments of the knowledge that could have been acquired had the information in question been processed adequately. If the assessment item was answered incorrectly, prompts asked the student to restudy the information in question. Findings showed that an adaptive assessment was better able to identify students' knowledge gaps compared with a non-adaptive assessment and that prompts that had been generated based on the assessment improved learning.

In our own lab, we currently evaluate an adaptive multimedia system that analyzes learners' gaze behavior in real time and offers individual instructional support tailored towards students' processing (i.e., contingent to the learners' gaze behavior; Wassermann, Hardt, & Zimmermann, 2012). In a first experiment, it was determined how successful and less successful learners differed in their viewing behavior in a non-adaptive multimedia learning session on mitosis. Based on these findings, it was decided when and how the adaptive system should support learners when learning with this material. To this end, specific threshold values were defined for several eye-tracking parameters (e.g., minimum picture processing times) that were linked to different forms of adaptation of the material (e.g., enforced restudy of the pictures). For instance, if the system noted that the learner performed too few transitions when studying text and pictures, a color-coded version of the same material was presented to foster more

integrative processing. Unfortunately, a first evaluation of the adaptive system revealed no improvements in learning outcomes when compared with a non-adaptive system, suggesting that the adaptation rules implemented so far require further optimization.

Modeling Cognitive Processes

If a certain eye movement behavior is related to better learning, it might actually be helpful for learners to be able to observe this behavior prior to studying instructional materials in order to internalize it and then apply it during learning. This is the basic idea underlying eye-movement pre-trainings and Eye Movement Modeling Examples (EMME) described in the following.

Skuballa et al. (2015) used eye movements as a pre-training to improve subsequent learning from narration combined with a static visual display explaining how a solar plant works. Students in the pre-training condition watched an animated circle moving on a blank screen before learning from the multimedia instruction. The movement of the circle reflected the order by which students were expected to later attend to the different components of the solar plant. Students were instructed to follow the moving circle with their eyes. The control group started learning with the multimedia instruction without receiving pre-training. The results showed that students in the pre-training group better understood the processes and functions underlying the way a solar plant works. Interestingly, the pre-training had no effect on students' gaze behavior during studying the multimedia instruction.

EMME consist of videos showing the gaze behavior of a skilled learner, who carefully studies text and pictures. These EMME are used as processing instruction for learners to illustrate how they should study multimedia materials to learn more effectively from them, thereby serving as strategy models (Jarodzka et al., 2012; Jarodzka, van Gog, Dorr, Scheiter, & Gerjets, 2013; Mason, Pluchino, & Tornatora, 2015). In EMME aimed at supporting multimedia learning, the eye movements of a skilled (instructed) learner, that is, his/her fixations occurring from reading text, inspecting the picture, and saccades illustrating how s/he moves back and forth between these two activities, are superimposed onto a multimedia training stimulus, resulting in a video of the model's learning behavior. Against the backdrop of the socio-cognitive theory of learning (Bandura, 1977), learners watching this video are assumed to internalize the model's behavior. To test this assumption in studies evaluating the effects of EMME, learners - after observing this video – are given a second set of multimedia materials to learn from, for which they do not receive any guidance. Recent research has shown that EMME yield a more effective processing of these subsequently presented text-picture combinations (as evidenced by eye tracking) and improve learning outcomes in both, children (Mason, Pluchino, & Tornatora, 2015, in press) and adults (Schubert, Schüler, & Scheiter, 2015).

Mason, Pluchino, and Tornatora (2015) studied the effects of EMME compared with a no-EMME control group in 7th graders. In the experimental condition, learners saw a gaze replay of a model, who first read the whole text, and then shifted his/her attention to the picture multiple times to connect corresponding elements from the picture with the text. The control condition received no strategy modeling. Students' eye movements and learning outcomes were assessed for a second illustrated text that was unrelated to the first. Results showed that learners in the EMME condition showed more integrative processing as measured by the duration of their look-froms compared with the control condition; moreover, they had better verbal and graphical recall and transfer performance. Finally, the duration of look-froms predicted better transfer performance in the EMME, but not in the control condition. These findings were replicated in a second study (Mason, Pluchino, & Tornatora, in press); this study moreover revealed that

especially students with poorer reading comprehension skills benefitted from EMME, whereas there was no effect for students with stronger comprehension skills.

Schubert, Schüler, and Scheiter (2015) investigated how EMME that illustrated a variety of different multimedia learning strategies supported learning for university students. Different prior knowledge aspects were assessed as control variables to test whether these cognitive prerequisites would moderate the effects of EMME. Learners in the EMME group showed more adequate visual processing of the materials as became evident through more intense processing of pictures and more frequent transitions between text and pictures. Regarding open recall, learners with weaker cognitive prerequisites showed poorer performance after having studied EMME, whereas EMME did not impact performance of students with stronger cognitive prerequisites. In a forced-choice verification task, this pattern changed in that students with stronger prerequisites benefitted from EMME, whereas there was no effect for students with poorer prerequisites. The time spent on processing of the pictures was suited to explain the positive effects of EMME regarding the latter outcome measure. The results indicate that more complex EMME illustrating multiple multimedia learning strategies can also support learning of adult learners, at least if these learners possess good cognitive prerequisites.

CHALLENGES OF USING EYE TRACKING IN MULTIMEDIA RESEARCH

To conclude, eye tracking can move the field of multimedia learning forward by serving as a research and instructional tool. However, there are also a number of challenges associated with its use.

Conceptual Background Knowledge

Eye tracking systems have become very user-friendly in the last years; however, what is neglected is that eye tracking requires more than just technical knowledge on how to operate the recording device; rather, conceptual background knowledge is required to avoid misinterpretations of results. For instance, there exist gaze tendencies in humans that are independent of materials and not considering them in the design of the materials may yield artifacts in the data. According to Tatler (2007) there is a marked tendency in subjects to fixate the center of the screen when viewing visual images on a computer monitor. There exist yet unexplored alternative explanations for this central fixation bias such as that the center may be the most informative point to look at while making best use of peripheral vision. Regardless of the reasons for central fixation bias, not knowing about it when designing materials may yield artifacts in the data, for instance, when comparing visual attention for material variants, where in one case relevant information is incidentally presented in the center of the screen whereas in the other case it is not. Analogously, in general horizontal and vertical saccades are more frequent than oblique saccades (Tatler & Vincent, 2008); attributing such a difference in frequencies as being caused by one's material would yield a wrong interpretation.

Moreover, the fact that a person has not fixated an AOI does not exclude the possibility that the person has perceived the information contained in it nevertheless. In some cases, peripheral vision which is not accounted for when limiting one's analyses on fixations may be sufficient to notice visual information (e.g., coarse colorless shapes or rapid changes in the display, which do not require high acuity vision to be noticed). In other cases, albeit being quite accurate the eye tracking system can only estimate where the "real" point of gaze is located at any given moment. Hence, there is always minor imprecision as-

sociated with it, which needs to be accounted for when defining AOIs – the smaller the AOI the more spatial imprecision is a problem, because there is a higher chance that fixations will be erroneously (not) counted as being on the AOI.

Also one needs to be aware of the assumptions one buys into when running eye tracking studies, which is particularly problematic when studying text-picture combinations. Many of these assumptions derive from reading research and it is yet unclear whether they can be reasonably applied to multimedia instruction in a one-to-one fashion. For instance, standard definitions have been established in reading research for fixations. According to these standards, an average fixation that allows for information intake needs to be about at least 100 ms long while reading text; however, much shorter fixations (e.g., as short as 19 ms; Greene & Oliva, 2009) have been shown to already allow for extraction of pictorial information from scenes (e.g., landscapes). Similarly, mean fixation durations typically differ between reading (for skilled readers: 200-250 msec; Rayner, 2009; Rayner et al., 2006) and scene perception (330 milliseconds; Henderson & Hollingworth, 1999). Finally, mean fixation duration is interpreted differently in these two areas of research: Whereas longer mean fixation durations in reading research reflect students' processing difficulties (e.g., Rayner et al., 2006), they are seen as indicators of increased interest in information elements in scene perception research (Henderson & Hollingworth, 1999). Whether or not these differences are relevant for multimedia research, we do not know yet. There is tentative evidence that in multimedia learning, reading and picture processing may be more similar to each other than suggested by the previously discussed findings. Ozcelik et al. (2009) compared mean fixation durations for text and pictures and found no differences between them; moreover, both values were well within the range that is considered typical for skilled readers. Thus, it might be that 'reading' instructional pictures is actually more similar to text reading than it is to scene perception, but further research is required to explore these issues.

Selection and Interpretation of Eye Tracking Parameters

The multitude of measures to choose from and the fact that their interpretation often is ambiguous are the major challenges in using the eye tracking technology as a research tool. First of all, the fact that eye tracking software automatically generates a list of potential dependent variables makes it very tempting to simply pick those that promise the 'best' (significant) results – irrespective of theoretical considerations regarding whether they are suited to answer a research question formulated a *priori.* This will inevitably lead to an increase in type I errors. Second, having so many measures to choose from makes it very difficult to compare findings across studies. For instance, whereas some studies use overall fixation count as a measure of attention, others use total fixation times.

More importantly, there exist hardly any standard interpretations for the various eye tracking parameters and the question whether these can in fact exist. This is certainly less of a problem as long as eye tracking parameters are interpreted as indicators for a person's distribution of visual attention; however, once a researcher wants to use them to make statements regarding a person's cognitive processing, the situation becomes more difficult. In this case, an interpretation of these parameters will likely depend upon the context (i.e., the task, materials, sample) in which it was measured. For instance, attending towards some information for a long time may mean that it was interesting, relevant, or complex; often, decisions among these alternatives will be possible only by relating eye tracking parameters to other measures such as learning outcomes. But even this will not resolve all interpretation problems, since the relationships with learning outcomes may be moderated by prior knowledge (Schwonke et al., 2009) or

unknown contextual factors. For instance, Ozcelik et al. (2010) found that longer mean fixation durations were associated with lower transfer performance, whereas the opposite was the case in the study by Ozcelik et al. (2009). The authors do not refer to this contradiction between their studies. It shows that interpretations of eye tracking parameters are bound to the local context in which they occur, which is rather unsatisfactory from a measurement perspective.

Similar contradictions have been observed for the use of text-picture transitions as a measure of integrative processing. In some studies, the number of transitions was affected by experimental manipulations aimed at facilitating integration (e.g., O'Keefe et al., 2014; Johnson & Mayer, 2012; Stalbovs et al., 2015) sometimes it was not (Scheiter & Eitel, 2015); moreover, it is inconsistently linked to learning outcomes. For instance, Hegarty and Just (1993) showed that students with less prior knowledge in the domain of mechanics performed less well in a comprehension test, but more frequently switched between single text expressions and picture elements, whereas in other studies the number of transitions was linked to higher learning success (O'Keefe et al., 2014; Stalbovs et al., 2015).

One reason for this inconsistency may be differences in the cognitive demands resulting from integrating verbal and pictorial information in memory rather than by physically switching the attentional focus between text and picture processing. These memory demands may vary both as a function of the age of learners and the complexity of the materials. That is, younger learners may have to move their eyes back and forth between text and pictures, because their cognitive processing resources are yet too constrained to manage integration of verbal and pictorial information in the mind (i.e., without being supported by an external representation). Moreover, some materials are so complex that integration from memory becomes too taxing; rather, in this case learners will need to go back and forth between text and pictures multiple times to arrive at a coherent understanding of the instructional message. Finally, the design of the materials and the costs that arise from switching attentional focus may cause differences in whether learners show integrative saccades or not. Accordingly, Bauhoff, Huff, and Schwan (2012) showed in an eye tracking study using a comparative visual search task (Hardiess, Gillner, & Mallot, 2008) that whether students moved their eyes between different representations to integrate them or whether they integrated based on memory depended on the physical distance between the representations. Closer proximity afforded a higher number of saccades between representations, whereas for more distant representations people were more likely to apply memory-based strategies. These findings correspond nicely with those of Johnson and Mayer (2012) revealing that text-picture transitions were more frequent in the case of physically integrated multimedia materials.

Moreover, the inconsistency regarding the role of text-picture transitions for learning may be also be due to the fact that its relationship with learning outcomes is more complex than what can be detected by the statistical methods used to analyze it. Most studies assume a linear positive relationship between the number of transitions and learning outcomes; however, it might well be that this relationship in fact follows an inverted u-shape. That is, up to a certain point more transitions will be linked to better learning outcomes, whereas beyond that point conducting even more transitions may be an expression of students' difficulties in relating information from text and pictures (e.g., Hegarty & Just, 1993). When analyzing such u-shaped relationships using linear statistical models, contradictory patterns of results can be obtained depending on which range of the distribution of number of transitions is analyzed (i.e., below or above the turning point).

The previous discussion suggests that even relatively simple, aggregate eye tracking measures may be difficult to interpret; however, the case becomes even more challenging with more complex measures sich as Levinsthein's distance. For the calculation of Levinsthein's distance certain decisions are made:

First, if the same events follow upon each other repeatedly (e.g., multiple, consecutive fixations within the same AOI) these are typically treated as only one occurrence. This means that a scanpath in which the person refixated the same AOI multiple times, thereby showing intense processing of that AOI, is treated as identical to a scanpath, in which the person fixated the AOI only once. Moreover, when looking at an event occurring later in the sequence, in the first case there were many events occurring before that particular event (meaning that this event occurred relatively late in time), whereas in the second case it occurred rather early in the sequence. In general, in scanpath analyses any information regarding the duration of events is lost. Moreover, the actions that are required to transform one string into another (deletions, insertions) are typically treated as being equally meaningful for determining the similarity among strings (although in principle one could assign different weights to them). However, whether or not deleting a fixation in a scanpath (suggesting that a person never attended an AOI although s/he did) and insertions (suggesting that a person attended an AOI even though s/he did not) is identical in meaning from a cognitive processing perspective is unclear. Thus, using Levinsthein's distance as a measure requires that one carefully reflects upon the assumptions underlying this measure before applying it to learning with multimedia.

Designing Eye-Tracking Interventions

The design of eye-tracking based interventions is still in its infancy. Regarding the design of adaptive learning environments, it is yet an open question which eye-tracking parameters should be chosen for an adaptation and how to best determine the threshold values that control when an adaptive response is elicited. Moreover, an online computation of eye-tracking parameters required in order to allow for immediate responses of the learning environment is still challenging in particular if one aims at using more fine-grained measures or combinations of multiple measures, which both require sufficient computational power to due the necessary computations without any delay. To effectively model multimedia learning processes via pre-trainings and EMME, it is important that we learn more about the exact nature of these processes from studies deploying eye tracking as a research tool. That is, once we have detailed insights into the most effective processes, we can design modeling interventions based upon them. Importantly, this does not yet address the question whether the most effective learning processes should be the ones that are shown to learners. Alternatively, learners might benefit more from a model showing an advanced processing behavior, which can potentially be more easily incorporated into their repertoire of learning than that of an expert learner. A discussion of these and related issues pertaining to characteristics of effective models can be found in van Gog and Rummel's (2010) review.

Data Analyses

Most often, the data derived from eye tracking is more difficult to analyze because they often violate assumptions of standard statistical procedures based on the General Linear Model (e.g., ANOVA, regression). In particular, there may be many missing values where one needs to be aware that calculating person or group means will be based on different numbers of raw values.

Thus, the variance associated with these means will differ as well, which may lead to variance heterogeneity. Moreover, time data are often skewed, thereby violating assumptions of normal distribution. One means to respond to these issues is to analyze eye-tracking data by using mixed models (e.g., generalized linear mixed models) because of their advantages in dealing with missing values. Another

challenge is that eye tracking provides high-frequent data with many parameters and data points. Hence, conducting multiple univariate analyses is likely to yield at least one significant effect, even if, in reality, there is none (type I error). Conducting multivariate analyses can become quite complex so that one good strategy would be to approach the analysis in a top-down manner, with clear hypotheses for specific eye tracking parameters for each given point in time.

CONCLUSION AND FUTURE DIRECTIONS

Eye tracking has provided us with important insights in how students learn from multimedia and may even serve to design novel forms of instruction as recent research suggests. However, it is important to keep in mind that is not the Holy Grail that will answer all questions whenever deployed. Rather, its use needs to be motivated by and grounded in theories on how people learn that allow formulating *a priori* hypotheses that can then be tested using eye tracking. Also it needs to be kept in mind that learning is more than just attending to information; rather, it requires additional cognitive processes such as elaboration to arrive at a deeper understanding. Thus, attending towards relevant information is a necessary, but not a sufficient condition for learning, which may explain why some studies have also failed to establish any link between measures of visual attention distribution and learning outcomes (e.g., Kriz & Hegarty, 2007).

There are a multiple avenues for future research. First, the field is still lacking models of learning with multimedia that describe the time course of text-picture processing in more details and how it is modulated by linguistic and pictorial features. For instance, regarding integration of text and pictures, Hegarty and Just (1993) showed that subjects interrupted their reading of the text multiple times to inspect the picture, thus, suggesting that the learning from illustrated text proceeds in a highly interleaved fashion. On the other hand, Mason, Pluchino, and Tornatora (2015) showed that EMME, which suggested to learners to first read all the text before inspecting the picture were effective in promoting later learning. It is yet unclear whether these different approaches to integrated processing are equally successful, whether their relative success is bound to individual learning characteristics, etc.

Moreover, the lack of models describing the time course of text-picture processing in more detail is paralleled by the shortage of studies analyzing and reporting the time-course of eye movements on a fine-grained level (for an exception see Lindner et al., 2014). In order to better exploit the high temporal resolution of eye tracking data, future studies should focus more on deriving and testing hypotheses about how eye movements develop across the time-course of learning with (complex) instructions.

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KEY TERMS AND DEFINITIONS

Eye-Mind Assumption: The assumption that what is attended with one's eyes is an indication of what is processed at the cognitive level. The eye-mind assumption is fundamental to a cognitive interpretation of eye tracking data.

Fixations: A state of the eyes when the eyes remain relatively still and focused onto one location of the stimulus, thereby allowing intake of information from this part of the stimulus.

Integration: The cognitive process of relating corresponding information from a text to that of a picture and building a coherent mental representation of information from both sources. Integration is seen as the pivotal process for learning from multimedia.

Look-Froms: An eye-tracking indicator related to second-pass processing. It describes the duration (fixation times) for re-reading text while re-inspecting the picture (i.e., look-froms picture to text) and vice versa (i.e., look-froms text to picture: re-inspection of the picture while re-reading the text).

Multimedia Learning: Learning from combinations of (written or spoken) text and pictorial representations (e.g., diagrams, animations).

Scanpath: The sequence of fixations and saccades that can be used to describe the time course of attending to a stimulus.

Signaling: Changing the visual appearance of elements of the multimedia message to highlight relevant information without altering its instructional message. Signaling is often deployed to highlight correspondences between text and pictures that are pivotal to integration.

Transitions: Move the eyes from one area of interest to another. Transitions between text and picture processing are often studied as an indicator of integrating information from both sources (integrative saccades or text-picture transitions).

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Chapter 36
Requirements to a Search Engine for Semantic Multimedia Content

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ABSTRACT

The authors investigate user requirements regarding the interface design for semantic multimedia search and retrieval based on a prototypical implementation of a search engine for multimedia content on the web. Thus, unlike existing image or video search engines, they are interested in true multimedia content combining different media assets into multimedia documents like PowerPoint presentations and Flash files. In a user study with 20 participants, the authors conducted a formative evaluation based on the think-aloud method and semi-structured interviews in order to obtain requirements to a future web search engine for multimedia content. The interviews are complemented by a paper-and-pencil questionnaire to obtain quantitative information. As a result, the authors elicit requirements to a web search engine for multimedia content. Among them, scalability and personalization of the presented information are identified as the main goals. Based on the requirements, they present mockups demonstrating the user interface of a future multimedia search and retrieval engine.

1. INTRODUCTION

Multimedia content, which is provided by PowerPoint presentations or Flash documents, is widely adopted and can be found in any domain. Despite the growing interest in multimedia web search, most major web search engines currently offer only limited multimedia search functionality. Unlike existing

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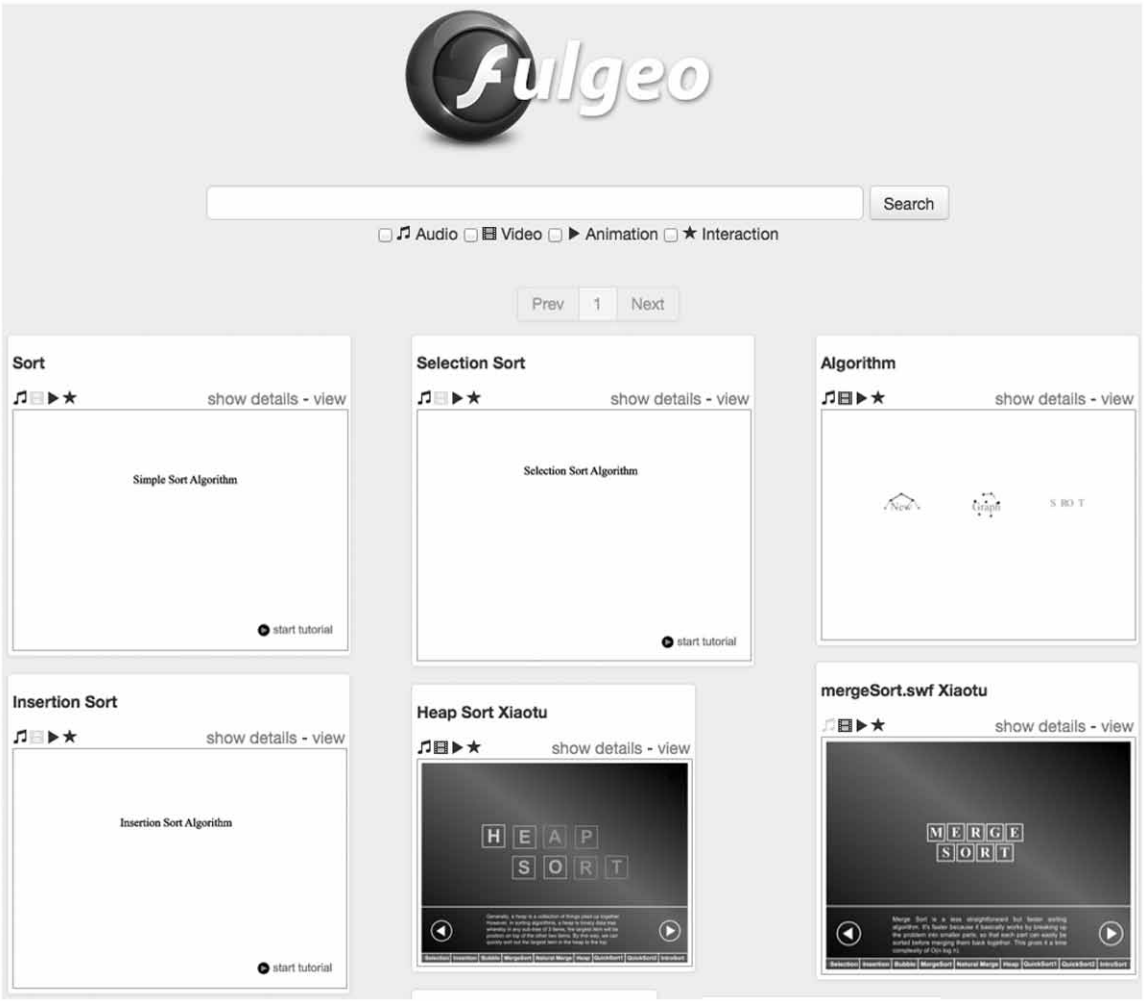
image or video search engines, the content a multimedia search engine has to deal with is the coherent combination of different types of media assets such as images, videos, audios, and text. Those media assets can be animated or rearranged by interactions (Candan & Sapino, 2010). The semantic within multimedia documents is given through relations dealing with time and space of media assets (Boll, Sandhaus, Scherp, & Westermann, 2007), e.g., duration of a video, width, height, and position of an image, but these are just partially taken into account by previous systems. Research on search engines dealing with a single media type like images and videos is well established and there exist studies that investigate how users apply media search engines (Maniu, O'Hare, Aiello, Chiarandini, & Jaimes, 2013; Kofler & Lux, 2009). However, regarding search and retrieval of *true* multimedia there is a gap in the research. Thus, we have developed an early prototype of a search engine for multimedia content on the web (Tingvold, Stohr, Schneider, & Amundsen, 2013)[1] (cf. Figure 1). The prototype offers users to search and explore for multimedia content. The goal of this early search engine was to provide users an initial idea of what a retrieval system for true multimedia could look like and to use this system to bootstrap requirement elicitation and detailed understanding of users' needs for semantic multimedia search. On the basis of this prototype, we conducted a user study evaluating the features for a future multimedia search engine. The current prototype is developed for keyword-based queries only. There are filters for audio, video, animation and interaction. These filters are applied by logical OR operators. The preview of the multimedia documents in the result list indicates if the document contains media assets fulfilling the filter. The thumbnails, which show the first frame or the first slide of the multimedia document, are of different sizes, starting with larger ones in the upper position to smaller ones in the lower position of the results page. Hovering over a thumbnail shows an animated preview of the document. Clicking on a document opens a detail view in the lower part of the search engine's window.

In the subsequent sections, we present the related work in multimedia search and studies on media search engines. In Sections 3 and 4, we describe the conducted user study and its results. Based on these results, we derive requirements to a future multimedia search engine in Section 5. We designed mockups combining good features of the existing prototype, with new requirements collected from the survey, and further ideas derived by the interview section (Section 6). Finally, we discuss the overall results and the limitations of our study (Sections 7 and 8).

2. RELATED WORK

Various media retrieval systems have been developed in the past like the MEMORAe project (Merzougui, Djoudi, & Behaz, 2012), where ontological knowledge is used for indexing and searching educational videos. Breaking the barrier of a single media modality, there are approaches for semantic cross-media search and retrieval like the semantic search engine Squiggle (Celino, Valle, Cerizza, & Turati, 2006) for images and audio. The FLAME framework (Flash Access and Management Environment) (Yang, Li, Wenyin, & Zhuang, 2007) is considered to be the so-far most comprehensive work on multimedia search. It supports retrieval based on some spatial and simple interaction constraints. Regarding the use of media retrieval systems, there have been some empirical investigations conducted in the past. Hearst (Hearst, 2009) states that there are three main search behaviors in web search: fact finding (looking for specific facts or pieces of information), information gathering (the collection of information from multiple sources), and browsing (visiting web pages without particular goal). Kofler and Lux (Kofler & Lux, 2009) conducted an evaluation of user intentions within image search. They conclude that existing

Figure 1. Fulgeo search interface and result view pagination is used and limits the result list to 20 documents per page. Overall, the prototype has about 4000 multimedia documents in the database.



taxonomies and models do not represent the users' intent while searching for multimedia content sufficiently. Maniu et al. (Maniu, O'Hare, Aiello, Chiarandini, & Jaimes, 2013) analyzed web server logs and all user actions during search sessions. They identified differences in search behavior caused by the different categories of search. Those categories are derived from the analysis of the server logs. They also conclude that current models and thus, interfaces, do not exactly represent the user's intent while searching for multimedia content.

3. USER STUDY

In July and August 2013 we conducted a user study with 20 subjects (eight female). The average age was 26-year-old (standard deviation (SD) = 2.87), ranging from 22- and 34-year-old. A pretest checked

minimum command of English (required to use the prototype) and computer skills. This is important to obtain feedback from users which are familiar with existing search engines. The majority (16 subjects) said to have "worked a lot with search engines" (rating 6 and 7 on a 7-point Likert-scale), while the others rated themselves as intermediate users (rating 3 to 5). The experience distribution about multimedia search was nearly similar (13 experienced users and one novice user). Special consideration was given to the subjects' diversity regarding educational background and profession in order to avoid bias by a specific population group (Miles & Huberman, 1994). The sample consisted of bankers, cooks, doctors, machinists, computer science students, media and communication science students, and students of teaching.

3.1. Apparatus and Data Set

At the time of the user study, the prototypical multimedia search engine was filled with about 4000 multimedia documents crawled from the web. These multimedia documents cover terms related to the topic climate change and global warming. The experiment was conducted at a normal workplace using the same laptop with a 19-inch screen.

3.2. Tasks

Every subject had to solve four tasks. The main aim was to find specific multimedia documents. For solving the tasks, the subjects had to use the different features offered by the engine. The tasks were of different levels of complexity. The first task was to find a document and to open it in a new window or tab. This document had to fit to the query "Climate conference in Kyoto".

In the second task, the subjects had to apply the filter for animations to find a multimedia document in the context of the "Greenhouse effect".

In the third task, they had to use the detail view and the highlighted keywords to find a document, which contains most occurrences of the keywords "Climate change, sea level, glacier, Kyoto, and climate protection".

In the last task, a subject had to start an animation or activate an interaction within the context of "Climate change and glacier". The tasks were motivated by a task scenario, wherein the subject is supposed to explain climate change to pupils using multimedia. No specific introduction was given to the subjects on how to use the search engine. Thus, the subjects had to solve the tasks based on their prior knowledge from existing search engines.

3.3. Procedure

At the beginning, we informed the subjects about the goals of the study and asked them to sign an informed consent form. We asked the subjects to write down their first impressions of the prototypical multimedia search engine. Then we asked the subjects to conduct the different search tasks. While conducting the tasks, the subjects were encouraged to think aloud. Subsequently, the subjects were asked to fill in a paper-and-pencil questionnaire. Here, a set of 19 closed-questions taken from the IsoMetrics (Gediga & Hamborg, 1999) questionnaire (version 2.01) were chosen and adapted to assess the prototype. The IsoMetrics questionnaire is a catalogue of questions aiming at summative and formative evaluations of

software. Questions in IsoMetrics address part 10 of the DIN EN ISO 9241, which defines principles of ergonomic user interfaces. Thus, IsoMetrics focuses at an evaluation of usability and user-centered design.

We focused on questions about the suitability for executing the task, for learning the application and individualization of the application, the conformity with user expectations, self-descriptiveness, controllability, and error tolerance. In addition, we asked specific questions regarding search and exploration of multimedia content: The features of the current prototype are about filtering by medium type, thumbnail preview of multimedia documents, the detailed view of a selected document, and the ranking by size to support the prediction of relevance. The subjects answered the questions on a 7-point Likert scale.

In addition, open-questions were asked to the subjects, e.g., "what do you like about the search engine", "what do you not like about the search engine", "what do you think is missing (any kind of design or functionality)?", and "what do you believe might improve the usability of the search engine?". These open questions were investigated in a semi-structured interview in order to explore emergent meanings and intentions of the subjects in context (Myers, 2009).

4. RESULTS

4.1. Task Execution

The mean duration for all sessions was 39 minutes (SD = 9min.), mean processing time for task 1 is three minutes (SD = 1 min.), task 2 also three minutes (SD = 2 min.), task 3 four minutes (SD = 2 min.), and task 4 three minutes (SD = 1 min.). All subjects were able to successfully accomplish their tasks. Considering the feedback from the subjects that they assess the tasks to be gradually more challenging but never unsolvable and considering the measured execution times, suggests that task demand was adequate. This fits the intention of an accessible test design.

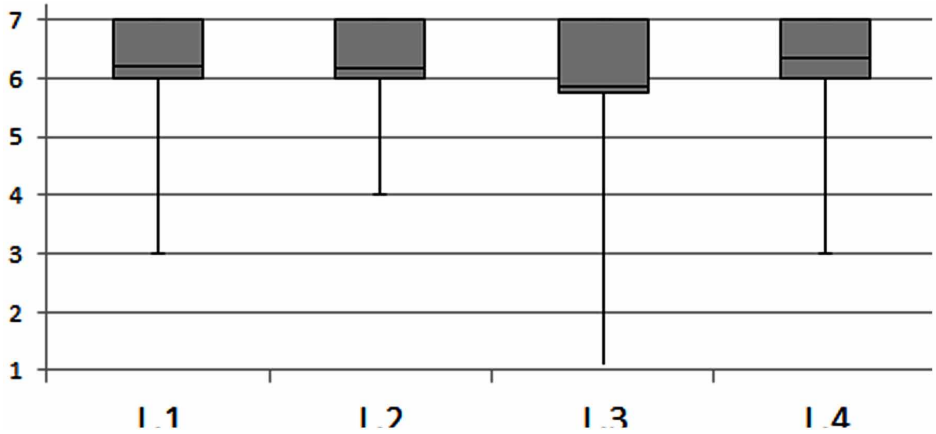
4.2. User Satisfaction

In detail we asked the following amount of questions from the categories. Abbreviations in brackets will be used in the latter and on the visualizations for the evaluations: S*uitability for learning the application* (4 items, L.1-L.4), c*ontrollability* (2 items, C.1-C.2), *suitability for executing the tasks* (2 items, T.1-T.2), and questions about the specific *features for multimedia search* (4 items, F.1-F.4).

4.2.1. Suitability for Learning the Application

Most subjects predominantly agreed to the statement L.1: "The interface of the search engine is understandable at first glance." (mean (M) = 6.2; SD = 1.12)(cf. Figure 3). Also most of the subjects predominantly agreed to L.2: "The search engine is designed in such a way, that functionality not yet known could be learned by trying out." (M = 6.15), with lower SD = 0.91. A higher deviation and lower agreement was received for L.3: "It did not take long time before I learned to operate the search engine." (M = 5.75; SD = 1.68). L.4: "I don't have to remember a lot of details to operate the search engine", reached a higher agreement and a lower deviation again (M = 6.35; SD = 0.96). Overall, the interface was easy to understand, but there were some features which require learning or explanation (See Figure 2).

Figure 2. User ratings about learnability shown as box plots



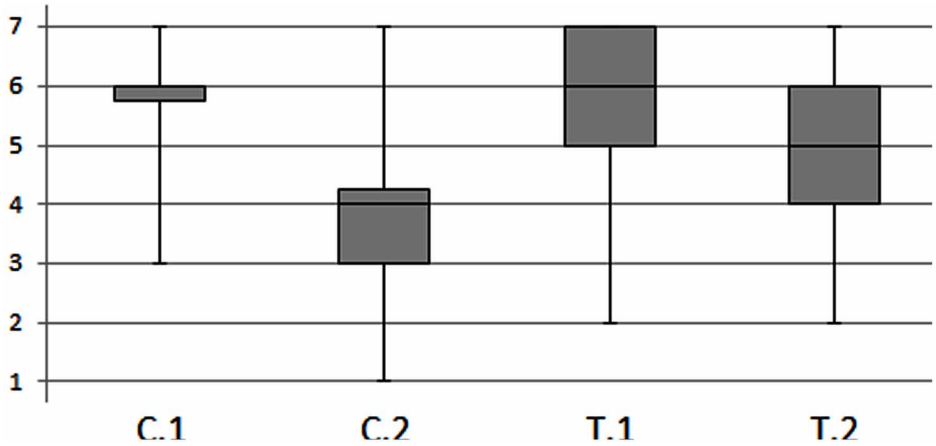
4.2.2. Controllability

The results for the L-items were supported by C.1: “Handling the multimedia search engine is easy.” (M = 5.8; SD = 0.98) and C.2: ”The engine can only be used in a rigid way.” (M = 4.05; SD = 1.66).

4.2.3. Suitability for Executing the Task

Suitability for task was represented by the following questions T.1: “The search engine permits to enter queries just the way it is necessary for searching multimedia content.” (M = 5.7; SD = 1.35) confirmed the initial keyword as approach for searching multimedia content. Nevertheless, generating and representing results need some rework, as T.2: “The results found by the search engine match my queries.”, only got an “agree” (M = 4.85; SD = 1.46).

Figure 3. Ratings of controllability and suitability for executing the task shown as box plots



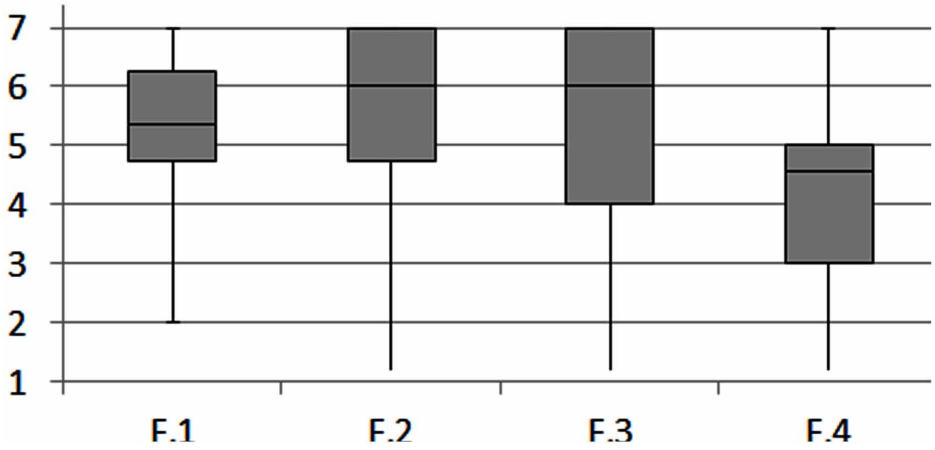
4.2.4. Features for Multimedia Search

The questions which were used to evaluate the specific features of multimedia search are about filtering by medium type (F.1), thumbnail preview of multimedia documents (F.2), the detailed view of a selected document (F.3), and the ranking by size to support the prediction of relevance (F.4). The median values of the ratings regarding the specific features of our prototype range between 4 and 6 (cf. Figure 4). As can be seen from Figure 4, all results were in median higher than 5.5. But the detail view needs improvement.

4.3. Semi-Structured Interviews

We conducted semi-structured interviews and applied a bottom-up process to analyze the results and obtain concepts from the detailed analysis of the collected data (codification) (Young, Kuo, & Myers, 2012). Overall, we can state that the subjects enjoyed using the multimedia search engine. Eleven subjects enjoyed the detail-view of the multimedia documents and found it, e.g., "very helpful" and "good for a preview so you do not have to open several pages". Eight subjects mentioned the four filter categories (audio, video, animation, interaction) positively, assuming these filters facilitate their research, especially because they can use multiple filters simultaneously. Six subjects liked the preview-animation as a concept, despite some technical issues (which were due to encoding problems). Other positively attributed comments by at least three subjects are: pleasant look, clarity, simple to use, simple to understand or conformity with user habits (see Google). Also, positively mentioned were automatic opening of the documents in a new tab, a good overall impression, automatic text highlighting of the query in the detailed view, a logo to restart a search, and the simultaneous presentation of the result page and the document details. Regarding aspects that could be improved, seven subjects mentioned that they found the results page unstructured, irritating, or chaotic, as they rather prefer representation of relevance by either size of thumbnails or a grid layout with descending order, but not both combined in one layout. Six subjects mentioned missing meta-data such as the authors, date, and URL. Four subjects mentioned to be confused by the imprecise use of filters. Three subjects did not understand the meaning or concept

Figure 4. Box plots showing the ratings of multimedia search features



of the animation, which starts playing when the user hovers over a thumbnail of a document shown in the result list. These three also mentioned that the icons and names for the filters are not self-explanatory enough. They proposed to add tool tips, which are shown when hovering over the icons.

5. REQUIREMENTS ELICITATION

Based on the results of the questionnaire, the user feedback in the semi-structured interviews, and existing literature we derive requirements for a future multimedia search engine. We organize the requirement along the different existing as well as new functional aspects of the prototype. For all requirements, we also provide further details on the user feedback.

5.1. Search Bar

The search interface of a multimedia search engine should offer an error tolerant autocompletion. According to Morville (Morville & Callender, 2010) queries should be easy to formulate, adapt and change according to the user's needs and preferences and direct the user to results, even if the user does not know exactly what he or she is looking for. More filters, which cover metadata, like author or date of creation, should be offered. To avoid an overload of the interface these additional filters can be hidden in an advanced search interface. These requirements to the search bar are suggested by analyzing the user comments, where eleven users stated that they would feel more supported by an autocompletion feature and less restricted by the implementation of further filter options. Six users suggested outsourcing more options, like further filters, into an advanced search interface.

5.2. Result Page

A multimedia search engine should offer several options or styles to view the result page. Two possibilities were suggested:

1. Arrange results strict from top to bottom. Representation of relevance is given from top to bottom in ascending order, without the representation of relevance by thumbnail size;
2. Results are presented in a grid layout with the same thumbnail sizes, but users can arrange their appearance on basis of adjustable relevance options or rearrange via drag-and-drop. The users are allowed to choose the appearance of relevance manually, so that a user can choose the relevance by size within the grid layout, like it is provided by the current prototype. This manually chosen relevance appearance prevents the user from being confused by a chaotic layout.

Overall, the subjects prefer consistency and clarity over style. As rationale for this requirement, we consider that some subjects rather want a simple list or at least the option to show the results as a list of names or headlines.

5.3. Thumbnail View

The aim of snippets is to support the user in predicting the relevance of result items. Therefore, the representation should be clear, self-explanatory, and provide enough information. The thumbnail view should provide icons for filters, which are more visible and, where the function, if a certain media type is included or not, is clear. As known from other search engines, the headlines should provide a link to the URL of the original document. Besides providing a link, a download button might also be useful. These requirements are supported by half of the subjects: they nearly ignored the icons for the different filters. Furthermore, four users thought that these icons are for interaction. They tried to click on the headers of the thumbnail in order to obtain the entire multimedia document. As there is a difference in "show-details" and "view", five users suggested to state the difference between those more apparently. Nevertheless, five users did not want or do not need snippets in the "detail view".

5.4. Detail View

The suggestion for the detail view is to enable the user to scroll through the whole text, search for further keywords within that document and to use the highlighted keywords as markers for navigating between them. When a user clicks on the highlighted keyword and then jumps to the next highlighted keyword, the preview image of the document will also change according to the text. Customization by resizing or moving the detail view window should be supported. Also adding buttons for navigating between detail views of several multimedia documents is recommended. The requirements are stressed by the statements and behavior of the subjects. Twelve of them suggested having the ability of customization, like resizing. The next and previous buttons to switch between detail views of the complete list of results are suggested by seven users. The requirement for scrolling through the multimedia document was directly expressed by two users; also two suggested adding the search inside feature within the detail view. One explained the jump navigation between highlighted keywords within the texts of a multimedia document. Thereby a user can jump back and forth between highlighted keywords which fit to the initial query. Thus, a user is able to find relevant passages quicker, without engaging the search feature first.

5.5. Request for New Features

Common browser-based features like a top menu bar, e.g., to save search sessions, a back-button, a right-click menu, should be added. One participant suggested a function to store the last search queries, settings, and result sets. Another user suggested including gesture interactions either by mouse movement and keyboard shortcuts for browsing the interface, or with regard to the rising mobile device usage and their ability of multi-touch gestures. Suggestion made by three other users were about being able to customize the order of result items, probably moving them by drag and drop. Two users suggested to stack collect multiple detail views in order to search within these presentations separately. Besides the already mentioned requirements for additional features, a play-button for videos was suggested. Finally, it was quite interesting to observe that none of the subjects requested a query-by-example or query-by-sketch feature. In fact, all subjects said they disliked the idea of query-by-example techniques.

6. MULTIMEDIA SEARCH ENGINE MOCKUP

Based on the user study and the derived requirements (cf. Section 3, 4, and 5), we created mockups for a future search engine for multimedia content, which will then also consider the semantic integration of time, space and, interaction. Overall we can state, that there are no requirements for totally new functions, but known and proven functions will be combined to allow a user centered design of a multimodal interface. The mockup provides an overview of the result list and presents additional information for each single result such as an advanced search, more filters, customization with choosing amount of shown data and thumbnails sizes and menu options like storing the current status (cf. Figure 5). The search by media type supports image, audio, and video. Additional filters for animation and interaction are added and explained when hovering over. The option for an advanced search is included in a dropdown list next to the textbox for entering the query. The advanced search enables to search for media in context, e. g. music, science, maps, or file type. The interface enables the users to customize the presentation of the result items, such as: changing scalability of the preview thumbnail and the amount of metadata by a slide control in line with the textbox. Another feature of customization is the button for activating or deactivating animations.

The results page enables users to view the result list by several aspects such as the overall relevance represented by the ranking position of the items, explicit headlines with a short and contextualizing subline (approx. snippets), a preview animation by mouse-over, metadata based on media type specifications, e. g., file size and duration, and metadata of common web content specifications, e. g., publisher, URL and release date (cf. Figure 6). The result list can be scrolled down to (in principle) infinity. Thus, no pagination is needed for users. The result view is divided into two parts: A vertical bar splits the list with the thumbnails of all relevant results from the detail view (cf. Figure 7). Using drag and drop one can move a document from the overview side to the detail view side. Alternatively, a user can also use

Figure 5. Mockup for the multimedia search bar: with filters, customization settings for previews, and options. Described with quick tips on mouse hover.

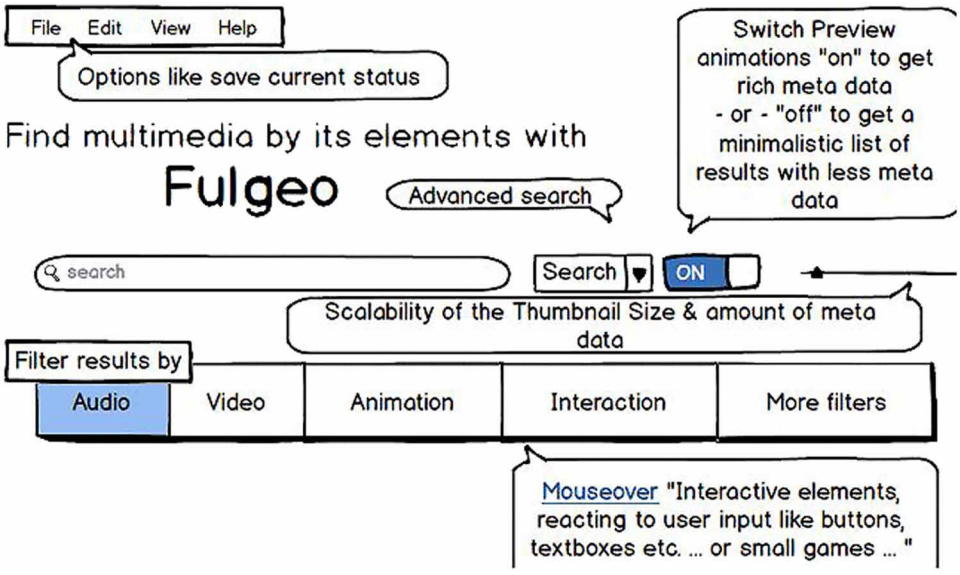
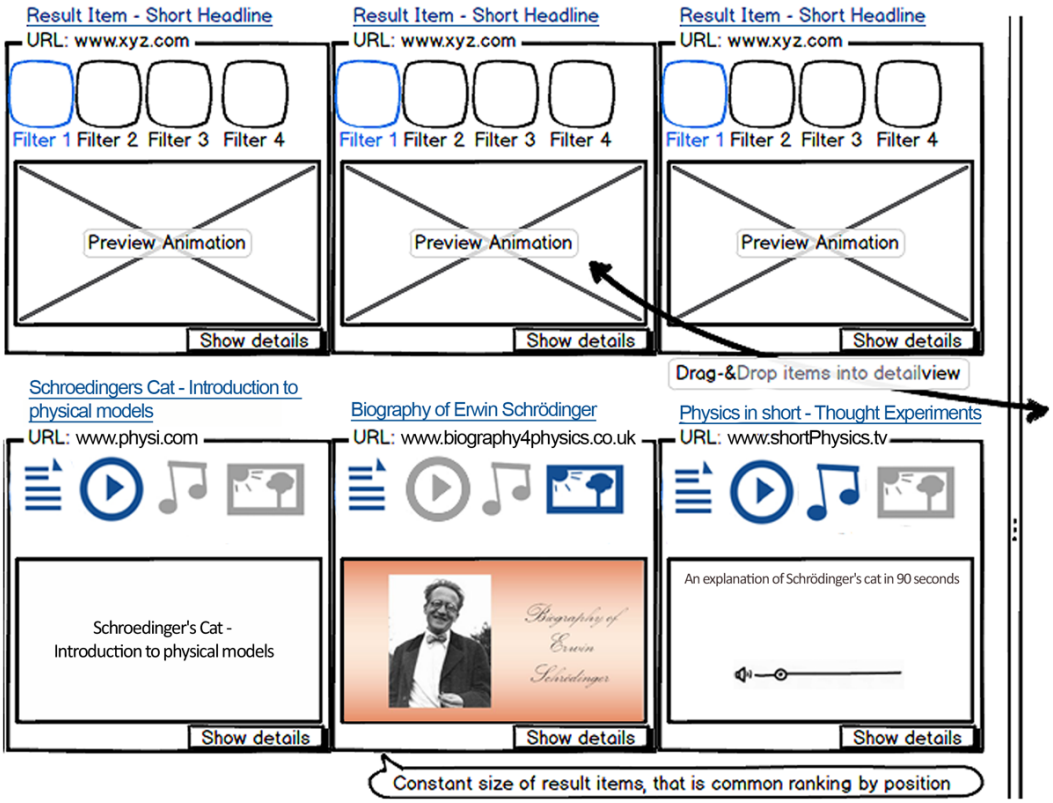


Figure 6. Mockup showing the result list view with thumbnails presented in grid-layout, more metadata, and bigger symbols for different filters. The three items in the upper row illustrate a template for the result list view. The bottom row shows three concrete examples of multimedia presentations appearing in the result list.



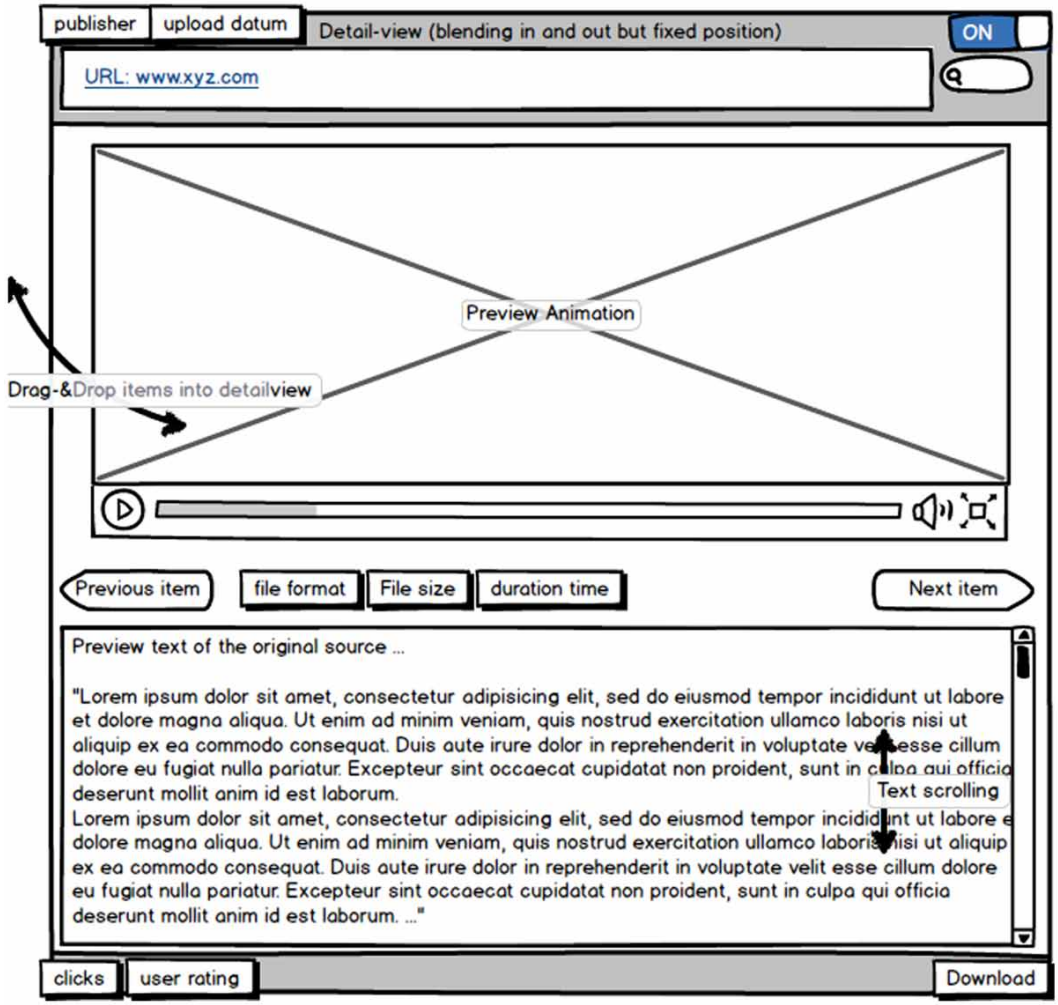
the "Show details"-button below a thumbnail. The preview text is scrollable as most users expected it to be rich in quality. When the users scroll through the preview text, the animation of the presentation changes, too.

Likewise, when the play-button is pressed to render the presentation also the text below changes. This allows to search in the whole multimedia document and has a strong focus on the visual media types. The affiliated text, which changes accordingly, supports the search for visual media types and represents the relation of visual media types and text. A user is able to navigate through the result list via the detail view by clicking on the previous or next item buttons (cf. Figure 7).

7. DISCUSSION AND LIMITATIONS

The purpose of this research was to gain insights into the requirements to a search engine or multimedia content. Based on these, we generated ideas for further research and development in the area of multimedia search and retrieval. Below, we reflect on the main insights gained from this study. In addition, we acknowledge aspects that are beyond the scope of this article and may be addressed in future work.

Figure 7. Mockup of a more advanced detail view, showing the whole text, more metadata and allows for interaction like navigating through the multimedia content



7.1. Discussion

Even though, the ergonomic quality of the prototype as assessed by users can be considered quite high, most users prefer a straight structure like a simple grid-layout of the result page in order to better orient themselves in the result list.

This is in particular important as naturally for a multimedia search engine the result set will be full of colorful animations. This insight is in line with findings of Lohmann, Ziegler and Tetzlaff (Lohmann, Ziegler, & Tetzlaff, 2009) who found out that fun and aesthetic aspects largely affect the user's interaction with, e. g., tag clouds or meaning. Tag clouds for example draw the user's intention to the center of the cloud or to colorful large tags, so that the user focuses less on content. A layout that is simpler might less influence the user's intention and encourage him in concentrating on the actual content. The subjects made clear that they did not want to have advanced features like query-by-example. This find-

ing is in line with the research by (Jaimes, Christel, Gilles, Sarukkai, & Ma, 2005) who states that in many real world applications it is hard to find an example to describe the user's information need. Many subjects asked for more individual filtering options which often referred to metadata like author, date of creation or the keywords given by the author, rather than technical differentiators such as the offered format filters for image, audio, video, and animation. Using filters supports the user in finding more relevant results to the initial query. If tags are shown next to the documents, which describe categories, e. g., persons or events, the user's assessment about the relevance of a document can be supported. This approach is inspired by Voxalead[2]. Altogether, the use of user generated annotations, comments, ratings, colorized tags etc. should be encouraged to enrich the metadata and include relevance feedback for the multimedia search (Jaimes, Christel, Gilles, Sarukkai, & Ma, 2005; Tjondronegoro, Chen, & Joly, 2008; Wang, Shih, Wu, Wang, & Jeng, 2011). Finally, it was interesting to observe that people do not have specific expectations to a multimedia search engine. However, they like to be able to customize in which modality, context, and detail of the preview or thumbnail they are looking for multimedia content.

7.2. Limitations

The fact, that models in search engines often do not fit to the intentions of users (Kofler & Lux, 2009; Maniu, O'Hare, Aiello, Chiarandini, & Jaimes, 2013), implicates a need for more psychological research to build models of human activity during multimedia information search and retrieval, e. g., connected to common dual channel theories (Kahneman, 2011) or concrete versus abstract thinking (Trope & Liberman, 2010). The tendency to request customization of the search engine suggests that there is a higher level of perceptual gap between content and current representation of content in contrast to personal requirements of users regarding the representation of search results to estimate relevance of results (Jaimes, Christel, Gilles, Sarukkai, & Ma, 2005). Despite the results obtained from the study, the evaluation also needs to be seen in context of the methodological limitations based on self-report using a standardized questionnaire. Thus, after having implemented the mockups we plan to conduct a longitudinal study.

8. CONCLUSION

We evaluated the user interface of a search engine prototype for multimedia content with the goal to generate grounded ideas for further development in the area of multimedia search and retrieval. We found that users prefer straight layouts of multimedia result sets, but would like to switch between different modes of result set presentation with different amount of information. Also they would like to be able to customize the search engine by filters and search by context or domain. Based on the user study, we derived requirements and created mockups of a future multimedia search engine. In the next step, we will implement the requirements elicited in the study and conduct more extensive evaluations using subjects from different background and different knowledge levels.

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ENDNOTES

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Chapter 37
A Model for Mind–Device Dialectic and the Future of Advertising in the Social Media Age

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ABSTRACT

Every advertisement text has a specific impact on the mind of receivers. Just like a water-mill or wind mill, human mind develops a specific systematic interaction against different advertisement texts. This section focuses on how information presented and carried by different texts are built on human mind. The basic aim is to reveal how advertisement texts operate human mind. In this sense, the authors try to understand the impact of analogue media on our minds through discussing the nature of science, the way human mind operates, and the structure of mass communication means. On top of that, the authors visualize this interaction on a model. This model would not only make it possible for us to understand our interaction with analogue media but also would give clues about digital media. With these clues, it would be possible to make predictions about changing advertising environment, and accordingly the way of making more effective strategies and future of advertising sector.

INTRODUCTION

Advertising is quite a dynamic sector. This field which has no problem about creative manpower and financial support is developing every day. This development also includes advertising media. Such that due to their radical transformations, media is candidate to transform the structure of human reality. transformation of human mind and indirect cultural structure can change advertisements, as well. By understanding advertising instruments and the way they present information and interaction with

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humand mind, it is possible to make some predictions for the future. Therefore, this section focuses on how information presented and carried by different texts are built on human mind. Our basic aim is to reveal how advertisement texts operate on human mind. In this sense, we try to understand the impact of analogue media on our minds through discussing the nature of science, the way human mind operates and structure of mass communication means. We formed a model from the connections we made. This model would make it possible for us to understand our interactions with analogue media; Such a perception would also give clues about impacts of digital media on human mind. With these clues, it would be possible to make predictions about changing advertising environment, and accordingly the future of advertisement and the way of making more effective strategies for advertisers.

Our study is organized as follows: the first chapter of the study focuses on the structure and mechanism of human mind. Within the chapter, current theories on the issue are to be discussed. Theories presented will be formed and guided by insights from philosophy and psychology. This and the following chapters will provide a base for the discussion part of the study, which is in the third section. The second chapter of the study divides and establishes some characteristics of mass communication devices. We share an explanation which has been previously used in other publications and accepted by the academic community. The third chapter will pave the way to explain how this device makes the mind work in other chapters. In the fourth chapter of the study, a model is introduced. The model is created and presented on the basis of theoretical background claimed in the previous chapters. The fifth chapter examines the issue, how discourse is shaped by the structure of human- device interaction in the process of knowledge building. The connection among the impact of digital media, augmented reality and digital rhetoric is established in this chapter. In conclusion, some suggestions relating to external factors to be refrained for the sake of exactness of learning, how to create effective advertising strategies, and the future of advertising, are made.

KNOWLEDGE AND THE DIALECTICS OF THE HUMAN MIND

Πάντα ῥεῖ; (Panta rhei); [Everything flows] (Heraclitus)

Motion is at the core of dialectical thinking (Hilav, 2012). In the case of the human mind, the concept of knowledge is defined in different ways in philosophy, sociology and psychology. Philosophers agree in distinguishing between knowledge in the first of these senses, and belief (Vesey & Foulkes, 1990, pp. 163-165). Sociology of knowledge is explained as "the study of how styles of expression and the character of ideas or systems of thought are related to different social contexts" (Bullock, Stallybrass & Trombley, 1988, pp. 457-458). In psychology, the most prevalent definition of knowledge is "the verified belief; dogmas and doctrines about the physical and social system (of human, society and culture); thoughts, hierarchy of principles; common things; whether it is innate or the experience gained, for the mental plane. In this sense, knowledge is close to what is meant by memory because the memory is the place for storing information" (Budak, 2005, pp. 129-130). However, all these definitions fail to provide us a full description within the circular frame of our study. To deal with a subject like mental construction of knowledge also requires the structure of its mechanism which provides us mental embodiment, as well as its nature.

The first thing we should determine is to reveal the difference between the mind and the external world. According to the British philosopher Bertrand Russell, human being is just a thinking agent

trying to interpret external reality in the light of his mental capability (Problems of Philosophy, 2008, pp. 11- 18). He claims that reality is unknown to human mind and man could detect only some parts of reality with his limited perception. Thus, it infers that the knowledge acquired could be fallacious. Consequently, man's reality is nothing more than a pure image, in other words, image is the reality itself. In his work, the relation manipulated between the external world and mind also exhibits the situation of reality and the direction of knowledge flow at the same time. However, it would be likely an incorrect behaviour to reduce this information phenomenon into a simple relationship with the external world, which is unique to man only. Accordingly, it seems inevitable to clarify the structure of information. First of all, we should perceive the materials human mind interacted while producing information and the ways materials interact, as well. The key concept here is the ability that is called 'symbolization'.

Symbolization forms man in two ways: firstly, socialization of man as an individual; secondly ontological development of man. Becoming a man as an individual stage initiates with the progression of an infant from the world of images to the world of symbols. Jacques Lacan calls it 'mirror stage' and explains that "the mirror stage is a phenomenon to which I assign a twofold value. In the first place, it has historical value as it marks a decisive turning-point in the mental development of the child. In the second place, it typifies an essential libidinal relationship with the body-image" (2007). For the very first time an infant recognizes his /her image on the mirror as a whole, the synthesis of this image produces a sense of contrast with the lack of co-ordination of the body, which is perceived as a fragmented body. The child experiences this contrast initially as a rivalry with his or her own image, because the wholeness of the image threatens the child with fragmentation—thus the mirror stage gives rise to an aggressive tension between the subject and the image. Successively follows the language, which is the most authoritative form of symbolization. As a kind of organizer, language provides mental construction and positioning of the icons provided; consequently individual acquires the characteristic unique to man and is situated in the society.

Ontological progression of man is the major of philosophical antropology and Jean Bruller Vercors provides a good example of it in his essay İnsan ve İnsanlar [Mankind and People] (1988). In his opinion, human alone signifies nothing unless the partipication of others. This could only be possible in case we accumulate our knowledge away from ourselves and employ symbols. By doing so it would be possible to transfer a mental activity produced by a man to the next generation safely. It is the fact that underlines the basis of civilization and our ability for symbolization. Likewise, philosopher Ernst Cassirer, who is accepted as the founder of Neo-Kantian tradition, describes man as an 'animal symbolicum' in his work An Essay on Man (1962). To Cassirer, what makes man is not his capacity for thinking, but his ability for symbolizing basically.

Thanks to this ability, man gradually isolated himself away from all other creatures and has entered a completely different world of his own. Thus, his talent is the unique key to his evolution; therefore, man, who creates a reality in his mind with limited perceptions, could be able to destine himself new horizons.

Man's ablity to symbolize is the basic component of being a human. Correspondingly, fundamantals of information also underlies this ability. Symbols have various functions in human mind; they enable external world to be permanent in mind, because man acquires knowledge through senses and decodes into images then transfers them to the mind. Among these inconstant images, mind can select the stable ones, which we call symbols. Symbols constitute the representations of external world in mind, barely consisting of morphemes and their compositions. We will name this kind of knowledge as 'perceptible'.

American Philosopher Charles Sanders Peirce cites about that kind of knowledge in his work On a New List of Categories (1868) and clarifies man's ability to 'conceptualize' instead of what we propose as 'symbolize'.

These conceptional configurations could only be provided through a relationship among object, representment and interpretant, which can be assumed as a sort of mechanism. Each concept may survive by the mediation of interpretants, being decoded into a sign. Let's take a duck in real life; it will be transformed into a representment of a duck depending on the willpower of interpretant. This representment exists as a concrete concept in human mind. Interpretant could correlate a representment to another object so that s/he could get another sign. Such a process will provide mind more abstract knowledge and gradually it will construct itself a world of its own. On a plain basis, from a white duck image, a wide range of knowledge could be deductible: from environmental conditions ducks have to encounter after the civil war, to the increase in death rates, all mental activities should be considered within this structure. Peirce proposed a list of triadic relations which he made the most fundamental categories of all 'things' of any sort whatsoever the categories of 'Firstness', 'Secondness', and 'Thirdness' and he often described things as being 'firsts', or 'thirds'.His triadism constitues the base of abstraction mechanism in general.

Hereby what we define about knowledge, implements us the facility of redefinition of knowledge. At present, we can redefine it as 'the act of rationalization of things'. New definition is now much more comprehensive and functional with respect to the ones in previous chapters. We deal with 'things' as obscurities which are already familiar to us and name other obscurities unknown to us as 'things', We envisage the abstract but obscure ones in our minds similarly. On this point, we encounter 'corollarium'[1] by virtue of hightlighting all sort of knowledge as a constituent of mind. The information acquired from mass media should be investigated on that platform.

THE CHARACTERISTICS OF MASS COMMUNICATION DEVICES

The primary characteristic of mass communication is that it takes place during a process. Understanding the process alone does not mean grasping its quality. Communication is at the same time an exchange of meaning. This exchange can be ensured by understanding the semantics rather than the approach constituting the process. The fact that mass communication is an exchange of meaning is the second feature. This is the realm of semiotics which is a branch of science analyzing the production and reproduction of meaning (Fiske, 1990; Isik, 2000, pp. 37-53; Mutlu, 2004, p. 114).

Another element required comprehending the essence or nature of mass communication is making a differentiation between its instrumental and implemental (device) aspects. When the codes loaded to devices are received by a certain person, the meaning is realized. Coding and encoding constitute the semantics of communication. One of the approaches that best clarifies this process –although on interpersonal level- is the theory of speech-act. According to a theory introduced by John L. Austin in his book How to Do Things with Word (1975) and developed by his student John R. Searle (1999), there is a connection between words and actions which cannot be explained through rules of physics. This connection functions by transforming the physical one into semantic one. Throughout his process, words turn into actions in external world. The theorists who underline the existence of three different speech-acts refer to meaning only as speech-act acquisition, its reception and transformation it creates on earth as impact speech-act concepts. If we are to transform this concept into communication technology, you perform only an act through coding but the change it shall create on earth will form its impact. The thing

that transforms mass communication into a device is that process of impact. What should be underlined at this point is that reception takes place between a device and mind. We shall refer to it with dialectic of mind-device and explain its structure in the next section. At this point we shall simply underline that this dialectic constitutes the essence of instrumentalism.

As a consequence of its definition, mass communication implies interaction with not one person only but a mass of individuals which points to the fact that a single mind-device interaction does not count. It is the interaction between identical devices and different minds (Taskiran & Yilmaz, 2007).

MIND-DEVICE DIALECTIC AND FORMS OF MASS COMMUNICATIONAL INTERACTION

As indicated in the previous part, we employ dialectic of mind-device to imply the interaction taking place between communicational devices and human mind (Yilmaz, 2008). As clearly indicated through its definition, such an interaction basically includes two parameters which are mass communicational devices and human mind. In that way the structure of dialectic shall find a meaning among variables since each of these devices has a specific character and unique interaction forms that come with this character. However, once the mind is handled as a meaning production unit, it offers just one mechanical structure –this topic has been analyzed in the second part. Throughout the process, each device operates a specific mechanism in a different dimension. Therefore, the attempted interaction gains a new quality each time. For that reason, in the present study, it seems plausible to continue on analyzing these forms.

Interaction Through Reading

Interaction through seeing takes place between devices such as paper and ink and the mind. The visuals and linguistic indicators presented in a certain form determine the functioning of mind, too. Another determinant is the element of temporality. Indeed, between concepts of present time and images formed with these concepts, temporality emerges as an element determining the nature of reception.

In the interaction through seeing the images uncovering iconic and symbolic indicators are perceived in a process which is totally dependent on the subject interacting. This form of reception provides various means to the mind in forming fantastic connections. In that way, the mind can find an exit to exhibit its upper abstraction capacity. Let us discuss an advertisement text where there is a bunch with one flower, a bunch with a few flowers and a bunch with a dozen flowers. On top of the text suppose that such a statement is written: "How angry?" Under such condition, the mind shall at first receive the elements. The mind shall identify the pictures on the paper with real world counterparts and imagine them as one and the same. Next, the mind shall make sense of the text by establishing the context between words. Then, it will form syntax between the elements. Since there is not an ordinary meaning in such a narrative form, the mind will be forced to establish some kind of a context. Whether such a context can be formed or time of its formation is something completely related to personal competency. Still something is constant; the paper is there itself and unless the subject turns or closes the page it shall remain that way. Sooner or later, a person with normal temporal competencies shall make sense of it.

Since what is mentioned here is an implication, the mind shall be forced to consult mind linguistics pragmatics. Other meanings embedded within social reality shall be the determiner of meaning which is phenomenon commonly present in idioms. For instance, while "Şekerleme yapmak" idiom in Turkish

is the equivalent of producing sugar, for an English person the same idiom means "taking a nap".In the advertisement text described above the person cannot solve the semantic structure between images of flower and linguistic message without knowing the element of discussion in man-woman relations and the role of flower in an apology ritual. Beyond that, once a subject that goes to upper abstractions is considered, this condition shall be carried to a far different level. For instance, a person contemplating on the relation between flower sales and advertisement shall not only think about the analysis explained above but, s/he also consider other parameters on a more abstract level. If s/he has an anti-system critical mind, based on this paradigm, this person can read the theorem on advertisement "buying flower in line with the level of anger" as "in capitalist system even love relations are materialized". A more competent mind can make sense of the same message as "reification". That is the way the mind functions on and on and what makes this possible is nothing but the stability feature of the device. Interaction which is actualized through reception that is based on the stability of device, enables the functioning of mental mechanism in deeper dimensions.

Interaction Through Listening

In the interaction through listening the device provides a verbal motion. This motion not only keeps the mind away from deep thoughts but it also operates the imagination intensely. A soccer match broadcast on radio is a good example. A subject listening to the match receives the story of speaker through verbal means. During this process the sound vibrating through air shall resonate in the ears of listener and turn into audio images in mind. Yet, unlike visual elements, these images are not presented in ready forms. The listener shall be obliged to imagine the narrated things in his/her mind. This condition pushes the imagination to operate intensely. The unique capacity of radio in creating a phantasm world is the determiner of its singularity as well. A mental world created through pure hearing is subjective to the same extent.

Mental interaction through hearing strengthens the emergence of subjective judgments as well. To illustrate, a verbal theorem "With the introduction of Post-Fordist production structure, surplus emerged" shall find a meaning within all mental designs that took place until the time theorem was presented. This meaning is a formation actualizing in an imaginary background. This formation does not take place in a form that is based on a personal graphics or gestures and mimics of a presenter. It is totally shaped within subjective semantic auras that are attributed to the historical transformation of the person's own production structure which adds a unique dimension to act of making sense. Among free associative semantic phrases any radio listener makes sense of the issue from a different aspect. This condition is a unique feature determining the quality of learning.

As a device, another feature the radio provides us is mobility. With the discovery of transistor technology in Bell Laboratories, this feature has forced us to take a new parameter into account about sense making. Indeed, while the presented images are made sense in a phantasm world, the space we are in can also emerge as a determiner. The mental condition of a person travelling in his car and the person drinking tea in his yard and listening to the radio at the same time are not identical at all. The mind shall meet a different imaginary environment depending on the place radio is used. This stands before us as an element determining the success of reception so much as the level of reception.

The disadvantage of radio as a device is that it offers a singular image. Ferdinand de Saussure in his work Courses in General Linguistics (2006) presents an indicator as a combination of one concept and audial image but, an indicator is a combination of one concept and a good number of audial images. For instance, a piece of cube sugar is the expression of the unity of'sweet, hard and white'images. In society

one or more than one of these images take prominence on pragmatic level and becomes the main image explaining the concept. For cube sugar, the dominant image here is the sense of tasting. Accordingly, this definition presents us a fact: A thing can assume its real meaning through various images. Pure audial images are at the same a conceptualization that is deficient. This shows us the hardship that surfaces on the free associative level of conceptualization of radio.

Interaction Through Seeing-Listening

The main components of devices that function according to the operating principles of television and radio are not only determined by visual and audial unity but element of motion as well. Arthur Asa Berger in his article Television as a Device of Terrorism (1991) reports that television as a device attacks to us with a beam of light. During this process the mind is forced to continuously monitor light beams and the motion. Television captivates the mind involuntarily. Such kind of a mental captivity impacts its reactance as well. In an interaction through television, the share of phantasm is rather limited. Due to the device characteristics, it minimizes its imaging competencies. It is no doubt that this is a feature that comes with a pure concentration.

Another characteristic of television is its capability to present visual and audial elements together as a device. That means while on one side semantic codes arriving through linguistics messages construct a discursive meaning, on the other side the semantic supplements that come with mobile audio indicators complete this discursive structure. Let us analyze the news narrating the operation of armed forces against illegal protestors. The images of the news shall be surrounded with chaos and combats. Simultaneously, a speaker shall read a text that constructs a discursive structure on these images. In the presentation stage the viewer shall focus on the news text guided by the news transmitted from news reporter. Generally, such type of information introduces question marks. While watching the news, a viewer finds answers to the questions in his/her mind at the same time. This reactionary model determines the act of making sense, too. Here, the images assume a secondary quality. They go beyond observation and function as evidence. However, in addition to this function, they also constitute the main component of making sense of the text. A person focusing on images gets away from imaginative competency and throughout act of watching, s/he moves away from abstract meaning auras which dwell on the upper dimensions of the mind. The main reason accounting for this fact is that verbal and visual motion operates quite fast. Similar to the example, we have shown two parts earlier, the mind cannot read the text within a conceptual formation like "reification". This constitutes the weakest point of the mental interaction through seeing and listening.

The strong aspect of such interaction is that when a visual indicator is required, it can provide it on the spot. Some things are, regardless of their strong literary competency, hard to explain through linguistic means. Television and similar devices present such an image and they can also mobilize this image. The integrity of audial component is another element strengthening the competency of description. Hence, such devices rise to a competent position not through imagination but the available capacity of presentation. Regarding unmediated description, there is nothing above television. This competency is present in narration as well. Narrative forms function as a primary element in assisting the individual to comprehend the world. Ludwig Wittgenstein in his work Philosophical Investigations (1953) explains it through metaphor of language games. According to him, our relationship with the world is totally determined within the metaphor of game. From this point of view, we can reasonably assume that television is quite a competent device for us in internalizing the world.

Another point to consider in television broadcasts is meta-communication. On radio this element is possible only via sound tones but on television the dubbing and attitudes of portrayed characters shall be determiners. Referring to the previous example, if the news reporter made a face while narrating the news, we would perceive this act as a sign of discontent towards the protestors and their ideology as well. Unquestionably, this would be an element that would affect us while reading the text. Again, the intonation of the speaker would be equally effective. That would be an element forming both its disadvantage and advantage. Pragmatic dimension of meta-communication is totally associated with its application.

Interaction

Interactivity stands before us as a communication form where mutual interaction is sustained. The difference of interactive communication devices from others is that they enable a reciprocal interaction. Teleconferences, live television links and internet use can primarily be given as examples. Interactivity is used mostly for situations where audio visual elements are reciprocally shared. Simultaneity is the main principle. Therefore, mediated feedbacks cannot be included within this context.

Regarding their device aspects, the devices that make interactivity possible are no different than the ones presented in the previous section. For instance, in an interaction via internet the elements valid for television shall be the same. Additionally, the windows enabling reciprocal chat shall be also included. This element shall be influential on communication course but, it shall also act as a process determining the direction. Indeed, a speaker shall form the direction of a speech according to the reactions and instead of a flat narration s/he will prefer a circular interaction.

One of the most critical aspects of interactivity is that the share of package forms is reduced. Communicational structures which are mostly based on reciprocal chat, limit the existence of production elements. Consequently, in an interactive communication environment, the devices are not as determinative as they are on television. However, during the process, the share of the domination of meta-communicational structures on meaning rises.

In interactive applications, the low quality of the conditions enabling the interactive communication is another striking point. Since vision, sound and transmitting elements are actualized in relatively low quality, there is a definite decrease in their effectivity rates. In addition to all, interactive environments lack the level of interaction provided via face to face interaction. For instance, in a course presented on electronic environment, the instructor is no more than a small image window for the viewers. For the instructor the viewers are simply a chat window on computer. That condition is determinant in the success of reciprocal interaction as well.

A suggestion made by Scandamalia argues the classroom conditions as a knowledge building environment. In her article (1994) Scandamalia focuses on the educational ideas for knowledge-building discourse - with some discussion, and she argues that the classroom needs to foster transformational thought, on the part of both students and teachers, and that the best way to do this is to replace classroom-bred discourse patterns with those having more immediate and natural extensions to the real world, patterns whereby ideas are conceived, responded to, reframed, and set in historical context. Her goal is to create communication systems in which the relations between what is said and what is written, between immediate and broader audiences, and between what is created in here and now and archived are intimately related and natural extensions of school-based activities.

MODEL

The subject matter is illustrated in Figure 1.

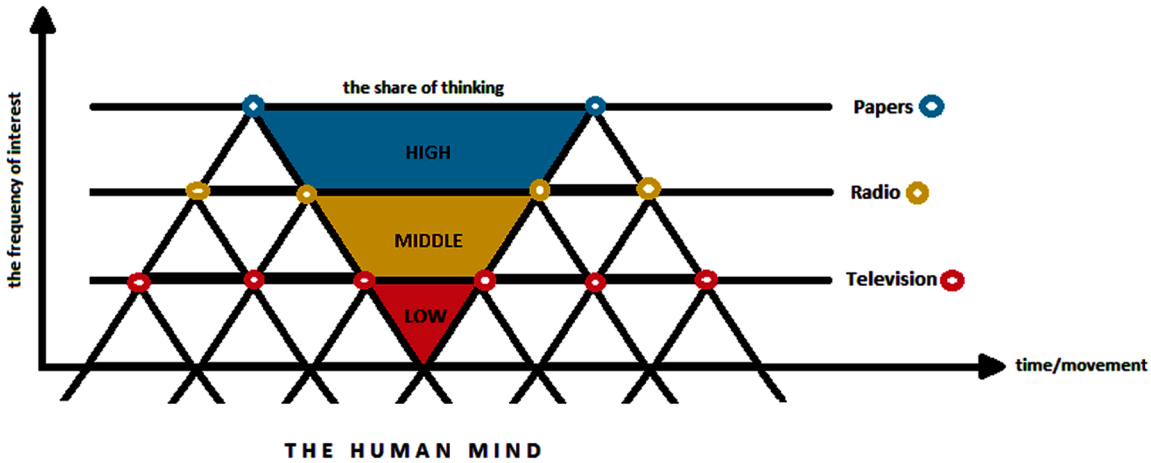
American Philosopher Charles Sanders Peirce cites about that kind of knowledge in his work On a New List of Categories (1868) and clarifies man's ability to 'conceptualize' instead of what we propose as 'symbolize'. He also claims that:

… universal conception which is nearest to sense is that of the present, in general. This is a conception, because it is universal. But as the act of attention has no connotation at all, but is the pure denotative power of the mind, that is to say, the power which directs the mind to an object, in contradistinction to the power of thinking any predicate of that object, -- so the conception of what is present in general, which is nothing but the general recognition of what is contained in attention, has no connotation, and therefore no proper unity. This conception of the present in general, of IT in general, is rendered in philosophical language by the word "substance" in one of its meanings. Before any comparison or discrimination can be made between what is present, what is present must have been recognized as such, as it, and subsequently the metaphysical parts which are recognized by abstraction are attributed to this it, but the it cannot itself be made a predicate. This it is thus neither predicated of a subject, nor in a subject, and accordingly is identical with the conception of substance.

If the concept of knowledge is defined as 'the act of rationalization of things', we define the concept of time as 'a mental sequence'. We think on the basis of the mental mechanism which is formed by Peirce, we can better understand Figure 1.

As shown in Figure 1, we see the mass media devices and the human mind which is directed towards them. The horizontal axis of the model is presented movement/time curve. This curve is linear. The vertical axis is presented us with the frequency of mental attention. Each point on figure represents the human mind's interaction with the mass media devices. When we follow-up contacts, we see the mental contact time increased gradually, which is necessary for thought. Clearly, decrease in hiatus which the thinking prevents, causes an increase in the share of thinking. Difference in level are shown as low,

Figure 1. A model for mind-device dialectics (analog media)



medium and high in figure. As described in the previous part of this study, television is in continuous motion, for this reason, requires a focus on high to get in touch with it. This situation leads to a lower consciousness. Therefore, the lowest share of thinking attributed to the mental contact with television. Due to the same reasons, consciousness is at medium level for the radio, high level for papers. Internet has a mixed content, so it is not mentioned and not inserted into the model.

THE IMPACT OF DIGITAL MEDIA, AUGMENTED REALITY AND DIGITAL RHETORIC IN THE PROCESS OF KNOWLEDGE BUILDING

It is possible to mention five basic characteristics of mass communication within the context of mental interaction. The first one is spatial independence. Unlike other communication forms, within their present communicational structures, mass communicational devices perform their interactivity by extending beyond contextuality in spatial meaning. They can perform the communication simultaneously in an area of thousands of kilometers. As a secondary feature, this simultaneity, which can be designed, determines the strength of devices together with spatial independence.

The third characteristics of mass communication are that it can be directed from a center. The existence of a central area and simultaneous interaction that is independent of space gains them a capability of public control. As explained in previous sections, this is an instrumental capacity originating from their implemental (device) aspect. Through mass communication, public opinion can be guided in a variety of ways. This guidance can be actualized on ideological dimension as well as learning dimension. Such public control constitutes the fourth dimension of mass communication within interaction.

The fifth feature is the cost efficiency. Installing a mass communication can be a real challenge. The installed communication may appear to be costly but, once analyzed within the scope of mass context, it becomes clear that in the long run the cost of communication decreases significantly. For instance, the cost of an advertisement reaching the consumers through television is around 3 Dollars per thousand people. Indeed, media planners calculate the costs per thousand instead of per one person for the ease of calculation (Basal, 1998).

Those five elements also construct the structure of communicational information. All these elements emerge as an indirect element determining order for orientation. People are likely to imagine mass communication as a device. Mass communication is indeed a device for its beneficiaries rather than users. The pragmatism of interaction operates through logic of coverage. This logic has spread to all media systems.

Learning is defined as the continual change occurring in behavior as a result of repetition and experience. People spend a great deal of their lives with learning hence a huge part of psychology is dedicated to learning as life goes on through learning. Learning mostly takes place in three forms which are classical conditioning, contingency conditioning and cognitive learning. People can learn through conditioning but they mostly learn through cognitive ways. Learning through cognition is usually an outcome of actual practices and element of cognizance is at the center. During this process, the individual transfers the data of external world to his mind and this mental accumulation grows continually (Morgan, 1956, Ch. 4-5).

Principally the first element determining human learning is language aptitude. Thanks to language aptitude, a person can abstract the words and concepts and construct the interaction between them. Personal success is on the other hand determined by intelligence level, age, anxiety and stimulation and previous learning. The longevity of something learnt is set according to the positioning level in memory. The structure of learning material, way of learning, level of affinity and repetitions are determiners here

(Morgan, 1956). It is obvious that after all, learning is a construction of information. If we handle information as raw information, processed information and reprocessed information, we can put learning through education to the third category. Information constructed through mass communication is also within this category.

Information constructed through mass communication is, above all else, a pragmatic information. People who consult to a mass communication device for information, perform a pragmatic act. The organizational structure conveying them the information becomes part of another type of pragmatism due to the relations outside its own realm. Hence, the act of informing is also pragmaticized in a different dimension. The association among ad-giver, media channel and viewer sets a good example to this dimension. The orientation of viewer to media channel will be different from the orientation of media channel towards viewer. Media channel will be forced to discover the viewer while viewer shall be oriented to the channel hoping to have fun or catch the news. State of stimulated condition and affinity that emerge as a result of such anxiety become a personal external element determining the success of learning. A trainee, since s/he will be consciously oriented to learning, shall have high affinity level and the level of forming mental effectivity through mass communication will be higher.

The functionality of mass communicational information is conditioned by the materials used. As indicated previously, each device operates the mind in different dimensions. For that reason, one of the points to focus on in act of learning is the outcomes of mind-device dialectic. For instance, while information on a newspaper allows the reader to make a comparison with previous learning, this is not the case on television. On the other hand, the power of visual imagination of television cannot possibly be compared to newspapers. Therefore, each device shall be effective in different levels and competencies. As regards systematic learning however, it is necessary to apply a design that goes beyond daily information. New technologies which have developed in our daily life have also changed learning. In addition to this, it depends on mechanic structure presented here above. Digital media devices present a kind of mixture of analogue media, in some cases exceed reality presented by analogue media. Augmented reality can be shown as an example for this case.

The term Augmented Reality (AR) expresses military technology. The mentioned technology which has been used for more than ten years can be regarded as candidate for the most popular advertisement applications of future. Augmented reality was developed as an extent of more general study field which is known as Mixed Reality (MR). Application field of Mixed Reality includes virtual reality (VR), augmented reality (AR), Telepresence and other related technologies. While virtual reality expresses reality which was created in non-physical environment, telepresence includes illusions created in concrete field. Augmented reality refers to semi-virtual, semi physical reality. Whole of practices which were developed from a technology called Head Up Display (HUD) is integrated into the field of advertisement today. Head up display was used on the cockpit monitor of war craft pilots and at glasses adapted to helmet used by infantry. Due to these glasses or monitors, it was possible to convey specific informative data such as speed, heat, height, coordinate, radar. Adaptation of technology to advertisement was possible with smart phones. Due to some application loaded on smart phones, it was possible to form interaction through ordinary billboards. This interaction makes it possible to make connection between virtual and real world. Technology is currently available in applications synthesis of billboard-smart phones. When you show smart phone on billboard, stable objects on billboard move within telephone. Let's consider a jeep advertisement. If you have a smart phone and applications are loaded on your phone, the vehicle which seems immobile to the naked eye would move when you show your phone, maybe tour around or tumble or even pierce the billboard and wander on the street. When it is imagined, it would be understood

how enjoying the advertisement is. The element of entertainment included within the core of application forms the ground of possible popularity. Augmented Reality technologies whose actualization is possible through combination of real and visual worlds, real-time interaction and existence of 3D recording elements seems to ease the job of advertisers in today's world, where the interest towards marketing messages is obtained quite difficultly (Taskiran & Yilmaz, 2013; Bimber & Raskar, 2005; Kuru, 2009; Silva, Oliveira & Giraldi, 2003; Yücel, 2005).

Another element which differs digital media and analogue media is digital rhetoric and its meta-communicative impacts. The concept of meta-communication refers to the whole of external elements in the communication process. These elements are decisive on the meaning. For example, we think, two people are talking to each other, each sentence will express a proposition in the process of speaking, however, the real meaning will emerge along with such factors as gestures, facial expressions, tone of voice, as well as verbal messages. This phenomenon that communication configuring in this way is called meta-communication (Demiray, 1994; Klinger & Coffman, 2011; Firat & Yurdakul, 2011).

The emergence of digital rhetoric as a concept is related to the transformation of lifeworld (lebenswelt). Digital rhetoric and traditional rhetoric are different concepts. The biggest difference between the two concepts is perceptions of meaning. In contrast to the traditional rhetoric, digital rhetoric is not considered to be a sign of linguistic messages alone. According to this new understanding of the meaning, complex images and sounds as well as the syntactical subtleties of words, and digital world has a shifting mix of words, images and sounds. "How the resources of different semiotic systems have been and can be combined?", answer the question of the search effort resulted in the emergence of the concept of digital rhetoric. Thus, the concept of digital rhetoric is the scope of visual rhetoric largely (Handa, 2001; Lanham, 1992; Lanham, 1994; Lanham, 1995; Lemke, 1998; Porter, 2009).

James Berlin claims that:

Our business must be to instruct students in signifying practices broadly conceived- to see not only the rhetoric of the college essay, but also the rhetoric of the institution of schooling, of politics, and of the media.…We must take as our province the production and reception of semiotic codes, providing students with the heuristics to penetrate these codes and their ideological designs on our formation as subjects. Students must come to see that the languages they are expected to speak, write, and embrace as ways of thinking and acting are never disinterested, always bringing with them structures on the existent, the good, the possible, and the resulting regimes of power (1996, p. 83).

In this context, we can consider digital rhetoric as a meta-communicational form. The concept is of great importance, especially in learning and interaction. Way of structure of digital media in knowledge-building, augmented reality and digital rhetoric give various clues transformation of our daily life and future of advertising. Let's discuss in the conclusion section how we can make use of these in order to form the impact of analogue and digital media and effective advertisement strategies.

CONCLUSION

From the models and issues we have discussed so far, it is possible to make specific inferences about effectiveness of advertisement texts of media means. The first point to pay attention is that while preparing a learning strategy, an inter-instrumental structure should be used as a base. As analyzed in detail earlier,

each device has different capacity regarding mind operation. While preparing learning materials, this should be taken into account and concept construction, different characteristics of different devices in language and visualization should be employed coordinately. To that end, first of all the deficiencies of devices should be clarified. The gaps which are likely to emerge in the act of learning should be filled by making use of other devices. These deficiencies can be given as: 1- For the interaction through listening, lack of visual image. 2- For the interaction through reading, the stability or mechanical immobility of visual image. 3- For the interaction through seeing-listening, shift of attention to visual images or lack of abstraction. 4- For interactivity, motivational lacks caused by spatial distance and meta-communicational deficiencies. However, it should also be remembered that while preparing the strategy the strong sides of devices should also be taken into account. These strong sides have been explained in detail in the fourth chapter.

The second point deserving attention is that learning is an activity that mostly takes place on conceptual level. In this level, the dialectic relation between language and thought should be paid heeds. Particularly in concept construction, printed materials (billboard, newspaper ads etc.) should be focused on more audio-visual and audial devices should act as a pre-information provider and reinforcer. The level of applied language also emerges as a significant element at this point. In all acts, except act of reading, it should be ensured that the abstraction of the employed language and familiarity of the words are not beyond the comprehension of receiver. It should be kept in mind that the success of communicational transfer is usually determined by the success of reception.

The speed of contact in the attempted interaction is the third point we must note. This is directly proportional to the mechanism of employed device. There is a connection between implemental (device) mechanism and the way this mechanism operates mental mechanism. In particular, the mechanical structure of printed materials draws a favorable picture for concept construction. On the other hand, audio-visual devices can be more effective in context formation and reinforcement. Purely audial devices can be useful in reinforcing through repetitions.

To sum up, the final point to pay heeds is the role of individuality in the success of learning. Each receiver has a different mental structure which eventually determines the final success of learning. For instance, for a person with high visual intelligence television or internet would be an effective channel while for a receiver with high verbal intelligence the opposite holds true. Also with respect to implemental (device) interaction forms, different reactions are likely to emerge.

Digital media has a different appearance. First of all instruments are different from analogue media and include characteristics of analogue media. For example on a smart phone one can both read a stable text and catch an audible mobile image. This enables opportunity to gather knowledge-building process based on analogue media operating human mind in advertisement texts.

The second important factor is that digital media means are more functional compared to analogue media means. Mobility is the foremost one among these functional characteristics. People not only fulfill their need of talking with their telephone but phones also enable people to have non-stop communication with the world on global scale. While applications created at high technology enable opportunity of interactivity on one hand, it also makes possible to carry out viral studies more powerfully.

The final issue to be mentioned is the position of digital media against reality. The issue that traditional media build human reality has been an important discussion issue of academicians until recently. Here is the difference of digital media. Beyond managing our reality perceptions, it would open path for shifting towards a new reality dimension in a near future. The term digital culture will be mentioned more explicitly apart from terms of verbal culture, written culture and visual culture. Even if we do not

improve as far as technological determinists assert, it is impossible to deny the impact of technology on human mind. Our minds which are shaped within augmented reality, effectiveness of advertisement texts and rules for advertisers to make more effective strategies will be formed with original structure of this status of humankind.

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KEY TERMS AND DEFINITIONS

Advertisement: An action for marketing communication which is carried out by place and time from advertisement media by emphasizing on its being advertisement.

Advertising: As the expression of the ad business area.

Analogue Media: Mass traditional massive devices which display activity on unidimension such as newspapers, radio, television.

Augmented Reality: The term which defines combined reality which is possible with applications in devices such as specially produced glasses, or smart phones, tablet and formed with intertwinement of reality and visual reality.

Digital Media: General name for communication means which has emerged with the development of communication technologies, includes characteristics of analogue media and combines them with digital methods.

Mind-Device Dialectic: The structure of interaction which explains media devices and how these devices operate human mind.

Semiotics: A field which was developed simultaneously within the same historical period by two philosophers who lived in two different parts of the world. Semiotics deals with the production and reproduction of meaning.

Social Media: A form of interpersonal communication, how is without limitation of time and space, and based on the sharing and discussion, such as Facebook, Twitter, etc.

ENDNOTE

[1] A logical and natural consequence obtained from a definition.

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Chapter 38
Interactive Multimedia and Listening

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ABSTRACT

The topic of this chapter is concerned with the use of interactive multimedia in teaching listening skills to English language learners. The chapter starts with the difference between listening and hearing, the definition of interactive multimedia, and interactive multimedia listening environments. Explanation is then given to why listening is so important. The chapter also addresses main types of listening, active listening process, and obstacles to listening. This chapter additionally shows the benefits of and rationales for listening using interactive multimedia resources in comparison with audio-only listening materials regarding visual support, authentic content, comprehensible input, vocabulary acquisition, and student motivation. The chapter concludes by suggesting some Internet sources and materials for listening practice as a part of learning English as a foreign or second language.

INTRODUCTION

With the development of information and communication technology (ICT), teaching with multimedia resources is becoming a trend in foreign language teaching environments. Recent researchers (e.g., Warshauer, Shetzer, & Meloni, 2000; Lombardi, 2007) tends to agree that interactive multimedia learning environments offer language learners a source for authentic materials, specialized materials, a place for authentic communication, a collection of tools which allow learners to share their ideas, knowledge, and student-or teacher-created materials. Especially, listening practice with multimedia materials offers learners appropriate support, guidance, training, and scaffolding. Language learners can choose the materials so that interactive multimedia materials enables them to become more autonomous, which is one of the skills learners need to develop today, as well as the materials allow them to monitor their learning and take on responsibility for their learning. Language learners can also use the Internet for self-study purposes without the need for a teacher. Moreover, interactive multimedia materials give learners the opportunity to acquire and practice essential 21st century professional skills such as critical thinking skills, problem-solving skills, cooperatively working skills, etc.

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In this chapter, I shall first give the definitions of key terms such as listening, listening comprehension, and interactive multimedia listening environments. I then review some studies on the importance of developing listening skills of language learners as a part of learning English as a foreign/second language. I additionally discuss the types of listening, the stages of listening, and the factors that influence listening comprehension. I also review some research on the benefits of the use of interactive multimedia resources in listening practice. I finally suggest some Internet sources and materials (see Table 1, 2, 3, 4, 5 and 6) for listening as a part of learning English as a foreign/second language.

MAIN FOCUS OF THE CHAPTER

What Listening Is

Listening is the vital skill that provides the basis for the successful communication and successful professional career. According to Purdy and Borisoff (1997), listening is a primary skill among the basic skills that bring success in our everyday life. "There is no meaningful communication without listening," (p. 4). It is said that people learn to listen first, then speak, read, or write, (p. 4). Research has indicated that among the four communication skills: listening, speaking, reading, and writing; people spend more time listening than the other three skills, (Cotton, 1986). Regarding foreign language learning, Nunan (1989) states that that foreign language learners spend over 50 percent of their time on listening. Brown (1987) also notes that "of foremost importance is the role of listening in language acquisition," (p. 5). There have been several definitions of listening, and it appears some confusion between listening and hearing. So, what are the differences between listening and hearing? And what is listening comprehension?

Listening vs. Hearing

There has been a variety of the definitions of listening comprehension process. One of the earlier definitions given by Lado (1961) emphasises that listening comprehension is "recognition control of the signalling elements of the language in communication situation," (p. 206). Another definition of listening indicates that listening is a complex communication behavior, involving a process of receiving, attending to, and assigning meaning to verbal and/or non-verbal stimuli," (Coakley & Wolvin, 1986, p. 20).

Chung (1994) defines listening as a communication activity in which listeners receive messages and understand the messages through the three types of information including oral messages (i.e. words and sentences), paralinguistic messages (i.e. extra-speech sounds) and non-verbal messages (i.e. facial expressions, gestures, eye contacts, etc.), while Nation (2009) claims that listening occurrs in two ways: the process of transmission of information (one-way listening) and the process of social interaction (two-way listening).

Therefore, listening is an active process in which listeners make their concentration and conscious effort to understand and respond to spoken and non-verbal messages. In other words, listening requires focus on and attention to what is said, how it is told with the use of language and voice, and how the speakers use his or her body language (i.e. gestures, facial expressions, and eye-movements, eye contact, body movements, etc.), (Brownell, 2010). For example, when we listen to a good song, a weather broadcast, an education report, etc. we give our full attention, which is different from hearing traffic noise or a child's shouting on the playground.

Hearing

Hearing refers to the act of perceiving sounds by the ear. Hearing is a physiological process, while listening is a cognitive process. For example, we hear someone's words or a noise outside such as the sound of traffic or music. Thus, hearing is an automatic and passive process which occurs when our ears pick up sound waves which are then transported to our brain. It uses one sense – hearing. However, listening requires more than one sense including the sense of hearing, observing, or even touching.

Both hearing and listening require the use of our ears, but hearing occurs all the time whether we like or do not like what we hear, while listening occurs only when we consciously choose what we want to listen to with a purpose. It may be to achieve information, solve problems, share interest, show support, or understand others. Therefore, we concentrate on the spoken message in order to comprehend it and perhaps react or respond to what the speaker is talking about.

Listening Comprehension

The term 'listening comprehension' is defined in the Longman Dictionary of Language and Applied Linguistics (1992) as follows. Listening comprehension is the process of understanding speech in a second or foreign language. The study of listening comprehension processes in second language learning focusses on the role of individual linguistic units (e.g. phonemes, words, grammatical structures) as well as the role of the listener's expectations, the situation and context, background knowledge and the topic. It therefore includes both top-down processing and bottom-up processing. While traditional approaches to language teaching tended to underemphasize the importance of teaching listening comprehension, more recent approaches emphasize the role of listening in building up language competence and suggest that more attention should be paid to teaching listening in the initial stages of second or foreign language teaching (p. 313).

Thus, it can be concluded that listening comprehension is not a passive process but a complex, active process of interpretation in which listeners match what they hear with what they already know. This process requires active involvement from the listeners to try to understand the message from both linguistic and non-linguistic sources. With the development of ICT, enhancing listening skills with interactive multimedia listening materials is becoming a trend in foreign and second language teaching and learning environments.

Multimedia

Multimedia is defined as the integration of several different types of media: text, audio, graphics, animation, and video into a program or a learning course (Cybermedia Creations, 2006; Turel, 2014a). According to the Longman Dictionary of Language Teaching and Applied Linguistics (1992), the term "multimedia" refers to "a collection of computer controlled or computer mediated technologies that enable people to access and use data in a variety of forms: text, sound, and still moving images," (p. 345). Multimedia is also defined as an optimum combination and instant delivery of a wide range of digital elements on the same digital platform which "provides a multidimensional, multi-sensory environment in which rich, efficient, instant, comprehensible, optimum and meaningful input and feedback can be presented" in effective ways (Turel 2014a, p. 167; Turel, 2015).

Today, the advancement of technology has made significant impact on the evolvement of English language teaching and learning methods from traditional face-to-face teaching to Computer Assisted Language Learning (CALL) or e-learning systems in all levels of education. Modern education and communication environments can offer alternative ways in the learning process. Multimedia has been widely used in educational technologies. It is believed that multimedia learning tools can be used as a supplement to traditional classes since it can assist language learning processes. Many researchers, including Lopuck (1996), Jones (2003), and Gaskins, (2010) tend to agree that multimedia helps enhance and enable language learners to acquire the target language and, consequently, it offers them more effective language learning. Therefore, using interactive multimedia in language teaching and learning attracts more attentions of researchers, institutes, educators, language teachers, and learners. More efforts are needed to design and create interactive multimedia language learning tools and software to fulfill a content-rich learning environments to provide to different language learners (Turel & McKenna, 2013). Because multimedia allows integration of text, graphics, audio, and motion video in a range of combinations, learners can now interact with textual, aural, and visual media in a wide range of format.

Interactive

Interactive is used in computer assisted instruction to describe the ability of a user to communicate with a computer, for example, the involvement of a question on the computer, a response from the user, and feedback from the computer (The Longman Dictionary of Language Teaching and Applied Linguistics, 1992).

Interactive Multimedia

The term "Interactive Multimedia" is used to describe a physical or digital system where multiple media or people have an effect on each other through their interactive behavior. When "Interactive Multimedia" is used in fields such as art or education it implies the use of multiple media for expression or communication and the existence of a dynamic user-state or content-altering capability. Cybermedia Creations (2006) defines interactive multimedia as a "two-way interaction with multimedia course material, another computer, or another user with direct response to the input, as opposed to one-way communication from T.V, video, and other non-responsive media," (p. 2). Moreover, Turel (2015) defines interactive multimedia as "the combination and delivery of digital elements on the same computer platform which have links between elements in the form of buttons, hotspots or hyperlinks to create an interactive application in which users can navigate" (p. 2505). Interactive multimedia also involves using mouse input, touch screens, voice commands, video capture and real-time interaction that allows users to actively participate in the learning process. England and Finney (2011) stated interactive multimedia was the combinations of different types of media including texts, graphics, images, animation, video, and audio into resources and materials that offered users in general and language learners in particular the ability to interact with these materials such as browsing, navigating, analyzing, annotating or personalizing the materials for various purposes emerge in various fields including entertainment, marketing, education, engineering, scientific research, medicine, business, art and communication. These resources and materials could include the Internet, telecoms, interactive digital television, and other information technologies.

Interactive Multimedia Listening Environments

Interactive multimedia listening environments are used to describe multiple-media systems, software applications, materials, products, or courses that are designed to allow language learners to process combined media (text, sound, and video) simultaneously through physical interaction (e.g. pressing a button, choosing a link) in order to navigate through the data enabling listening skills acquisition. As multimedia technology becomes more accessible to language teachers and learners, its potential as a tool to support listening skills development becomes a practical option. Building interactive multimedia listening environments needs much more attention from researchers, educator, and language teachers so as to help learners improve their listening skills as listening is the primary skill among the four language learning skills.

The Importance of Developing Listening Skills

Wilson (2008) discussed the importance of developing listening skills in learners of English. He indicates that there are many good reasons why learners should listen to English, including access to the world, pleasure, travel and tourism, work purposes, and academic requirements. Similarly, Tramel (2011) also agrees that it is very important to develop listening skills in children because through listening and attention activities, children can explore the world by themselves, build relationships around them, develop their own behavioral patterns, and have a higher chance of good grades and outstanding comprehension of lessons. Kurita (2012) claims that, "listening comprehension is at the heart of language learning. Learners want to understand second language (L2) speakers and want to comprehend a variety of L2 multimedia such as DVDs and the Internet," (p. 30).

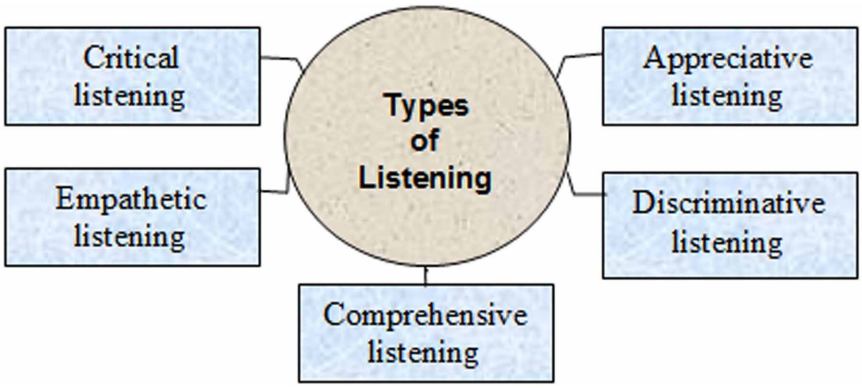
Besides the importance of listening skills, it should be said that listening competence is a complex skill that needs to be developed by practice. Wilson (2008) asserts that listening is a difficult skill in terms of the characteristics of the message, the delivery, the listener, and the environment (p. 12). Having the same opinion as Wilson (2008), Kurita (2012) states that, "in spite of its importance, second language (L2) learners often regard listening as the most difficult language skill to learn," (p. 30). Thus, the teacher plays a very important role in providing their learners with opportunities to reflect on their listening processes and practices. The teacher can help language learners with listening lessons not only to guide them through the process of listening, but also to motivate them to hear as much English as possible (Liubinienė, 2009, p. 92). For all these reasons, it is vital to develop listening skills, especially in English as foreign language (EFL) learners, and using interactive multimedia resources can develop learners' extensive listening.

Types of Listening

Coakley and Wolvin (1995) identified five types of listening which do not always exist singly. During the listening process, the listener sometimes requires to use more than one type of listening. These types of listening are clearly displayed in Figure 1.

- Appreciative Listening: The term 'appreciative listening' refers listening for enjoyment to the information that the listener is highly interested in. This type of listening is often made used of when listening to many forms of entertainment, music, television programs, and shows. For ex-

Figure 1. Types of listening according to Coakley and Wolvin's categorisation (1995)



ample, listening to a piece of good music, sports broadcasts, funny stories, or poetry is considered 'appreciative listening'. Also, we often use 'appreciative listening' in casual daily conversations to enjoy others' thoughts and experiences. Our appreciation of what we listen to will vary relying on our personal preferences and may have been shaped through our experiences and expectations.

- Discriminative Listening: 'Discriminative listening' is the most basic form of listening where the listener is able to identify the speaker's inferences or emotions. This type of listening also involves the ability to distinguish different sounds. With 'discriminative listening', listeners can recognise the gender of the speaker or the number of the speakers in the message. For example, they can probably distinguish the voice produced by a male, a female, a young person, or an old one. Listeners also probably know how many speakers are involved in the message. In addition, they may recognise differences in the way that sounds are made. These differences include distinguishing between regional accents, recognising foreign languages, emotional variation in speaker's voice (whether the speaker is happy, excited, upset, sad, angry, or stressed, etc.). 'Discriminative listening' does not involve understanding what the speaker is speaking.
- Comprehensive Listening: In 'comprehensive listening', the listener's goal is not only to understand the speaker's message, but also to be able to recall what has been said. The listener pays attention to all the information - the speaker's words, the tone of his voice, his body language, and the physical setting in which the conversation is taking place. Thus, 'comprehension listening' is also known as 'content listening', 'informative listening' and 'full listening'. To understand the meaning of the message, listeners need to have their linguistic knowledge and ability of the language such as knowledge of phonology, morphology, and syntax. An example of 'comprehensive listening' is that you are listening to a weather broadcast to get helpful information of weather conditions of the place you are going to travel to, or you are listening to a lecture presented by your professor to reach understanding of a particular subject in your course.
- Empathetic Listening: The emphasis of 'empathetic' listening is on understanding how the speaker is feeling and being truly empathetic and supportive. This requires an ability to listen to others and to feel empathetic for their feelings and needs. It additionally requires excellent discrimination and close attention to the nuances of emotional signals to be able to listen empathetically. For example, let us say that your close friend tells you that he has failed to get into college; you will probably listen to his story empathetically and feel sorry about that.

- Critical Listening: Unlike 'empathetic listening' which is non-judgmental, 'critical listening' involves judgment where listeners critically respond to the message and give their opinions. With 'critical listening' or 'evaluative listening', the listener listens in order to evaluate, judge, and give opinions about what is being said. Judgment includes assessing strengths and weaknesses, agreement and disagreement. This form of listening requires cognitive effort, as the listener analyses what is being said, relating it to existing knowledge as well as keeping listening to the incoming message to understand in order to make evaluations and judgments about the content of the message.

The Process of Listening

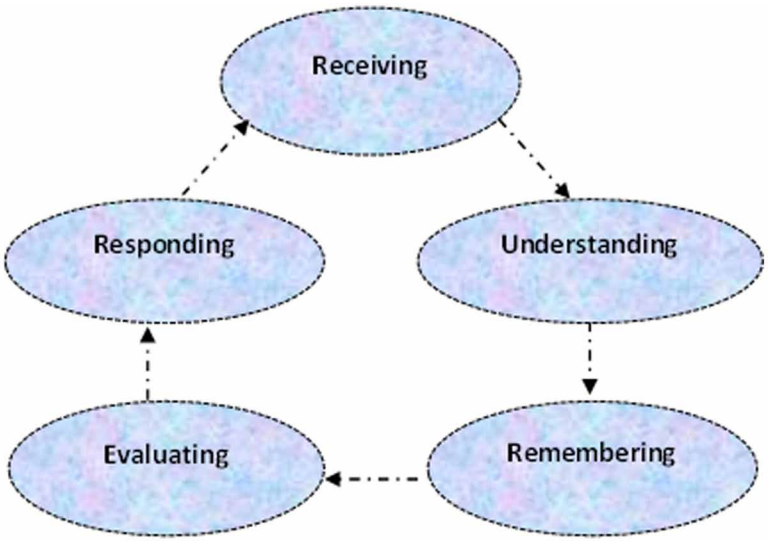
Listening is the psychological process of receiving, attending to, constructing meaning from, and responding to spoken or nonverbal messages. Listening process involves five stages which occur in sequence, showed in Figure 2.

The first stage in the process of listening is 'receiving' the message. In this stage, a listener perceives sound waves stimulating the sensory receptors of the ear; thus it is a physical process.

Understanding is also called interpreting or decoding. It refers the process of accurately decoding messages which are expressed through both verbal and nonverbal cues and finding the meaning of what is being said. During this process, listeners connect the information they have received from the message to their prior knowledge to make sense of it.

The third part of the listening process is remembering, which is also called recalling. It is believed to be an important part of the listening process because it is often used to indicate how well the listener understands information presented in the message. Remembering is well-known as the process of transferring the information from short-term memory which is a mental storage capacity that can hold a small amount of information in mind for a short period of time) into long-term memory which is relatively permanent memory and in which information can be stored for long periods of time (Hargie,

Figure 2. The process of listening



2011). What listeners might do at this stage is focusing attention on the central ideas of the message, organizing what they hear, summarizing the content of the message, relating new information to what they already know, etc.

Evaluating is the fourth part of the listening process in which listeners determine how the information they receive from messages is truthful, authentic, or believable, based on what listeners know about the topic of the message. In this stage, listeners are required to use critical thinking skills to make a worth judgment about what is being said.

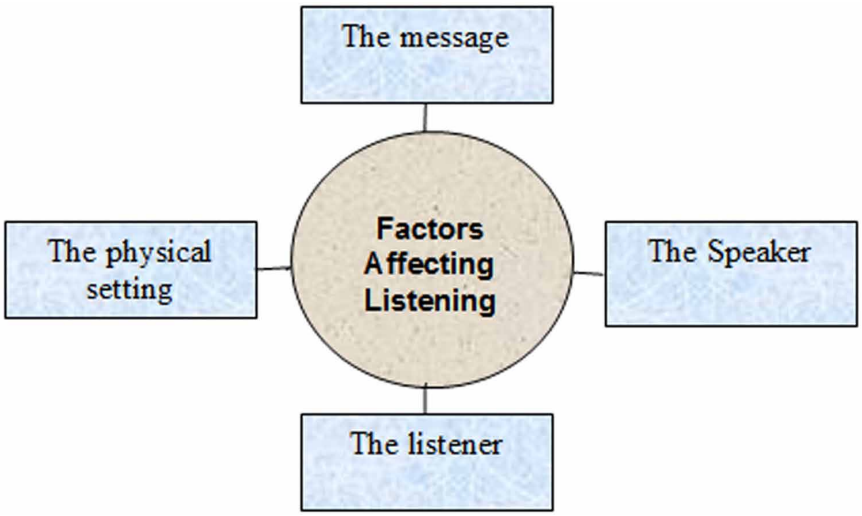
Responding is the process of reacting to what is being said. In the responding stage, a listener provides verbal or nonverbal responses (facial expressions, eye contact, nods) about the message or speaker. For example, the listener shows focused attention, asks questions to get additional details about the topic, shows support, agreement, or disagreement indicating whether the listener has understood the message and what the listener thinks of the message delivered by the speaker.

Factors Making Listening Comprehension More Difficult

Listening is a demanding process, not only because of the complexity of the process itself, but also due to factors that characterize the listening process. These factors are (a) the speaker, (b) the message, (c) the speaker, and (d) the physical setting (Brown & Yule, 1983), as shown in Figure 3.

- The Message: Studies have indicated some characteristics of the delivered message including length, content, organization, language forms, information density, delivery rate, and visual support that can affect second language listening comprehension. In terms of the message length which is measured as duration or word count, a longer message is associated with more difficult comprehension items. However, this effect is inconsistent across studies. The second characteristic is the content of the message which can interfere with listening comprehension. If content is fa-

Figure 3. The factors making listening comprehension more difficult



miliar, it is easier to comprehend than content with unfamiliar vocabulary or for which the listener has insufficient background knowledge. Regarding message construction, the third characteristic, poorly structured messages or messages that are too vague, too jargon filled causes listeners find it difficult to follow the message, whereas a message with well-organized structure, coherence, and discourse markers or transitions used improve listening comprehension. The fourth factor, language forms which refer syntactic and morphological features used in a message also affect listeners' understanding of the message. Krashen (1981) in his study about second language acquisition and second language learning indicated that language learners needs "comprehensible input" to learn a language. Thus, syntactic and morphological modifications have an important role in making input more comprehensible. For example, simple sentence structure and simple vocabulary used in a speech decreases the difficulty of listening material. Another characteristic of message is information density which refers how closely packed information is in the message. If the message is filled with more ideas, it makes the message more difficult to comprehend. There are many reasons for why a great amount of information in a message may increase comprehension difficulty. The primary reason is that with a message filled with a great deal of information, listeners often need additional effort to understand information that they have failed to comprehend. As a result, they may miss information that follows or are unable to understand later information because it depends on how much they understand earlier information (Goh, 2000). The fifth characteristic is the rate of delivery of the message which refers how fast or slow the message is delivered. A message delivered at varying rates of speed influences the listener's comprehension. Brown (2007) showed the difference between reading and listening is that in reading, the reader can stop and reread what he may concern, whereas in listening, the listener cannot stop or control the stream of speech which keeps flowing. Having the same opinion with Brown, Underwood said that "many English language learners believe that the greatest difficulty with listening comprehension, as opposed to reading comprehension, is that the listener cannot control how quickly a speaker speaks" (Underwood, 1989). For example, a listener cannot reach the speech because it has been delivered too fast, and this results in missing some information in the speech or not fully understanding its content, while a message delivered with few pauses will benefit the listeners because they are given extra time to listen. Finally, visual support accompanying the message such as video, pictures, diagrams, gestures, facial expressions, and body language help to improve comprehension (Turel, 2014b).

- The Speaker: The speaker's accent can make the message more difficult. People come from different parts around the world will have different accents. Thus, if learners are familiar with a particular accent, they might find it difficult to understand messages in unfamiliar accents. It would be a great idea that listeners should deal with a variety of British, American and Australian accents, and other accents. In addition, the language which the speaker uses impacts the listening process. For instance, if the speaker uses too many reduced forms, idioms, slang, or reduced forms in his speech, these will hurt second language listening comprehension. By contrast, if the speaker uses a lot of redundancy which includes hesitations, corrections, rephrasing forms, repetition, insertions, and pauses during his message, the listener may be beneficial from these because they can get more time and more information to comprehend the delivered message with ease, (Brown, 2007).

- The Listener: Listener characteristics appear to affect listening comprehension. These characteristics include listeners' background knowledge about the listening topic, their language proficiency level, their working memory ability or willingness to concentrate during listening. When a listener knows well about the topic, it may increase the listener's listening comprehension because his prior knowledge helps to facilitate understanding of the message as well as predict what is going to be said. Otherwise, a listener listens to a message about which he has insufficient background knowledge; the message becomes more difficult to comprehend. For example, the listener may use some of extra cognitive processing abilities to repeat, rephrase, or reorganize messages in a way that reinforces the primary message. Moreover, English is a "stress-timed language as well as the language with rhythm and intonation patterns. If listeners become aware of these characteristics of the English language, it helps process listening, (Brown, 2007). Language proficiency level is an additional factor that has a profound impact on effective listening. For example, a listener who has greater phonology, morphology, syntax and vocabulary size of the target language are able to make sense of the message easily. In addition to the characteristics above, personal factors such as interest and motivation also aid comprehension. If the listener is very interested in what is being said, this makes the listening process take place more easily than a listener without interest in the message. Motivation is an additional factor that influences listening comprehension. When a listener is motivated to listen or has a specific listening purpose, he tends to pay attention to information that benefits him in some ways and may ignore other information that he does not find personally relevant. Physiological and psychological variables such as weakness, sleepiness, and tiredness, mental anxiety, boredom, and frustration also impact listeners' ability to understand the spoken message. Aside from cognitive capacities and personal factors above, listening practices and listening strategies can interfere with listening. For example, listeners with limited prior exposure to the language, a bad listening practice, or poor listening strategies during the listening process finds failure to understand what is being delivered, compared with those who has frequently listening practices and use effective listening strategies such as listening for the main idea or specific details, summarizing, predicting a speaker's purpose, seeking clarification, drawing inferences, etc.

Though we are in full agreement that message, speaker, and listener characteristics are all responsible for successful or unsuccessful listening comprehension, there are additional factors which may cause comprehension prevention. One of these factors is the physical setting.

- The Physical Setting: The physical setting includes environmental and physical factors which present barriers to effective listening. One of these factors is the classroom environment itself such as lighting, temperature, furniture, and the presence of environmental noise that can affect our ability to listen. For example, the uncomfortable feeling resulting from an exam room that is too dark, too hot, or too cold can affect the students' concentration and ability for listening comprehension.

In addition, the quality of sound in the recordings, technical problems with the audio equipment, background sounds and noise inside or outside the room such as sounds of traffic or people talking or distortion in the audio signal are barriers to comprehension.

Reasons for Using Interactive Multimedia in the Language Classroom and for Listening Comprehension

Lopuck (1996) claims that language learning in interactive multimedia environments can provide better ways of presenting information than single media (e.g. only audio or video). Especially, listening practice with interactive multimedia materials offers better understanding, easier learning, more engagement, and more empowerment, and more enjoyment than with single media. Consequently, learners become responsible for their own learning and gain control over the listening process.

According to Gaskins (2010), there are many advantages of using multimedia in the classroom. One of the advantages is student motivation. In multimedia environments, students become motivated to participate in classroom activities since various learning styles are addressed simultaneously (e.g. seeing, hearing, imaging, etc.) to meet the needs of many students, to attract students' attention, and to make learning fun. Another advantage is that both learners and teachers can access to endless materials or resources for their learning and teaching. Multimedia additionally offers student-centered learning in which learners can control their own learning and are responsible for their learning through collaborative learning activities, project-based learning activities, or even self-study. Life-long learning and critical thinking skills are also believed to be built for learners in interactive multimedia learning conditions. Multimedia helps learners to retain their learning, enjoy the learning, and study much more with the provision of enjoyable learning styles, scaffolding, visuals, etc. Lastly, through a multimedia learning environment, learners may build many life-long skills, e.g. critical-thinking skills which will also be required for their daily activities beyond school as well as for their future work.

According to Warshauer, Shetzer, and Meloni (2000), there are five main reasons to use the Internet for English teaching: authenticity, literacy, interaction, vitality, and empowerment. In terms of authenticity, the authors states, "language learning is most successful when it takes place in authentic, meaningful contexts" (p. 7). Another reason for using the Internet for language teaching is literacy. Language teachers offer students an opportunity to develop their abilities of listening, speaking, reading, writing, communicating, researching, and publishing. Interaction is additionally an important reason why English teachers should use the Internet in their teaching. It provides students with opportunities to interact with native speakers and non-native speakers around the world. For vitality, the fourth reason for using the Internet, "the Internet can inject an element of vitality into teaching and motivate students as they communicate in a medium that is flexible, multimodal, constantly changing, and connected to their real-life needs" (p. 7) Lastly, regarding empowerment, the Internet allows teachers and students to empower their teaching and learning. The Internet offers them chances to become "autonomous lifelong learners," (pp. 7-8).

Besides the reasons for using Internet-based resources for general language teaching and learning, research has shown that adopting Internet-based resources to listening skill teaching brings many benefits for students compared with using materials on CDs or tapes (Brett, 1997) In fact, listening to materials on the Internet supplies students with multimedia input including visual support, such as texts, captions, illustrations, photographs, etc., while CDs and tapes provide only audio input (Turel, 2014c).

There are five specific multimedia benefits. First, listening with visual support helps to promote students' listening comprehension and is more useful for less proficient language learners (Mueller, 1980; Rubin, 1975, as cited in Suvorov, 2008, p. 16). Second, studies tend to conclude that the advantages of video over audio-only format is providing learners with more authentic content, context, discourse, paralinguistic feature, and cultural aspects, (Coniam, 2001, as cited in Suvorov, 2008, p. 15). Obviously, these benefits support learners in their listening comprehension. Third, Jones (2003) indicated that using

visual and verbal annotation assists learners in their listening comprehension and vocabulary acquisition (p. 41). Fourth, according to Peterson (2010), the effectiveness of Internet-based resources improves listening comprehension. He believed that "while listening to digital audio or watching a video clip, learners have the opportunity to pause at will, and listen and read a transcript. Moreover, learners can get instant feedback on what they have done (e.g., you watch a video clip/listen to audio and check answers immediately after watching/listening)," (p. 140). Finally, in terms of motivation, Nobar and Ahangari (2012) states that with the introduction of computers and the Internet into language classrooms, it helps improve language learners' attitudes and motivation since language lessons become practical and enjoyable for learners, (p. 39).

Chapelle (1999) also indicates that teaching listening skills with Internet-based resources contributes to enhancing EFL students' listening comprehension both in and beyond the classroom. For example, CALL software, online discussion boards, and online conference tools such as text chat, whiteboard, audio and video, offer opportunities for comprehensible input and output, and negotiation of meaning. Luu (2011) also suggest that "computer use in listening instruction should be given much more consideration so as to improve the listening skills of EFL learners, and to motivate both teachers and learners" (p. 5).

Some Internet Resources and Materials for Listening Practice

There are many varieties of Internet sources for EFL learners to extend language learners listening skills as a part of learning English as a second/foreign language (see Table 1, 2, 3, 4, 5 and 6). Some of suggested sites, categorized according to themes, are presented in Appendix 1- Websites for Listening Practice.

FUTURE RESEARCH DIRECTIONS

Many researchers have appreciated the benefits of interactive multimedia technology in teaching and learning listening skills, including fostering learners' listening skills and their motivation in listening classes. However, many aspects relating to the development of the listening skill in second language (L2) and EFL learners with multimedia resources have not been paid much attention from researchers. For example, they should have recommended appropriate sources or tools of multimedia which can be used to enhance EFL learners' listening skills as well as the most effective uses of multimedia tools for developing listening proficiency in EFL learners. Therefore, this is a need to explore these issues to contribute to recent studies.

CONCLUSION

The introduction of interactive multimedia into language teaching and learning gives language teachers and learners opportunities to facilitate their teaching and learning. Especially, interactive multimedia listening environments provide visual support, authentic content, and comprehensible input for learners. Moreover, listening practice with interactive multimedia resources allows learners to monitor their learning, thus they are motivated to learn. Thus, multimedia resources and materials have been viewed as wonderful and rich sources for improving listening skills. In other words, interactive multimedia helps both language teachers and learners facilitate the process of English listening skills teaching and learning.

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KEY TERMS AND DEFINITIONS

Hearing: The physiological process of perceiving sound produced by any source in the environment.

Interactive Multimedia Listening Environment: Including multiple-media systems, software applications, materials, products, or courses that are designed to offer language learners opportunities to process or interact with different types of media to enhance their listening skills.

Interactive Multimedia: Interactive multimedia allows the user to interact with textual, aural, and visual media in a wide range of formats.

Listening: The physiological and cognitive processes in which listeners pay particular attention to and understand what is being spoken.

Listening Comprehension: The process where listeners use both background knowledge and linguistic knowledge in understanding the meaning of spoken and/or nonverbal messages.

Listening Skills: The ways to help a person listen something more effectively. So, listening skills can be trained and developed.

Multimedia: The combination of text, graphics, audio, motion video, or interactivity content forms.

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APPENDIX

Websites for Practice Listening

Table 1. Websites for songs

	Site Names and URL	Brief Descriptions
1	Alpozo's Phonetic Blog http://allphonetics.blogspot.com/search/label/videos	This is a great blog for songs. The blog is mainly based on the field of phonetics addressed to teachers and students of English at all levels. You can listen to songs you like and do the tasks following the songs if you wish. The activities are interactive and can be used as lessons in class, a language lab, on-line or off-line.
2	Elllo http://www.Elllo.org/english/1001.htm	This website supplies teachers and students with free online listening activities. Many of them have quizzes and a transcript. There are many kinds of authentic materials such as songs, interviews, and casual lectures on this website. It is suitable for intermediate and advanced students.
3	ESL Videos: Category: 'Songs' http://www.manythings.org/b/e/category/songs/	This site features folk songs, campfire songs, and group-singing songs that native English speakers sing. These podcasts are short and designed to be listened to more than once, so learners can listen and sing along as many times as they need to in order to learn the song.
4	MusicTube 101 http://www.youtube.com/watch?v=anxqSb3XrGE	This video is about a famous song, including its transcript. You can listen to the song and practice singing the song. It is recommended for all levels.
5	Songs for Teaching http://www.songsforteaching.com/phonemicawareness.htm	This website is a great idea for using music to promote language learning. It has audio and video songs categorized into a broad range of topics. It also includes transcripts, so you can listen to the song and read its transcript at the same time. You not only listen to your favorite songs, but also practice phonetic features. It is appropriate for elementary and intermediate young learners.
6	VOALearningEnglish http://www.youtube.com/watch?v=33qbMCuJ5XI&feature=player_embedded#	This is the video about a VOA Special English Education Report about songs. Through this report, you may find your favorite songs.

Table 2. Websites for news reports

	Site Names and URL	Brief Descriptions
1	6 Minute English http://www.bbc.co.uk/worldservice/learningenglish/general/sixminute/	Learners can listen to current news from Europe in a way that is easy to understand and download the files to listen to many times. Another great thing is having a copy of the text available for reading at the same time or after listening. This site is suggested for advanced English learners or native-like speakers.
2	CNN Streaming Video News http://www.cnn.com/videoselect/	Learners can listen to clips of individual news items or to whole programs. The CNN site is predominantly American English.
3	ESL Videos http://www.manythings.org/b/e/	In this site, learners can choose from a variety of videos to help them learn English, which can be accessed by date or subject. It is appropriate for adult learners.
4	Euronews http://www.euronews.net	The website has Euronews TV, radio, and video about news, European affairs, business, special reports, sports, and culture. It is suggested for advanced level.
5	Listen and Watch http://learnenglish.britishcouncil.org/en/listen-and-watch	The site has five-minute audio reports and transcripts on subjects such as famous people, pop music, and entertainment. Learners can listen to or watch news on the computer, or download audio and video files to their mp3 players. Audio and video materials are accompanied by language practice activities that learners can do on their computers while they listen or watch, or print out and do them when they want to.
6	VOA Learning English http://www.voanews.com/specialenglish/	This website is recommended for adult learners and learners who are interested in politics, current news as well as special features on life in the U.S. including: science, education, health, famous Americans, and American history. They can read and listen to them on their computer or download them to their iPod or mp3 player.

Table 3. Websites for conversations

	Site Names and URL	Brief Descriptions
1	Elllo http://www.Elllo.org/english/1001.htm	This website supplies teachers and students with free online listening activities. Many of them have quizzes and a transcript. There are many kinds of authentic materials such as songs, interviews, and casual lectures on this website. It is suitable for intermediate and advanced learners.
2	ELT Podcast http://www.eltpodcast.com/	ELT Podcast provides basic conversations for EFL and ESL students and classes. ELT Podcast presents a common conversation theme in each episode. The first presentation is spoken at a normal speed, and then at a slower, less natural speed to help with comprehension. The site also provides a transcript of the conversation.
3	Focus English: http://www.focusenglish.com/	This resource is suggested for intermediate to advanced EFL learners. Through this site, learners can hear real English, including idioms, vocabulary, and other commons words and phrases.
4	Learning English Online http://esl.wikidot.com/listening	This site provides teachers and students listening exercises from intermediate to advance levels. It also gives learners many links to practice listening from many different sources. Most listening exercises focus on real speeches, or real life conversations. It is recommended for beginning, intermediate, and advance levels.
5	Learning Oral English Online http://www.rong-chang.com/book/	Learners have an opportunity to practice their listening and speaking through daily conversations on a wide range of topics. The website is recommended for all levels.
6	OM Personal English Conversation http://www.ompersonal.com.ar/omaudio/contenidotematico.htm	This site includes daily conversations on a variety of topics. The conversations are categorized according to elementary, intermediate, and advanced levels.
7	Real English http://www.real-english.com/	There are thousands of topics from easy to difficult levels on this website. Learners can watch and listen at the same time. One special thing is that they can watch a short video with or without subtitles. It is useful for pre-intermediate to advanced levels.

Table 4. Websites for stories

	Site Names and URL	Brief Descriptions
1	Annenberg Learners http://www.learner.org/resources/series71.html	The website has video stories about people and their lives in slow English. It includes 50 fifteen-minute video programs and coordinated books. It is suggested for college and high school classrooms and adult learners.
2	Beeoais.com Beeoasis.com	The website has stories with audio about people and their lives, spoken slowly. Learners can listen to and read along with the stories. It is recommended for three levels: beginning, intermediate, and advanced.
3	ESL Videos: Category: 'Stories' http://www.manythings.org/b/e/category/stories/	This site provides language learners with stories, videos with subtitles, and videos with transcripts, spoken at slow speed. Thus, they can listen to and read along with the stories. It is appropriate for beginning, intermediate, and advanced levels.
4	Npr http://www.npr.org/	The website is recommended for advanced language learners who are interested in listening to stories. These short stories are deep and touching.
5	Spotlight http://www.spotlightradio.net	The site is about podcasts, stories, and news. The English is at almost normal level. Language learners can listen to and read at the same time. It uses a specially modified form of English to make listening to the radio easier. It is suggested for beginning and intermediate levels.
6	StoryCorps http://storycorps.org/	The website has a collection of stories told by ordinary people in the United States. Visiting the website, you will have the opportunity to listen to over 80,000 people who have shared life stories with family and friends through StoryCorps. The site is recommended to advanced learners.
7	StorylineOnline http://www.storylineonline.net/	StorylineOnline is a collection of video recordings of children's stories being read by notable actors and famous people. The videos are short and easy to follow. Each video has a short introduction by the actor before transitioning to the reading of the story. Learners can follow along with the pictures and words of each story. It could be a nice resource for three levels: beginning, intermediate, and advanced.
8	Takako's Great Adventure http://international.ouc.bc.ca/takako/index.html	This is a full novel told in parts that learners can listen to. They can also download PDF files of it to read. The site is good for advanced learners.

Table 5. Websites for film clips/drama

	Site Names and URL	Brief Descriptions
1	Annenberg Learners http://www.learner.org/resources/series71.html	The website has video stories about people and their lives in slow English. It includes 50 fifteen-minute video programs and coordinated books. It is suggested for college and high school classrooms and adult learners.
2	Learning English through movies http://cinema.clubefl.gr/	There are a series of videos and cartoon videos that provide learners with listening skills. Most of the videos have subtitles and they are quite easy to understand. Therefore, they are relevant to young learners at lower levels.
3	Living English (Australianetwork) http://australianetwork.com/livingenglish/	People speak at a slow speed. A drama is divided into forty-two parts, which look at the English language used in real life situations such as making an appointment or asking and giving directions. There are full transcripts to follow along with the audio files. It is good for beginner or near beginner level learners.
4	Movie trailers http://www.movies.com/movie-trailers/	You can download free movie trailers. Since it is to promote the movie, a trailer usually shows the high points and low points of a movie, which makes it exciting. The trailers are not very long which means learners can see a variety of them in a short time. This also leaves a lot of time to reflect on what students saw in the trailers and focus on the language. It is appropriate for upper beginners to advanced levels.
5	Top Documentary Films http://topdocumentaryfilms.com/	This site is very helpful because it provides non-fiction movies. There are 25 documentary categories with 847 movies. You can choose many videos related to your topic. The language is appropriate and quite slow, so it is easy for students to understand. All the videos are free. The summary of each movie is also provided before you watch it. This site is recommended for high intermediate to advanced levels.
6	YouTube http://www.youtube.com/	There are endless possibilities for watching video clips from movies or TV shows, as well as videos created and contributed by regular people. The site is suggested for high school and adult learners who are interested in current events, or have niche interest areas.

Table 6. Websites for lectures

	Site Names and URL	Brief Descriptions
1	FreeVideoLectures http://freevideolectures.com/	You can watch more than 18400 video lectures from top 30 universities on 35 categories. You can even download the lectures in MP4, FLV, 3GP, and MP3 for easy access later. The site is recommended for advanced learners.
2	Nobelprize.org http://www.nobelprize.org	The Nobel Prize web site has an archive of video lectures from winners dating back to 1999. You can watch winners in every subject talk about their lives and their research. This website is suggested for advanced learners.
3	Prezi http://prezi.com	On this website, you could listen to and watch great Prezi presentations with videos, images, texts and other presentation media. This site is recommended for advanced adult learners.
4	reddit http://www.reddit.com/r/lectures/	The website provides advanced learners with video lectures on mathematics, physics, computer science, programming, engineering, biology, medicine, economics, politics, social sciences, and many other subjects. This website is suitable for advanced learners.
5	TED Ed Lessons Worth Sharing http://ed.ted.com/	On this site, you will find carefully curated educational videos, many of which represent collaborations between talented educators and animators nominated through the TED-Ed platform. The website is suggested for intermediate to advanced learners.
6	TED Ideas Worth Spreading http://www.ted.com/	On TED.com, you will watch the best talks and performances about Technology, Entertainment, and Design. More than 1500 TED Talks are now available, with more added each week. All of the talks are subtitled in English, and many in other languages, too. The website is suitable for advanced learners.
7	videolectures.net http://videolectures.net/	VideoLectures.NET is an award-winning free and open access educational video lectures repository. The lectures are given by distinguished scholars and scientists at the most important and prominent events like conferences, summer schools, workshops and science promotional events from many fields of Science. It might be best for students in college who are pursuing Computer Engineering since the site puts a special emphasis on that particular topic, but they also cover several general topics such as biology and mathematics.

Chapter 39
Design Patterns for Integrating Digitally Augmented Pop-Ups With Community Engagement

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ABSTRACT

This article explores the opportunities of translating existing community engagement techniques into digitally augmented pop-up interventions, for on-the-spot feedback around infrastructure within the built environment. Pop-up interventions allow for more inclusive forms of community engagement through the combination of digital and physical media. The paper draws on Alexander et al.'s idea of pattern languages to put forward a set of design patterns for integrating digitally augmented pop-ups into community engagement activities. The patterns are based on a review and analysis of existing community engagement techniques, digital technologies used in urban environments, data from our own field studies and a focus group with engagement professionals. The aim of the patterns is to: (1) capture collective wisdom; (2) reuse and extend ideas; and (3) converge on designs that work for communities.

INTRODUCTION

Citizens of the 21st century live in a world where they are more connected than ever before, more exposed to an unprecedented amount of information and have a greater awareness of social, political and environmental complexities. As a result, engaging citizens in the urban planning process is not only a complex and divisive issue due to busy lifestyles and competing priorities, but also a result of top-down government approaches and current engagement tools and techniques used. Governments around the

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world undertake formal community engagement either as a legislative requirement or for the political interests and agendas of elected representatives (Cuthill, 2003). However, current practices, such as town halls, workshops, drop-in sessions and online platforms do not necessarily capture the opinions of the wider community and pose a number of other challenges. It has been shown that some of these traditional community engagement techniques are outdated, resource intensive, lack public interest and exclude certain demographics within local communities (Falco, 2016; Hosio, Goncalves, Kostakos, & Riekki, 2014; Sarkissian, Hofer, Shore, Vajda, & Wilkinson, 2009; Schroeter, 2012). As a result of this, time poor citizens, younger demographics and culturally and linguistically diverse people are either disengaged or excluded. Legally required community engagement and top-down decision making therefore rarely achieves genuine engagement outcomes, but rather fragments communities and creates dissatisfaction amongst citizens, who feel they have not been heard (Innes & Booher, 2004). Head (2007) argues that a greater dialogue between governments and citizens encourages deliberation between stakeholders in the decision making process.

Within the last decade communities around the world have taken it upon themselves to drive bottom-up initiatives through temporary installations in the form of pop-ups. This contemporary approach is commonly referred to as pop-up urbanism (Fredericks, Tomitsch, Hespanhol, & McArthur, 2015), tactical urbanism (Lydon et al., 2014), guerrilla urbanism (Caldwell, Osborne, Mewburn, & Crowther, 2015) and DIY Urbanism (Caldwell & Foth, 2014). Pop-Up interventions 'hack' public space by appropriating new and temporary purposes within communities. They have the ability to attract passers-by, create awareness amongst citizens and stimulate the imagination of participants (Fredericks, Caldwell, Foth, & Tomitsch, 2015; Fredericks, Tomitsch, et al., 2015). Examples such as PARK(ing) Day ('http://parkingday.org', 2016), Build a Better Block project ('Better Block', 2016), Pop-up town halls (Lydon et al., 2014), and InstaBooth (Caldwell, Guaralda, Donovan, & Rittenbruch, 2016) demonstrate the successful application of pop-ups within public space. The design patterns proposed in this article build on these previous interventions and provide new insights into the use of pop-ups in conjunction with new digital technologies for community engagement.

Existing digital technologies used within the built environment also offer opportunities to devise novel participation strategies that can engage previously difficult to reach, as well as new, segments of society in urban planning. Foth et al. (2009, p. 97) pose that "Information and Communications Technology has contributed to the globalisation of cities and facilitated increased contacts between places and people at both global and local levels." Tomitsch (2014) discusses the evolution of information and communication technology (ICT) and its transition from the workplace into all aspects of daily life within the last decade, including the urban built environment. New digital technologies are providing numerous opportunities for the efficient use of existing infrastructure within the built environment. In this article, we contribute to these emerging fields through the development of eight design patterns that integrate digital technologies, pop-ups and urban planning.

The concept of pattern languages and design patterns, originally developed by Alexander et al. (1977), is an established practice within the field of architecture. This original concept has inspired many disciplines, such as software engineering, ICT and human–computer interaction (HCI) to create their own pattern languages. Based on three field studies we conducted in Sydney, Australia, which used a combination of digital and physical media, supported by a review of existing work and an expert focus group, we propose an initial set of design patterns for integrating digitally augmented pop-ups into community engagement. Although, there have been a number of projects and studies that integrate situated digital technologies with community engagement initiatives (Fredericks, Tomitsch, et al., 2015;

Hespanhol et al., 2015; Koeman, Kalnikaité, & Rogers, 2015; Vlachokyriakos et al., 2014) there is no generalised framework available that can guide the implementation of such hybrid initiatives. We aim to fill this gap by proposing our design patterns as a first step towards forming a foundation for creating a future pattern language for creative and interactive community engagement facilitated through pop-up interventions. The design patterns are intended to be dynamic as we encourage other researchers to test and improve the patterns and to contribute new patterns.

The rest of this article is structured as follows: We first provide an overview of digital technologies in the urban environment. We then introduce the concept of pattern languages, discuss examples of design patterns used in other disciplines and introduce existing community engagement assessment frameworks. This is followed by an overview of our three field studies and an expert focus group, which led to the development of our patterns. We then present eight design patterns, which follow the format of Schuler (2008) and Lyle et al. (2015). Each pattern is introduced through a problem statement, its context, a discussion and a description of the solution proposed by the pattern, illustrated through examples from our own field studies and previous work.

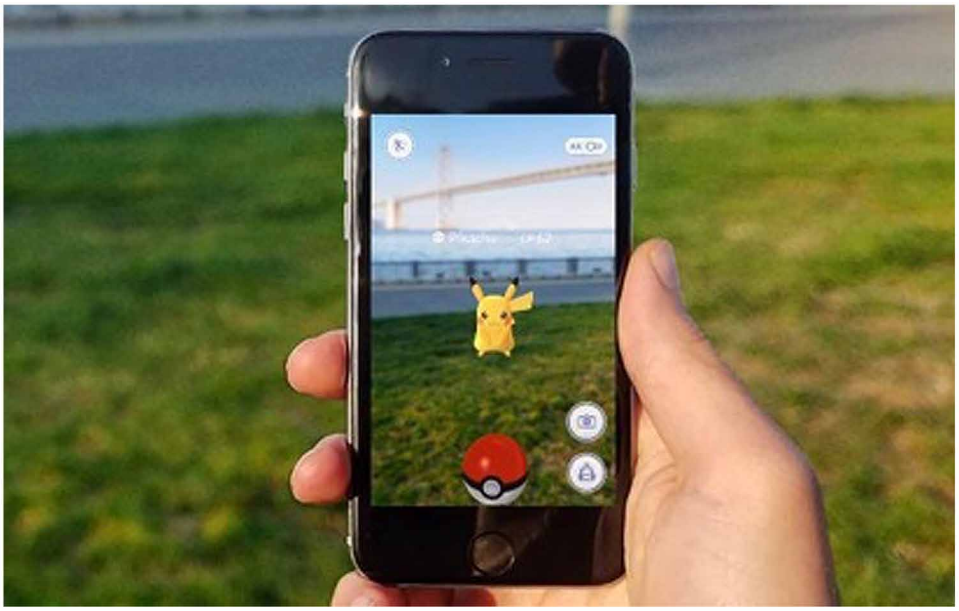
DIGITAL TECHNOLOGIES IN THE URBAN ENVIRONMENT

Digital technologies within urban environments are becoming increasingly pervasive. Over the past few decades they have evolved from being located and used in official locations, such as workplaces and government agencies, to being integrated into all aspects of daily life (Tomitsch, 2014). Digital technologies provide a significant opportunity to level the social playing field. It no longer matters who you are, how much money you have or who you know. It has become a mediocracy by providing opportunities for citizens to be involved in society and recognised for their abilities and accomplishments (O'Connor, 2016). Technologies are increasingly being used in urban environments, such as, the internet of things (IoT) (Gubbi, Buyya, Marusic, & Palaniswami, 2013), smartphones (Fredericks & Foth, 2013), tablet devices (Takano et al., 2012) and Web 2.0 applications (O'Reilly & Battelle, 2009).

An example of a recent social phenomenon is Pokémon Go, a smartphone gaming application using augmented reality (Hern, 2016). The game is interactive both digitally and physically, by taking people out onto the streets to compete with other people using digital characters within a physical space (Figure 1). This is not a new idea – augmented reality has been previously proposed for enriching urban experiences, for example by Human Pacman (Cheok et al., 2004), a project based on the 1980s arcade game Pacman. Like Pokémon Go, the game encourages collaboration and competition between players in both a digital and physical setting. However, the enormous popularity and uptake of Pokémon Go by people around the world demonstrates that technology is reaching a maturity, which demonstrates the potential of integrating digital technologies into the urban environment. The success of Pokémon Go further highlights that people want to engage and be engaged within the urban environment.

Technological advancements have led HCI researchers to investigate the use of digital technologies in city making, postulating the need to shift from thinking about people as 'users' of technologies to 'citizens' (Foth, Tomitsch, Satchell, & Haeusler, 2015). A number of fields and approaches have emerged that each use particular lenses to investigate new opportunities for urban communities enabled through digital technologies, including ubiquitous computing (ubicomp) (Weiser, 1993), urban informatics (Foth, Choi, & Satchell, 2011), urban computing (Kindberg, Chalmers, & Paulos, 2007), digital placemaking (Fredericks, Hespanhol, & Tomitsch, 2016; Latorre, 2011), and urban interaction design (urban IxD)

Figure 1. Pokémon Go used in a public space
(Credit: Gamespot)



(Brynskov et al., 2014). What all these concepts have in common is the application of digital technologies for improving the use and experience of existing urban infrastructure and providing new opportunities for connecting citizens with their city. We will describe some of these concepts and their relevance in the context of this article below.

The concept of ubicomp dates back to the early 1990s. It was first introduced by Weiser (1991) to describe the vision of moving computing from the desktop and integrating it in the 'fabric of everyday life' (Weiser, 1993). Mobile phone communication, wireless internet, location-based mobile services, situated interactive public screens and electronic information signs are examples of ubicomp infrastructure being actively used by citizens. Urban informatics research investigates the relationship between people, place and technology with a focus on urban environments, location-based services and mobile technology. Foth et al. (2011) describe urban informatics as the collection, classification, storage, retrieval, and dissemination of recorded knowledge in a city. Essentially it is the integration of technologies into cultural practices within the context of specific communities, cities and spaces (Foth et al., 2011).

The notion of urban computing focuses around the integration of computing, sensing and mobile technologies into everyday urban environments, cultures and lifestyles (Kindberg et al., 2007). Urban computing has the ability to provide a broad range of opportunities through the extensive use of everyday technologies, such as public WiFi networks, mobile data networks and features provided in smart phones, tablets and computers. It has the ability to encourage citizens to use existing technologies in a creative and spontaneous way to appropriate spaces that create significance and meaning to them (Greenfield & Shepard, 2007). Urban informatics and urban computing share similar core ideas, such as the use of data and networks. Urban informatics however emphasises the role of people, and their relationships with places and technologies, whereas urban computing is more focused on the underlying technologies for deploying digital applications in urban environments. Both concepts provide a technological foundation

for the design patterns presented in this article. Urban informatics further contributes case studies of digital technologies, such as urban screens (Schroeter, 2009) and mobile devices (Anastasiu, 2012), and their use for engaging local communities around civic issues.

Both, urban informatics and urban computing focus on site-specific localised interventions, whereas urban planning is more concerned about the city as a system. To address this limitation, Foth (2009) proposed the notion of 'urban anatomy' (Francey Jr, 1995) which suggests that cities, like living organisms, are more than the sum of its parts. This notion shares aspects with other urban planning methodologies, such as placemaking, which focuses on the holistic planning, design and management of public spaces (Schneekloth & Shibley, 1995). With the increasing availability of and access to digital technologies, a number of scholars have suggested to augment placemaking strategies through digital technologies. This hybrid approach, referred to as 'digital placemaking', offers two distinctive perspectives. The first perspective suggests the use of situated digital technologies as a means of revitalising activity in public space. This can take the form of a purpose-built structures, digital urban screens ordinarily used for advertising, or temporary urban festivals using light and media projections (Tomitsch, 2016). The second perspective sees digital technologies as a means of informing placemaking strategies. Latorre (2011) describes this perspective as being a community-centred and transparent process, which leverages digital technologies to encourage collaboration between stakeholders. Fredericks et al. (2016) further extend this perspective by suggesting the use of situated digital technologies as part of community engagement initiatives, therefore informing placemaking strategies by engaging local communities within public space. This view aligns with the position taken in this article, as such a form of digital placemaking provides opportunities to facilitate interactive discussion within a localised context.

Urban IxD shares some of the core principles of digital placemaking. Similar to digital placemaking, it puts an emphasis on involving all stakeholders in the design of urban environments and experiences. More specifically, it focuses on the interaction of humans within their urban surroundings, and provides citizens with options to enhance everyday urban experiences to be more pleasurable, interesting, productive and efficient. Building on the tradition and philosophies of the interaction design discipline, urban IxD can be used as a platform to bring various professional disciplines together to address urban development within the built environment (Brynskov et al., 2014). It provides a framework for building relationships with and engaging urban planners, urban designers, academics, bureaucrats and members of the community. The concepts discussed above provide a foundation for the existing research and examples we draw on for the development of our design patterns.

PATTERN LANGUAGES AND ENGAGEMENT FRAMEWORKS

The concept of design patterns and pattern languages used in this paper follows the definition outlined by Alexander et al. (1977). Alexander and his colleagues observed that most architectural design projects involved solving similar types of problems. To assist designers in developing solutions to these common problems, they created a 'language' composed of a collection of 'patterns' based on practical experiences. Each pattern was represented through a description of the context in which it can be applied, a problem statement and a proposed solution along with practical example implementations. According to Alexander et al. (1977) "[e]ach pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice". The language is divided

into three categories, 'towns', 'buildings', and 'construction', which start broad and then narrows down to more specific and localised problems. An example for a pattern that relates to community engagement is 'Small Public Squares', which describes the need for public spaces situated along the intersection of paths most commonly used to create an activity node. Another example is the pattern 'Necklace of Community Projects', which encourages community driven grassroots movements situated around or in close proximity to a local town hall. These two examples highlight that grassroots initiatives, whether that be government-organised community engagement, political activism or community driven DIY tactics, require activated and accessible public space in order to succeed.

The use of pattern languages in architecture is well established, however, other disciplines, such as software engineering, ICT, and HCI, have developed their own sets of pattern languages and design patterns. Hafiz (2013) created a pattern language for developing privacy enhancing technologies (PET). Twelve patterns were created to address three key themes: PET software design; drawing on previous experiences to customise patterns; and, allowing practitioners to explore the big picture. The patterns have an architectural structure, provide a high-level solution and demonstrate how it can be applied in a variety of PET contexts (Hafiz, 2013). *Liberating Voices* (Schuler, 2008) is a pattern language focusing on social change in information and communication media outlets. The 136 patterns promote bottom-up grassroots activism and citizen empowerment in order to shift the decision making from top-down government and corporate organisations. Schuler (2008) applies a different approach to pattern language by providing detailed explanations of each pattern's problem, context and solution.

Lyle et al. (2015) developed design patterns for urban gardening consisting of a set of eight design patterns to bring communities together across digital and physical spaces for urban gardening practice. The patterns were grouped by aligning them along two axes – the first covering the themes highlighted through their research, and the second identifying whether the pattern applies to physical or digital space. We draw on both approaches employed by Schuler (2008) and Lyle et al. (2015), as our patterns are community-centred and involve the use of both digital and physical interactions. Pop-up community engagement studies (Caldwell et al., 2016; Fredericks, Tomitsch, et al., 2015) have identified a variety of themes relating to the types of information available, participant interactions – both digital and physical, the civic space and public feedback. By employing design patterns for digitally augmented pop-ups, we aim to support a variety of actors, including built environment professionals, interaction designers, university students, researchers and members of the community.

Our patterns complement other engagement frameworks that have been developed for the evaluation of the types of tools and techniques used for community engagement. Arnstein (1969) developed the ladder of participation to identify levels of community engagement in urban planning decision making. The framework describes a continuum of engagement, from 'nonparticipation' to 'citizen empowerment'. Similarly, the wheel of participation (Davidson, 1998) developed by the Shire of South Lanarkshire, Scotland is a further adaptation of the ladder of participation. This concept identified the extreme of no community input, from top-down government 'informing', through to bottom-up citizen 'empowerment', where the community makes all the urban planning decisions (Sarkissian et al., 2009). The International Association for Public Participation (IAP2) developed the public participation spectrum ('IAP2', 2006) to assess the level of engagement undertaken. Similar to the wheel of participation, the IAP2 spectrum is seen as a further adaptation of the ladder of participation. The spectrum's stages include: inform, consult, involve, collaborate, and empower. These stages show the differing levels of engagement, the goals, timeframes, resources and the levels of concern in the decision making process. These engagement frameworks have been developed with the intention to identify and assess the levels of community engage-

ment undertaken. The proposed design patterns can be used in parallel with these existing engagement frameworks to evaluate the deployment of digitally augmented pop-ups for community engagement.

DISCOVERING POP-UP ENGAGEMENT PATTERNS

The design patterns presented in this article have emerged through a review of previous work and concepts, and reflecting on three pop-up interventions we implemented for community engagement. This was followed by an expert focus group with professional representatives who have been involved in the strategic planning and facilitation of community engagement. The purpose of the focus group was to evaluate the proposed design patterns and their applicability in community engagement initiatives, and to seek feedback from participants for revising the patterns. We drew on the themes and experiences from these investigations in order to develop our design patterns, which are presented in the following section. In this section we describe the three pop-up interventions and associated field studies as well as the findings from the expert focus group.

Encouraging Community Discussion through Pop-Ups

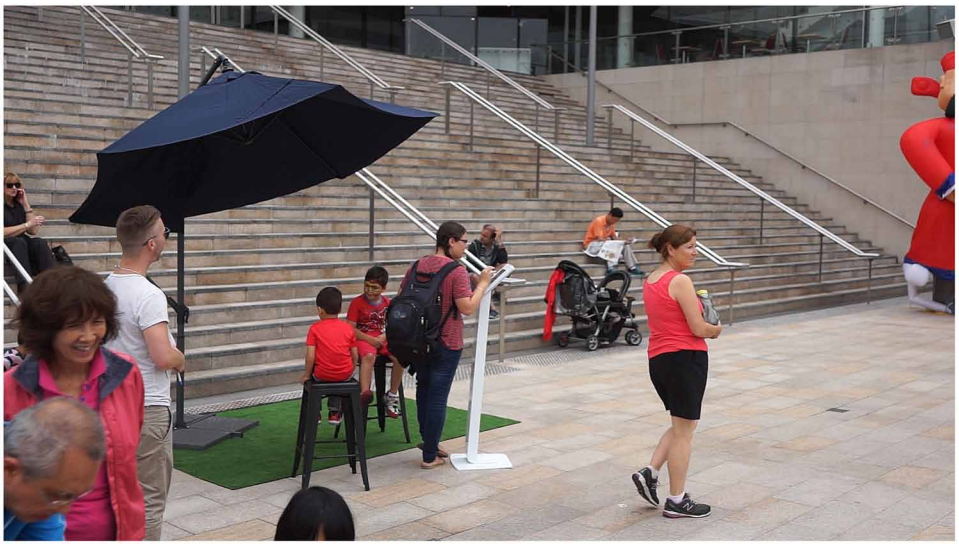
The pop-up interventions were carried out between 2014 and 2016 across a variety of locations in Sydney, Australia. During the field studies we interacted with people from a range of demographics, including, cultural and linguistically diverse communities, people who live in social housing areas, and residents from affluent suburbs. Each pop-up intervention used a combination of digital and traditional physical media for the purpose of community engagement. Each intervention built on the findings from the previous intervention(s), which led to an iteration of the physical structure and form of the pop-up as well as the media channels used within the pop-up to engage passers-by around topics of local relevance. The topics also varied from field study to field study, as each intervention was aligned with an on-going community engagement initiative. We will now describe the specific setup for each intervention and the key findings that relate to the design patterns proposed in the following section. The field studies were part of a larger research program, and we therefore collected a variety of data from interviews, surveys and observations for each of the interventions. The field study-specific findings and more detailed evaluations of the design process leading to the interventions are described in previous publications (Fredericks, Caldwell, & Tomitsch, 2016; Fredericks, Hespanhol, et al., 2016; Fredericks, Tomitsch, et al., 2015).

Digital Pop-Up

The first pop-up intervention comprised a series of community engagement activities in collaboration with a Local Government Authority (LGA) (Figure 2). The LGA's aim of the activities was to obtain public feedback around council services and the implementation of healthy infrastructure. We designed three variations of the pop-up intervention, which we deployed over three separate days consisting of:

1. A tablet device on a stand with a customised yes/no voting web interface used in conjunction with an existing urban screen
2. An unstaffed pop-up using a tablet device – with an adapted web interface that allowed participants to type text responses, the urban screen, market umbrella, synthetic turf and barstools

Figure 2. Digital Pop-Up study



3. A staffed pop-up using the same tablet device with web interface, the urban screen, gazebo structure, synthetic grass, seating, plants, and 'call to action' signage, which was displayed on the urban screen and on physical posters at the pop-up (Fredericks, Tomitsch, et al., 2015).

We observed and took notes about the behaviour of people moving around the space, such as people walking near the tablet, people noticing the tablet but not engaging with it, and people interacting with the tablet. We also held a focus group with three professional representatives from the local council to obtain feedback on the study outcomes and how this approach could be further improved. The findings of this study gave insights into the following themes:

- Interactive digital pop-up interventions have the potential to facilitate effective community engagement, e.g. attracting varied demographics, local discourse and decision making
- By deploying the pop-up within a civic space citizens were able to participate on the spot, with little effort in comparison to attending traditional community engagement events (e.g. focus groups)
- Digital methods of engagement provide effective means of complementing existing engagement techniques
- Pop-up interventions can help address community wide topics, and how citizens would like their responses to be addressed

Digitally Augmented Pop-Up

The second pop-up intervention was carried out as a community engagement study in collaboration with an electricity supplier using a combination of traditional physical media and digital technologies within a pop-up installation (Figure 3). The study was held in four locations across the Sydney metropolitan area to obtain community feedback around tree trimming and powerlines. Reflecting on the outcomes of the first intervention, Digital Pop-Up, we decided to involve a variety of stakeholders in the design

process of the second pop-up intervention. More specifically, we collected early feedback on potential engagement activities, engagement questions, pop-up setup, and locations to deploy through informal meetings with representatives from a variety of LGAs and local community organisations. The information obtained from these participants highlighted the types of issues people wanted to discuss, and therefore informed the initial design of the engagement activities. Following this process, we held a focus group in which we presented mock-ups of the pop-up engagement activities to practitioners with backgrounds in graphic design, public relations and communication and stakeholder engagement. We invited focus group participants to interact with the proposed engagement activities and to provide feedback around the design of the pop-up and how the activities could be adapted to be more relevant to the overall topic.

By undertaking this collaborative and iterative process we were able to develop three effective engagement activities consisting of

1. A selfie voting app, where participants could answer yes/no questions by taking a selfie in front of a fabricated tree
2. The same yes/no questions printed as physical media in the form of a paper leaf, which were then placed on a second fabricated tree
3. A tree game, using augmented reality where users could see virtual powerlines and trees by looking through Google Cardboard augmented reality goggles and using customised tracking markers to move the virtual objects around the physical space

Similar to Digital Pop-Up we took observations and notes about the types of behaviours of people moving past the pop-up. The findings of this study gave insights into the following themes:

- Involving a variety of stakeholders in the design of engagement questions and activities highlights topics that communities want to discuss and how they would like to provide their feedback;
- Passers-by generally avoid standalone formal looking pop-ups in public space (e.g. charity organisations, corporate organisations). However, informal looking pop-ups surrounded by other activities (e.g. local markets) encourage people to stop and inquire; and
- Fun and creative activities attract people to pop-ups, therefore creating a honeypot effect (Wouters et al., 2016).

Pop-Spot

The third intervention, Pop-Spot, was architecturally designed as a booth structure, made up of a series of modules (Figure 4). The study was held at The University of Sydney to obtain feedback from staff and students around transport infrastructure on and around the campus. Reflecting on the design process and the engagement outcomes of the previous pop-up interventions, we developed this study to incorporate five thematically themed engagement activities consisting of digital, physical and mechanical media channels. We held several workshops over a 12-month period to design, develop and test the engagement activities, and to execute the architectural design of the booth structure. Similar to the second intervention, Digitally Augmented Pop-Up, we presented mock-ups of the pop-up structure and engagement activities at a focus group with industry professionals from urban planning, computer science, public relations and communication and stakeholder engagement backgrounds. This allowed us to collect early feedback on the booth structure and the proposed engagement activities.

Figure 3. Digitally augmented study

The engagement activities deployed as part of the pop-up included five media channels:

1. An analogue display with a large transparent screen, facing the direction from which the majority of passers-by approached the pop-up and thus enticing them into interacting with the pop-up. This analogue display used a robotic writing mechanism to visualise the responses submitted to an engagement question. The answers to the question were drawn as emoticons representing yes (happy face) and no (sad face). People were able to submit answers by either using a Twitter hashtag on their personal mobile device or through a tablet device affixed to one of the module structures.
2. A tablet installed on one of the modules displaying a selfie voting app – similar to Digitally Augmented Pop-Up – allowed participants to answer an engagement question by picking up a picture representing a mode of transport (car, public transport, walking, cycling) and taking a selfie.
3. An interactive 40-inch multi-touch screen, which provided a visual representation of selfies taken on the selfie voting app. The screen also allowed participants to view local public transport options and points of interest (e.g. entertainment and restaurants).
4. Chalk stencils, representing modes of transport, drawn on the ground adjacent to the booth, to display the cumulative results of responses submitted via the selfie voting app.
5. A static chalkboard, installed on the opposite side of the booth, on which participants were able to provide feedback through freehand drawing and writing.

The findings of this study gave insights into the following themes:

- A collaborative and iterative design process helps refine the engagement activities and ensures they are relevant for data collection;
- Bright pop-ups (in our case taking a red colour), background music and a range of digital and physical activities surrounding the pop-up creates curiosity and thus entices passers-by; and

Figure 4. Pop-Spot study

- Presenting real-time data (chalk stencils, selfie pictures and static chalkboard results) adds meaning and encourages reflection by showing participants accumulative results from the engagement activities.

Categorising Community Engagement Techniques

Having discussed the themes of digital engagement and the findings from our three field studies, we now discuss the outcomes of an expert focus group held with professional representatives from urban planning, communication and stakeholder engagement, public relations, marketing and computer science (Figure 5). The recruitment of participants was based on their experience in the strategic planning of engagement programs and facilitation of community engagement. The objective of the focus group was to create a dialogue about three key engagement themes: Notification – the process of notifying communities about upcoming community engagement; Interaction – the types of forums people participate in for community engagement; and Engagement Results – the types of data collected and how it will be reported back to communities. Specifically, we wanted to understand the current industry practice for these three themes and how digitally augmented pop-ups can be integrated into them. The aim of the focus group was to gather input from experts for the synthesis of our findings into the set of proposed design patterns.

The focus group was conducted over two and half hours and consisted of the following format:

1. A presentation of the challenges of traditional community engagement, highlighting the limitations of current engagement activities and online forums;
2. An open discussion about current community engagement tools and techniques and how they are categorised into – Notification, Interaction and Engagement Results;

Figure 5. Expert focus group

3. A presentation on current pop-up engagement projects around the world, and the three field studies discussed above; and
4. Categorising the types of digital and physical media used in community engagement activities into Notification, Interaction and Engagement Results.

The focus group was held in an environment (a lounge area in our faculty building) that encouraged open discussion, inviting participants to draw on their professional experiences in the planning and facilitation of community engagement. We first identified the current techniques used by practitioners, which then prompted discussion around what does and doesn't work in current practice. This then enabled us to create a second list of techniques using both digital and physical media that can be integrated into pop-up engagement.

DESIGN PATTERNS FOR DIGITALLY AUGMENTED POP-UPS

We now present eight design patterns, which synthesise our research in the form of directly applicable strategies for community engagement activities. The final set of patterns that is presented here draws on our review of digital technologies used in urban environments, existing community engagement techniques, our three field studies and the expert focus group. For each design pattern we present a problem description, the context in which it is placed and the solution, adopting the format used by Schuler (2008) and Lyle et al. (2015). Each pattern uses the following structure:

1. Name and number.
2. **Problem:** Statement of the reoccurring engagement challenge.
3. **Context:** An overview of the engagement issues it applies to.

4. **Discussion:** Examples of where and how the problem occurs, and ways in which the problem has been approached in engagement activities.
5. **Solution:** Approaches to address the problem.

We grouped the patterns around the three engagement themes of notification, interaction and engagement results as shown in Table 1.

Pattern 1: Raising Awareness

Problem

Undertaking successful pop-up engagement depends on the ability to draw the attention of passers-by and converting them into active participants. This can be problematic as people are either in transit between locations or reluctant to stop due to the unknown. What types of measures can be put in place to raise the awareness of the pop-up engagement?

Context

This problem applies to government organisations, community groups and individuals where the intent is to undertake pop-up engagement in a public space. This pattern focuses on the ability to raise awareness of the pop-up engagement through situated advertising materials, community networks and online platforms.

Table 1. Design patterns for digitally augmented pop-ups

	Design Pattern	Description
Notification	1. Raising Awareness	Raising awareness through situated advertising materials, community networks and online platforms.
	2. Creating Activity	Embedding pop-ups into existing events, and providing staffing, music, signage and bright colours.
Interaction	3. Local Information	Understanding the demographics of the local area and tailoring the pop-up accordingly to encourage localised discussion.
	4. Community Discussion	Providing on-the-spot discussion between participants and staff and providing assistance with engagement activities.
	5. Submitting Responses on the Spot	Designing engagement activities that have a clear direction, are quick to interact with and don't require staff assistance.
Engagement Results	6. Balancing Digital & Physical	Providing a range of media channels that are both digital and physical to address the needs and abilities of various demographics.
	7. Contextual Representation	Displaying engagement results in a form that is appropriate and adopted for the context of the local community.
	8. Immediate Feedback	Showing accumulative results on the spot either inside or around the pop-up.

Discussion

Pedestrian traffic flows through public space are similar to the types of experiences people have on motorways and public transport. During high volume periods there are many activities and obstacles to manoeuvre, including street performers, which often draw large crowds, charity organisations seeking donations, homeless people asking for money, companies giving away free merchandise, and local markets and pop-up shops. As a result of these everyday urban activities, passers-by have either become immune to what is going on around them or deliberately avoid interacting. This also applies to formal looking pop-up interventions that appear to be stand-alone, lacking in character and posing an uninviting appearance.

We deployed our first pop-up field study Digital Pop-Up during a cultural festival in a busy public space surrounded by other market stalls. A majority of passers-by ignored the pop-up due to lack of situated advertising and call-to-action for people to interact. The limitation with this approach was the assumption that passers-by would stop and interact with the pop-up without needing too much information, or gathering this information through the digital media channel (the tablet) itself. Reflecting on this limitation we designed large signage for the second iteration of Digital Pop-Up and our subsequent field studies Digitally Augmented Pop-Up and Pop-Spot. The studies used large call-to-action signs in three languages (English, Chinese and Korean), and information signs explaining how to interact with the engagement activities. This helped to communicate the purpose of the pop-up, clearly linking it to topics of local relevance, and therefore enticing passers-by stopping to enquire about the pop-up engagement.

While situated signage material can be effective, there is an opportunity to collaborate with local community organisations to promote the pop-up engagement within their member networks. This can further be complimented by promoting pop-up engagement through online platforms that provide information about the engagement, its objectives and results. An example of this is the Visualising Mill Road (Koeman et al., 2015) project that undertook community engagement with a local community around a redevelopment. In addition to advertising their engagement in the physical space they also provided the project information and aggregated results online via a dedicated website.

Solution

Appropriate advertising of pop-up community engagement raises awareness around the engagement objectives and activities. This should include collaboration between a variety of government and community stakeholders and advertising within the physical location and online platforms.

Pattern 2: Creating Activity

Problem

Pop-up engagement needs to create curiosity and draw people in. The risk is passers-by might not be aware of the pop-up or deliberately avoid interacting as a result of the set-up looking too formal and uninviting. How can activity around pop-ups be created that encourages people to interact?

Context

Locating pop-up engagement in conjunction with other urban activities, such as local markets, cultural events and community fairs creates a more informal environment and has a greater opportunity to attract participants. Additionally, standalone pop-ups that stand out from the surrounding environment (e.g. through bright colour or their architectural design) and have activity (e.g. music, interactive and playful activities) can create curiosity and attract passers-by.

Discussion

Pop-up engagement that is embedded into an existing event or surrounded by activity has the ability to attract passers-by to stop and enquire and therefore participate. We deployed our Digitally Augmented Pop-up study in four locations over a two-week period. The first three locations formed part of a local community event with the last one as a standalone within a local community plaza. Based on the observations we took during the course of these studies we identified that the awareness rate and therefore the participation rate was significantly lower on the last day deployment. The set-up of the pop-up was the same as the previous three deployments but the location and surrounding activity did not attract passers-by to interact. This finding highlights that a pop-up design that was successful in one location does not necessarily work in another. However, there are other types of techniques that can be used to make a standalone pop-up look and feel less formal.

Reflecting on Digitally Augmented Pop-Up we designed our Pop-Spot study to be used as a standalone pop-up located in a high pedestrian area on a university campus. Taking into consideration that our study would not form part of an existing event we experimented with the overall pop-up design and engagement activities. This included the structural design and colour (bright red), and linking the activities to the engagement topic. To make the pop-up feel less static we played music, had call-to-action signage and made sure it was staffed at all times. Passers-by were intrigued by the look of the pop-up and the activity surrounding it, leading them to enquire and consequently interact with the pop-up's engagement channels.

While pattern #1 Raising Awareness above is concerned with the advertising component of pop-up engagement, this pattern focuses on the social interactions in public space and how curiosity can create its own natural advertising and lead to a honeypot effect (Wouters et al., 2016), which in turn attracts other by-standers to engage.

Solution

Locating pop-up engagement in a busy location and making it part of an existing event leverages on opportunities to engage with members of the public. It is also important, in particular in situations where the pop-up is not integrated with another event, to create activity. This can be achieved by incorporating music, using bright colours, having staff dressed up according to the theme and clear and instructive 'call to action' signage.

Pattern 3: Local Context

Problem

Traditional community engagement has been shown to exclude certain demographics in engagement process, such as time-poor citizens, younger demographics and people who are culturally and linguistically diverse.

Context

Understanding the demographics of a pop-up engagement location is crucial. This can assist in tailoring the engagement activities, the deployment timing and how the pop-up can be aligned with other events.

Discussion

In order to engage with the wider community in one location, pop-up engagement should be conducted over several days and times, and be tailored according to the demographics of that location. Our Digital Pop-Up study was deployed in a public square over three separate days. The location had a high volume of traffic from office workers, local businesses and a large Chinese and Korean speaking community. Working in collaboration with the LGA our intention was to capture the opinions of local residents and people who worked in the area but not necessarily lived there. We deployed our pop-up during a Chinese New Year event with the intention of engaging with people who are culturally and linguistically diverse, and over two working days to engage with office workers and local businesses. The study had its own limitations in regards to some of the pop-up design elements, highlighting that pop-up engagement cannot be generic. It needs to take into consideration the local context, the demographics who live and work there, and the best times to interact with people (e.g. weekends for local residents versus lunch time for office workers).

This pattern compliments pattern #1 Raising Awareness and #2 Creating Activity by considering the local impacts to pop-up engagement. It cannot be assumed what works in one location will work in another. These patterns have the ability to be tailored to the local context.

Solution

It is critical to choose activities that are appropriate for the local context and to take into consideration the place, its demographics and time of deployment. For the pop-up engagement to be successful it needs to be designed and deployed to reach the right people at the right time.

Pattern 4: Community Discussion

Problem

Pop-up interventions located in public space are not always attended by staff to assist with any questions from members of the public. The intention is to provide an information kiosk where people can freely interact. However, this approach has the ability to cause communication breakdown. The design

of pop-up engagement should take into consideration what types of human interactions will take place, juxtaposed with the engagement activities.

Context

This pattern applies to all pop-up interventions used for the purpose of community engagement. Stand-alone and unstaffed pop-ups can be static and appear unengaging to passers-by. Members of the community who stop to interact with the pop-up may prefer face-to-face discussions with staff about the engagement objectives before engaging in the process. Members may also require assistance with the activities, including the use of digital technologies.

Discussion

During our Digital Pop-Up study, we investigated the difference between having a stand-alone unstaffed pop-up and a staffed pop-up with information signage. The unstaffed pop-up failed to communicate its objective as a majority of passers-by did not notice it. Instead people used it as a shelter to sit and rest, talk amongst each other or make mobile phone calls. Interviewed participants highlighted that the pop-up appeared to have no purpose as there was no information around it, they didn't know what it was for and it was uninviting. The design and deployment of this pop-up is an example of a communications breakdown, due to lack of information surrounding it and staff attendance. The staffed pop-up coupled with information signage was more effective in making passers-by aware of the pop-up. Interviewed participants expressed that the activity and energy at the pop-up attracted them to the space and that they enjoyed interacting with the staff. Similarly, our Digitally Augmented Pop-Up study was successful in attracting the attention of passers-by as a result of signage, the design of the engagement activities and the playful character of the engagement activities. This was complimented by a multi-disciplinary team who were available to answers a variety of questions and to assist with the engagement activities. The culmination of those activities resulted in a honeypot effect (Wouters et al., 2016), making people curious about what was going on and therefore drawing them in to enquire and interact.

This pattern has some aspects in common to Lyle et al.'s (2015) pattern #7 'Community Communication', which suggests that designers should consider what means of communication is appropriate within a local setting in order to avoid a communications breakdown. Similarly, the design of pop-up engagement should take into consideration the engagement objectives, what information needs to be provided and collected, and how this will be communicated to participants. The pattern also draws on Schuler's (2008) pattern #122 'Community Enquiry', which states that people should come together and collaboratively work on problems in an experimental and critical manner. Similarly, collaboration between participants and staff and the types of data collected through their interactions at pop-ups can be experimental, however, they may need to be adjusted according to location and demographics. This pattern compliments pattern #1 Raising Awareness by allowing open dialogue between participants and staff.

Solution

Not all passers-by will be able to understand the immediate purpose of the pop-up, therefore it is critical to provide information through signage and staff presence. The design should be flexible and allow for adjustments during deployment, including information channels and the set-up of engagement activities.

Pattern 5: Submitting Responses on the Spot

Problem

Community engagement demands an investment of time with engagement sessions generally held on specific dates and times. Participants would need to learn about the engagement topic and how it could potentially benefit or directly impact them before being able to submit their responses. Like many variables in urban living, this investment of time competes with other priorities.

Context

This pattern can be used with any type of pop-up engagement where competing interests, priorities, and time constraints might come into play. The pattern is also specifically useful for engagement initiatives that require input from time-poor people who aren't able to come to dedicated sessions or spend a long time engaging with the topic. Members of the public may have limited time due to work, social or family commitments, which might conflict with the designated timeframes allocated for the proposed engagement. Community engagement is resource intensive and involves a significant amount of research and preparation, which therefore dictates its duration and timeframes.

Discussion

This pattern indicates a need to design engagement activities that have a clear direction, are quick to interact with, and don't require staff to assist. One of the constraints with traditional community engagement is time poor citizens are unable to attend due to other commitments. Traditional engagement methods, such as workshops, focus groups and town halls can run up to several hours. The objective of this pattern is to encourage passers-by who don't ordinarily attend community engagement sessions to quickly submit a response on the spot. With pop-up engagement people can stop for a few minutes on their way to work, lunch or home to engage and submit their response. Participants would not be required to undergo a lengthy registration process or provide any personal information. The project Vote As You Go is an example of deploying a digital intervention for the purpose of situated community engagement in a public space (Hespanhol et al., 2015). This study investigated the use of two voting systems that allowed passers-by to interact with the activities on the spot. The digital interfaces used for this study provided an effective strategy for attracting the attention of members of the public and converting them into active participants. Similarly, Koeman et al. (2015) deployed small scale voting devices in local shops to obtain feedback about a local community development. This enabled people to quickly vote on the spot about the topic without having to spend a significant period of time filling out forms or surveys.

Solution

As outlined in Digitally Augmented Pop-Up involving a variety of stakeholders in the development of engagement activities provides a greater understanding of the types of issues people want to raise and topics they would like to discuss. The location of the pop-up also plays a crucial role, making sure that any barriers between the flow of pedestrian traffic and the engagement activities are removed. Similarly,

the instructions to using the engagement activity should also be clear. For digital engagement channels, it is critical to design them as walk-up-and-use interfaces (Hespanhol et al., 2015) that don't require people to spend time learning how to use the interface and submitting their responses.

Pattern 6: Balancing Digital and Physical

Problem

Pop-up engagement needs to cater for the wider community. Not all participants are able or willing to use digital technologies due to language, literacy or ability barriers. At the same time, certain demographics may be more interested and willing to engage with digital media channels. Providing participants options to participate either through physical or digital media can therefore enhance the community engagement process by attractive a wider demographic to participate.

Context

This pattern can be used to create opportunities for a more inclusive pop-up engagement experience by providing a number of media input channels that are both digital and physical. This pattern particularly applies in situations where communities consist of a mixed demographic (older people, culturally and linguistically diverse). Balancing digital and physical also applies to situations where multiple responses are required to answer the engagement question – some of which are better collected via physical and some via digital media.

Discussion

Providing a balance of digital and physical media for pop-up engagement is an effective means of attracting and enabling a greater cross section of the local demographic to participate. During our *Pop-Spot* study we designed five engagement activities; three with digital inputs and two as physical media that were thematically themed. Each of these media channels had a connection to the other, ensuring coherence between the channels and their alignment with the overall engagement topic. The study was designed to allow participants to interact with the engagement activities that they felt most comfortable with, which provided an enhanced engagement experience. Similarly, Caldwell et al. (2016), deployed the *InstaBooth* as a pop-up engagement booth using both digital and physical media for engagement activities. Participants were encouraged to respond to engagement questions through SMS and Twitter, or storytelling through drawing pictures and writing responses on paper. The digital media responses were displayed on digital screens located inside the booth, and the physical media was displayed on pin boards both inside and outside of the booth.

These two examples demonstrate that a combination of digital and physical media can provide a different material experience, which can lead to richer forms of engagement. For example, writing on chalkboards or paper evokes different emotional connections compared to typing answers into a smartphone or tabled device. More playful engagement activities, such as voting by taking a selfie, can help to attract younger demographics. Therefore, depending on the engagement topic and the intended target demographic it is important to shift the balance between digital and physical media.

Solution

Pop-up engagement should employ a combination of digital and physical media, which needs to be balanced according to the local context, demographics and the intended engagement questions.

Pattern 7: Contextual Representation

Problem

One of the limitations of traditional community engagement is that people feel disconnected from the engagement results, as they are either too high level or presented in a way that is difficult to understand or not accessible.

Context

This pattern can be used to display or present pop-up engagement results that are in the context of the local community. For example, feedback on strategic planning proposals, local area plans and proposed developments.

Discussion

Traditional community engagement results are generally presented in planning reports or as high level statistics. As a consequence, local communities often feel that their contribution was not considered in the decision making process (Innes & Booher, 2004). Pop-up engagement presents an opportunity to provide a localised representation of engagement results that is relevant and directly addresses the local context. This pattern works in conjunction with pattern #3 'Local Context' – tailoring engagement activities to local communities. This pattern takes this further by adapting the engagement results to the local community in which it was collected. Our expert focus group participants highlighted that such an approach would have the potential to alleviate the feeling of disconnection amongst communities. This can be achieved through using digital (urban screens, digital displays, online platforms), analogue (chalkboards, chalk stencils on the ground), or physical (expert staff on the ground) output channels. Our *Digital Pop-Up* study displayed the engagement responses of local participants on the urban screen. This is an example of providing localised engagement responses for all people to see. Similarly, the *Visualising Mill Road* project, which spanned across two communities, used two different types of chalk stencils displayed in different locations to distinguish the results of each community.

Solution

Presenting engagement data that is relevant to the local area provides an opportunity to connect citizens with a localised dialogue around community topics. This approach also provides further opportunities to alleviate disconnection between what is happening in a local community and how it might connect into a greater city wide project or initiative.

Pattern 8: Immediate Feedback

Problem

Traditional community engagement techniques fail to provide feedback collected from participant interactions and input immediately after the engagement. Participants therefore experience a very isolated view as they don't know what responses others have submitted.

Context

This pattern can be applied during pop-up deployments to display the immediate and accumulative engagement results. These can be displayed in a digital or physical form either inside or surrounding the pop-up.

Discussion

Enabling participants to visualise the local engagement results in real-time has the ability to enhance the overall engagement experience for local communities. Participants can see what others had to say in regards to the engagement questions. Our Digital Pop-Up study is an example of displaying immediate feedback through digital media. Using an existing large urban screen, we displayed the yes/no voting results and text based responses as participants interacted. Schroeter et al. (2009) undertook a similar study, which enabled participants to SMS and tweet responses to engagement questions that were displayed on a large urban screen in a busy public square. Both of these studies showed the immediate and accumulative results of the engagement topic.

Digitally Augmented Pop-Up used both digital and physical inputs for people to answers questions, which displayed the results of the physical media (pining the paper votes to a fabricated tree) and displaying previous participants' selfie responses - through thumbnail pictures displayed on the home screen of the web interface tablet device. Pop-Spot displayed engagement results through digital and physical media. Participants that used the selfie voting app could see their picture on an adjacent digital display along with other participants' pictures. In addition to that we used physical media (chalk spray and stencils) to keep an accumulative tally of participants' responses grouped by type of response (in this case mode of transport). These results were displayed on the ground directly next to the selfie voting app. Through interviews with participants, our studies have shown that people prefer to see the results of other people on the spot. This approach validates the overall engagement objective and has the ability to inspire other people to further contribute to what others have said.

Solution

Displaying immediate feedback at pop-ups has the potential to further enhance community engagement in local communities. This can be achieved by employing a combination of digital and physical media in and surrounding the pop-up, taking into consideration the local context, demographics and use of space.

DISCUSSION

The design patterns presented in this article have been created as guide for the deployment of digitally augmented pop-ups for community engagement. The eight patterns were designed within the three engagement themes of Notification, Interaction, and Engagement Results. The review of existing community engagement frameworks, our own field studies and the expert focus group informed the structure of the three engagement themes and therefore the design of each pattern. People wishing to deploy digitally augmented pop-ups may choose to follow the format outlined, however, we have deliberately avoided suggesting specific relationships between patterns to allow pop-up interventions to be appropriated according to the proposed community engagement objectives and activities. We have however, suggested connections between the patterns, for example in the discussion of pattern #3 Local Context, we highlight that this pattern compliments pattern #1 Raising Awareness and #2 Creating Activity. Similarly, in the discussion of pattern #4 Community Discussion we draw on the pattern examples of Lyle et al. (2015) and Schuler (2008) and how that relates back to our pattern #1 Raising Awareness. As these design patterns evolve we feel that distinct relationships will emerge once they have been tested and refined in real world practice.

We acknowledge that there are a number of limitations with the data collected through our three field studies Digital Pop-Up, Digitally Augmented Pop-Up, and Pop-Spot. Conducting field studies in public space with the intention to interact with passers-by are notoriously difficult to run. Throughout each of these studies we collated and analysed the engagement results, took observations and undertook interviews with willing participants. However, there are data inconsistencies between the studies, for example, in Digital Pop-Up and Digitally Augmented Pop-up we interacted with a variety of demographics within local communities. This included office workers, culturally and linguistically diverse people and residents who lived in public housing areas. Whereas Pop-Spot was conducted within a university campus where participants were predominately from younger demographics and have been exposed to higher levels of education. Our studies also highlighted clear points for improvement regarding the usability of pop-up engagement. For example, we learned from interviewed participants that some people were unfamiliar with the novel context of our pop-ups, and were confused about its purpose and how to navigate around the activities effectively. Digitally augmented pop-ups are not intended to replace existing community engagement but rather used as an additional channel to engage with local communities. This approach does not propose that existing methods of community engagement are redundant, but rather suggests that these patterns can be used to complement existing tools, techniques and frameworks already established and widely used for community engagement.

CONCLUSION

In this article, we outlined eight initial design patterns that can be applied to the context of digitally augmented pop-ups that incorporate a combination of digital and physical media. The patterns were designed to address limitations of traditional community engagement techniques used in local communities, and to be able to reach and include a wider demographic. The focus of this work is to provide an alternative to the ‘one size fits all’ approach generally employed for community engagement in urban planning by providing an initial set of design patterns to be tested and challenged by built environment students, researchers and practitioners. The development of these design patterns contribute to the field

of urban planning practise and research in three ways. Firstly, we have advanced the field by proposing a novel and interactive approach for community engagement mediated through digital and physical media. Secondly, we further expanded on the work undertaken by Alexander et al. (1977), Schuler (2008) and Lyle et.al (2015), by presenting real world examples that have been tested within the built environment. And finally, these patterns set a foundation for creating a future pattern language that encourages creative and interactive community engagement facilitated through pop-up interventions, which can be applied to urban planning practice. These patterns are intended to be dynamic as we strongly encourage students, researchers, practitioners and members of the community to test, refine and improve the current patterns.

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Chapter 40
Applying Digital Storytelling to Business Planning

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ABSTRACT

Digital storytelling for business planning has two different modes of perception, thinking, and communication: the narrative and the logical scientific. This chapter pointed out how the structure and the contents of the digital storytelling work influence its effectiveness through examination of works and the audience's evaluation of the works. Critical points regarding the structure of work were the consistency and the balance. The most important link was from a contrast between the initial situation and obstruction in the narrative part, to key success factors deriving in the analytical part. The link represents what is the problem that the storyteller found. Regarding the contents of work, familiarity to the audience—a story of "something like you"—is effective in understanding, persuasiveness and empathy of the story's message.

INTRODUCTION

Digital Storytelling

In this chapter, digital storytelling means a short digital work that combines narration and visual-auditory material, such as photographs, music, and movies, produced by an individual as his or her own story[1]. The origin of digital storytelling was a kind of democratization movement of visual art on the West Coast of the United States in the 1970s–1980s. In the 1990s, the movement developed through the appearance of low-cost and easy-to-use equipment, such as personal computers, digital cameras, and the Internet. In 1994, the San Francisco Center for Digital Media was founded and developed into the Center for Digital Storytelling (CDS) in 1998 (Lambert, 2013). Although a virtual reality game in which players develop their own stories with a character is also called digital storytelling (Murray, 1998), this chapter addresses digital storytelling following the CDS's movement.

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Lambert, one of the founders of the CDS, pointed out that digital storytelling has seven components: self-revelatory, personal or first person voice, scenes of a lived experiences of the storyteller, photos more than moving images, soundtracks, short-length (under five minutes) and simple designs, and the storyteller's ownership of the entire process and distribution (Lambert, 2013). As Lambert (2013) noted, the storyteller's private life need not always be revealed, but telling a storyteller's non-fiction expressed in the first person is recommended because it is the easiest way to deeply reflect himself or herself.

Regardless of whether or not a story is the storyteller's nonfiction, digital storytelling is oriented to be subjective, personal experience-based, emotional, sensory, and self-reflective in general. Through these aspects, digital storytelling contrasts with the ideal of logical scientific presentation in academic society.

Hartley and McWilliam (2009) added the definition of an element: that digital storytelling is a workshop-based practice called a story circle, although the workshop basis is an implicit premise from the beginning of the digital storytelling movement. In a story circle, participants not only learn how to create works but also communicate with each other during the process of developing stories. A story must be told to someone; thus, members of a story circle function as both author of their stories and hearers of other members' stories. In addition, if the workshop has a specific social theme, such as an environmental problem, digital storytelling can assist the social movement by sharing members' consciousness.

Digital storytelling has been applied to a variety of fields, not only visual arts but also a new style of media, education, therapy, and various social movements in public health care, social services, and others. Digital storytelling has spread not only in the United States but also in countries in Europe, Oceania, North America, Asia, Africa, and South America (Hartley & McWilliam, 2009). In Japan, where the workshop for this research was held, workshop-based practices by educational institutes and non-profit organizations have been observed since the 2000 (Nishioka, 2014).

Digital Storytelling in Business Situation

From the earliest time of the CDS, business use of digital storytelling has been positively attempted. For example, Coca-Cola adopted digital storytelling early in its brand marketing process. The company's brand story appeared on its website and recently has become more interactive with customers on social networking services (SNSs), such as Facebook. Because brand is an identity, a story can be told even for an agent who is not a human being.

The narrative approach did not result directly from the influence of the CDS but has expanded in social sciences from the 1980s and has broadly influenced businesses. A number of narrative approach practices have appeared, such as narrative planning, narrative marketing, storytelling for career development and storytelling in system development. Denning (2007) focused on leadership language; leaders must tell true stories about themselves, think through narratives, and understand the audience's story. Kusunoki (2010) advocated that an excellent corporate competitive strategy is a story. Future scenario planning (Schwartz, 1991; Van der Heijden, 1996; Wade, 2012) is also an example of narrative approach in business. In the early stage of the scenario planning process, one tends to place importance on logical analysis by identifying a focal issue, listing and classifying key factors and driving forces, and selecting scenario logic. In the latter process, the narrative approach becomes more pertinent as it fleshes out, interprets the scenarios and finds indications of the future (Schwartz, 1991). Scenario planning could be regarded as a hybrid version of the narrative approach and logical analysis.

Although a narrative approach in business is not always accompanied by the use of information technology, the usage of digital media is becoming increasingly prevalent these days. The narrative approaches in business have naturally changed to "digital" storytelling.

The focus of this paper is to understand application of digital storytelling to business planning. The differences in digital storytelling for business and non-business, such as art and therapy, are assumed as follows:

- There is a clearer aim of storytelling (i.e., business goal).
- Concrete business methods should be mentioned as conclusions at the end of the storytelling work.
- Evidences for business success are expected.

These traits develop a scientific attitude in storytellers. Thus, we expect that a hybrid style of the narrative and logical analysis would be observed in the digital storytelling for business planning.

Digital Storytelling as a Narrative

Clearly, digital storytelling is a form of a narrative. A narrative is an organized interpretation of a sequence of events. The function of a narrative is to bring order to disorder and to reflexively provide structure to our very sense of selfhood. The character of the story told depends on to whom the story is being told, the relationship between the narrator and the audience, and the broader social and cultural context (Murray, 2015). The narrative has the power to arouse the imagination, understand circumstances, facilitate communication with other entities, and rebuild the storyteller's own reality.

As compared to a simple narration or text, digital storytelling supposedly strengthens and expands the traits of a narrative. To summarize, the difference between "digital" storytelling and other types of "analogue" narratives, such as a simple narration or text, is assumed as follows:

- Digital storytelling strengthens the sensuous and emotional effect of a narrative in terms of visual images and auditory effects when compared to an analog narrative. The power of making sense of a confused real world might be enhanced using multi-sensory expressions.
- A digital format allows the storyteller to exhibit his reflection to other participants in the workshop. In the editorial process, the authors also tend to become reflective by hearing their own voices.
- Digital storytelling helps broaden social communication in digital form. The storyteller can reach out to a global audience and new narrative possibilities, which go beyond the constraints of time and location, may appear.

Objectives of This Chapter

The application of digital storytelling to business planning is assumed to be a hybrid version of the narrative approach and logical analysis, which strengthens the sensuous, emotional, reflective and communicative traits compared to an "analog" narrative. It becomes a curious case when one observes how the interaction of narrative and analytical approaches impacts the digital forms in business. This chapter aims to explore the potential of the narrative to create new value and synergy with the traditional analyti-

cal approach. This can be achieved by demonstrating a case study of applying digital storytelling to the early stage of business planning. The findings of this research will contribute to business administration because management literature has rarely been exposed to the synergistic effect of the narrative and analytical approaches.

BACKGROUND

Narrative Mode and Logical Scientific Mode

Bruner (1996) advocated that human beings have two modes of thinking: the logical scientific mode and the narrative mode. The logical scientific mode is used to explain something causally through a theory that elucidates necessary and/or sufficient conditions. It does not depend on the specific contextual setting. In contrast, the narrative mode is used to understand something through an interpretation process and depends on the specific context and history. A sequence of events is interpreted as having various meanings, and different people can interpret such a sequence in different ways (Bruner, 1996, 2003).

The criteria for the two modes of thinking are different. Logical scientific thinking should verify propositions using context-free logic and evidence. For narrative thinking, the interpretation should not only be rooted in factuality but also be better contextualized and rhetorically fair-minded, and there should be an awareness of the requirements of the narrative, such as a mutual understanding with the audience on how stories are developed and become realistic (Bruner, 1996, 2003). The narrative has a kind of logic regarding consistency and plausibility, but its criteria have very different qualities from that of the logical scientific mode.

In the 1980s, hermeneutics in the literature developed in a variety of social science fields, such as psychology (Murray, 2015). Although the "narrative turn" has appeared in academia in recent years, people in practice have perceived, thought, and communicated with others in the narrative mode from ancient times; the logical scientific mode is rather extraordinary.

However, the logical scientific mode broadly influences ordinary individuals through schools and academic society, whose formal mode is logical scientific. In business administration, although a very punctual logical scientific mode is rarely seen, as it is in academic society, semi-logical scientific thinking is broadly observed. Business administration presentations and reports have a form that is similar to that of academic presentations and papers, although the thoroughness of the literature review and the verification method is weaker than in academia. At least the business planning and assessment process typically require clear logic and some evidence.

On the one hand, a business plan must rigorously solve problems because of the variety of types of stakeholders and required resources, such as money, talent, and facilities. Typically, a business planner puzzles over a number of complicated problems, and the problem solving matches the logical scientific mode that develops propositions logically and verifies them systematically.

On the other hand, a business plan must point out problems that have not yet been solved. Essentially, the purpose of the narrative mode is to find problems (Bruner, 2003). Thus, it could be considered effective, particularly in the early business planning stage. The sensuous and emotional function of the narrative mode is also important to refine thoughts and communicate it to other people (Bower, 1981; Forgas, Bower, & Krantz, 1984). "… emotion powerfully influenced such cognitive processes as free associations, imaginative fantasies, social perceptions, and snap judgments about others' personalities

... when the feeling-tone of a narrative agreed with the reader's emotion, the salience and memorability of events in that narrative were increased (Bower, 1981, p.129).

Although the narrative mode and the logical scientific mode are fundamentally different, explaining and interpreting are linked (Bruner, 1996). Actually, even in a scientific style presentation, presenters frequently insert impressive episodes. The possibility is strong that digital storytelling for business planning includes both narrative and logical scientific modes.

Exploring a form of a link between the narrative and the logical scientific modes is a curious endeavor. When both narrative and logical scientific modes exist in a presentation, what is the structure of the work and how effective is it?

Structure of Narrative

The narrative in digital storytelling for business planning might have commonalities with folklore, the novel, and other stories. Bruner (1996) defined a (fictional or actual) story of an agent who acts to achieve a goal in a recognizable setting by the use of certain means. Although a number of variations exist, the sequence of events of a story always has a single pattern that begins with an explicit or implicit prorogue representing the ordinariness or legitimacy of its initial circumstances and the hinted evaluation of the end of the story. Next is the most important part: trouble. Trouble means a misfit among agents, acts, goals, settings, and means, and a violation of the initial legitimate expectancy. Then, the agent struggles to recover legitimacy. Finally, restitution of initial legitimacy or a revolutionary change in affairs with a new order of legitimacy is achieved.

Bruner (1996) referred the original concepts of the narratology literature such as Propp (1928). Comparing to the framework of Propp (1928), a prorogue that represents ordinariness corresponds to the initial situation before the functions of a story start. After symptoms of trouble occur, such as absence and interdiction, the main character encounters significant problems. In Propp (1928), the center of trouble is described as villainy or lack. Then, the main character attempts to solve the problem by, for example, departure and struggle. The solution sometimes comes from the power of donors' magical agents (tools). At the end of the story, legitimacy is recovered through, for example, victory, liquidation, or rescue, and revolutionary change comes through, for example, transfiguration, or wedding.

Propp's theory has elaborated on other refined theories such as Greimas (1970). The focus on the forms of narrative as well as its contents have led to the appearance of narrative discourse theories such as Genette (1972). This paper, however, adapts Brunner's theory in the psychology literature concerning the narrative approach based on the simplified framework of the narratology literature such as Propp (1928), and does not aim to conduct a deep analysis of the narrative's contents and structure.

Basically based on Bruner (1996), we suppose that the narrative side of digital storytelling for a business plan has the previously described four units, similar to other types of narratives. We call the four units an old situation (prorogue), obstruction (trouble), the solution (struggle), and a new situation (recovery or change). In our study, the core of the narrative may be considered a unit of obstruction because the workshop in this research was held during an early stage of business planning. Finding a problem is more important in the early stage of business planning than detailed problem solving, and an obstruction is a strong suggestion of where a problem occurs, in contrast to an old situation that represents ordinariness.

This research explores the influences of the structure and contents of digital storytelling on the audience's evaluation of business plans. In particular, we observed a qualitative link between the narrative and the logical scientific modes.

METHOD

Digital Storytelling Workshop

During April–July 2014, we held a workshop on business planning using digital storytelling that were instructed by an academic researcher and a business consultant at a Japanese university. Six graduate students participated. Two of them had experience in working with companies and had started a new business in their 40s and 50s. Four of the participants had no work experience and were in their 20s.

Ten sessions on digital storytelling lasting one and one-half hours were conducted. The workshop schedule was as follows:

Session 1: Three-minute speech on business plans with an image: What do I want to do and why do I do it?
Session 2: My personal history: How is my personal history related to my business plan?
Session 3: Presentation of storyboard and discussion.
Session 4: Digital storytelling technique and engaging in digital storytelling.
Session 5: Presentation of digital storytelling prototype and discussion.
Sessions 6–8: Engaging in digital storytelling.
Sessions 9–10: Presentation of final digital storytelling work and discussion in front of the audience.

All six participants completed the storytelling work up to session 8. Sessions 9 and 10 were held as an open meeting and six works were presented. Graduate students, staff, and outsiders interested in business planning using digital storytelling participated.

Data Collected

In the last session held on July 18, 2014, the completed six works were shown to 35 members of the audience and their positive and questionable responses were recorded during the presentation of each work by an audience response system. [2] At the end of each presentation, the audience filled out a questionnaire.

During July–October 2014, the same survey was conducted online. Through the Internet, respondents observed presentations of the digital storytelling works, and during the presentation of each work, their positive and questionable responses were recorded using the online audience response system. At the end of each presentation, they filled out the same questionnaire as the offline one. 39 responses were collected.

A total of 74 members of the offline and online audiences responded to the questionnaire. The audience was 53% male and 47% female, the average score of age was 30.5 years old, and 74% were graduate students and 26% were working. All the participants of the workshop have a basic knowledge of management through university education or through their experience of running a business. A few participants actually have the experience of starting a new business.

The composition of the questionnaire was as follows:

Questions regarding the work after each presentation:

1. Open-ended questions:
   a. Good or interesting points.
   b. Questionable points.
   c. Other points noticed.

2. Prefixed questions:
    a. Overall evaluation of the work (0–10 point scale).
    b. Attribute evaluation of the work.
    c. (1: Unlikely, 2: Rather unlikely, 3: Cannot say, 3: Rather likely, 5: Likely):
        i. I can well understand the contents of the business plan.
        ii. I can understand the business planner's vision and motivation.
        iii. I am interested in the business plan.
        iv. The business plan is persuasive.
        v. I have empathy with the business plan.
        vi. Visual expression is good.
        vii. Narration is good.
        viii. The description of the storyteller's personal experience is good.
        ix. I had a similar experience.
        x. The story is realistic.
        xi. The overall structure is well considered.
        xii. The business plan has a good point of view.
        xiii. The business plan is well considered.
        xiv. I would help if I could.
        xv. I would fund the plan if I were a venture capitalist.

Overall questions at the end of all presentations:

1. The difference between digital storytelling and the traditional presentation style.
2. Compared with the traditional presentation style, digital storytelling is…
3. (5: Effective, 4: Rather effective, 3: Cannot say, 2: Rather ineffective, 1: Ineffective):
    a. Understanding the contents of the business plan.
    b. Understanding the business planner's vision and motivation.
    c. Interest in the business plan.
    d. Persuasiveness of the business plan.
    e. Empathy with the business plan.
4. Open-end questions on overall comments.

The questions pertaining to the evaluation of attributes (1.b.ii.) were selected keeping in mind the types of cognition and behavior. The first type is reasonable, and the objective cognition is mainly affected by the logical scientific mode (No. 1, 11-13). The second type is sensuous, emotional, and its episode memory-related cognition is mainly affected by the narrative mode (No.5-10). The third type is affected by the mixture of both the modes and intention of the final behavior (No. 2-4, 14-15).

Method of Analysis

Participants of the workshop were instructed to tell a story about what they want to do and why they want do it that reflects their personal history. Instructions were given to keep the total time length to approximately 5 minutes. However, participants were not told the details of the contents and structure of the work. Thus, the contents and structure naturally appeared in the process of developing the work.

Although participants were not told, the work could be divided into two main parts: the narrative part and the analytical part. The researchers identified the parts and units of the works by focusing on the owners of the viewpoint of the story. The part of the story told from the viewpoint of a personal character, including that of the storyteller, was regarded as a narrative. The part of the story viewed and told objectively and scientifically, i.e., from a point of view of God, was regarded as analytical. All storytellers started from the narrative part and ended with the analytical part, except for the beginning of the work (see Figure 3).

The methodology of the analysis, first, is to identify the structure of the parts and units of the works by examining length of time, order, and position throughout the entire work. In addition, we observed qualitative aspects regarding the interaction of each unit.

Second, we observed the audience's response and evaluations that were collected in the workshop and online. The audience's evaluation was measured using data from the audience response system and the questionnaire described in the previous section.

Finally, we qualitatively estimated the influence of the structure and contents of each unit on the audience's evaluation. The first point of view was from the impact of the proportion of the time length of each unit on the evaluation. Second, we observed the contents of the narrative part and focused in particular on the influence of personal experiences in this part. The third point of view was the influence of other factors, such as the quality of the concept, the existence of objective evidence, visual expression, and narration.

STRUCTURE OF DIGITAL STORYTELLING WORKS

A summary of the digital storytelling works of the workshop participants is provided in Figure 1 and Figure 2. [3]

The structure of the digital storytelling works that the participants developed are indicated in Figure 3. In total, the storytellers' narrative part consumed 53% (average 185 seconds) of the total time and the analytical part consumed 47% (average 167 seconds) of the total time.

The narrative part consisted of four functional units: old situation, obstruction, solution, and new situation. The old situation unit took 51% of the time, the obstruction part took 30%, the solution unit took 14%, and the new situation unit took 4%. Four of the six works had no solution and no new situation unit.

The analytical part consisted of six functional units: factor, resource, evidence, element explanation, method, and expected result. The time length of the analytical part was 29% for the factor, 3% for resources, 11% for evidence, 11% for the element explanation, 43% for the method, and 3% for the expected result.

The participants were not provided instructions regarding the structure of their work during the workshop. Thus, the structure of the work, which is indicated in this section, could be considered as the outcome of the unconscious and spontaneous activities of the participants.

Structure of the Narrative Part

Two patterns to the composition of the narrative part appeared in the works. The first pattern (Works B, C, E, and F) was that the narrative part includes only the old situation and the obstruction units. In this pattern, the factor unit of the analytical part immediately follows the final obstruction unit of the episode and the solution is never indicated.

Figure 1. Summary of the digital storytelling works for business planning (Work A, B, C)

Work A	**Title: Japanese-style home delivery system in China** **Time Length:** 417 sec, **# of Screens:** 24, **Music:** yes, **Main Character:** Storyteller **Author:** 20s, student with no working experience
Narrative part	**Episode 1:** When I was a child in China, I was lonely because my parents lived overseas **(Ob).** One day, my parents gave me a Japanese manga **(So)** and my personality became cheerful, encouraged by Japanese animation **(New).** **Episode 2:** I came to Japan and encountered thoughtful Japanese services **(Old)**. I started a small business to export animation character models, but it failed because of the immaturity of the Chinese delivery service **(Ob)**. I found a solution for exports to China using the Japanese home delivery service **(So)**.
Analytical part	**F1:** New style of home delivery service in China **F2:** Customer-oriented service for special needs **E1:** Cases of service for golfers and refrigerated transportation service by Japanese home delivery company **F3:** Marketability of the delivery of fragile goods in Shanghai **E2:** Specific demands for animation character models and level of existing delivery service **M:** Standardization of packet, fee system according to size, human- oriented services, value-added services, staff education, expanding category of fragile goods **ER:** Delivery service that connects human relationships
	
Work B	**Title: Recycling system for university insiders** **Time Length:** 307 sec, **# of Screens:** 20, **Music:** yes, **Main Character:** Storyteller **Author:** 20s, student with no working experience
Narrative part	**Episode 1:** I moved recently. I wanted to exchange unnecessary and newly required goods and sought people with which to exchange them through SNS **(Old)**. I found an appropriate person, but we failed to exchange goods because of a change in the counterpart's situation **(Ob)**.
Analytical part	**F:** Trusted and easy-to-use recycling system **E:** Problems of existing services **M1:** Use of internal network and system of the university, closed membership only for students and staff of the university, expanding services to other universities **R:** Existing system of my university **M2:** Testing in my university and expanding to other universities **ER:** Service placing value on things and people
	
Work C	**Title: New style Japanese school for factory workers in China** **Time Length:** 396 sec, **# of Screens:** 14, **Music:** no, **Main Character:** Storyteller **Author:** 20s, student with no working experience
Narrative part	**Episode 1:** When I was a college student in China, I was depressed because I failed to enter the expected university **(Ob)**. However, I met an excellent and enthusiastic teacher who is handicapped, and I made up my mind to become a teacher **(So)**. **Episode 2:** I went to teach Japanese to Chinese factory workers as an intern **(Old)**, and I knew the factory workers faced difficulties learning **(Ob)**.
Analytical part	**M1:** Japanese school for factory workers of Japanese company in China **F:** Time-saving for busy workers, interactive and practical learning **M2:** Targeting specific industrial area in China where Japanese companies accumulate, small classes at night, practical teaching methods, motivation management, a close relationship with Japanese companies and universities
	

Narrative Part: Old situation = **Old**, Obstruction = **Ob,** Solution = **So**, New situation = **New**
Analytical Part: Factor = **F**, Resource = **R**, Evidence = **E**, Element Explanation =**EE**, Method = **M**, Expected Result =**ER**

Figure 2. Summary of the digital storytelling works for business planning (Work D, E, F)

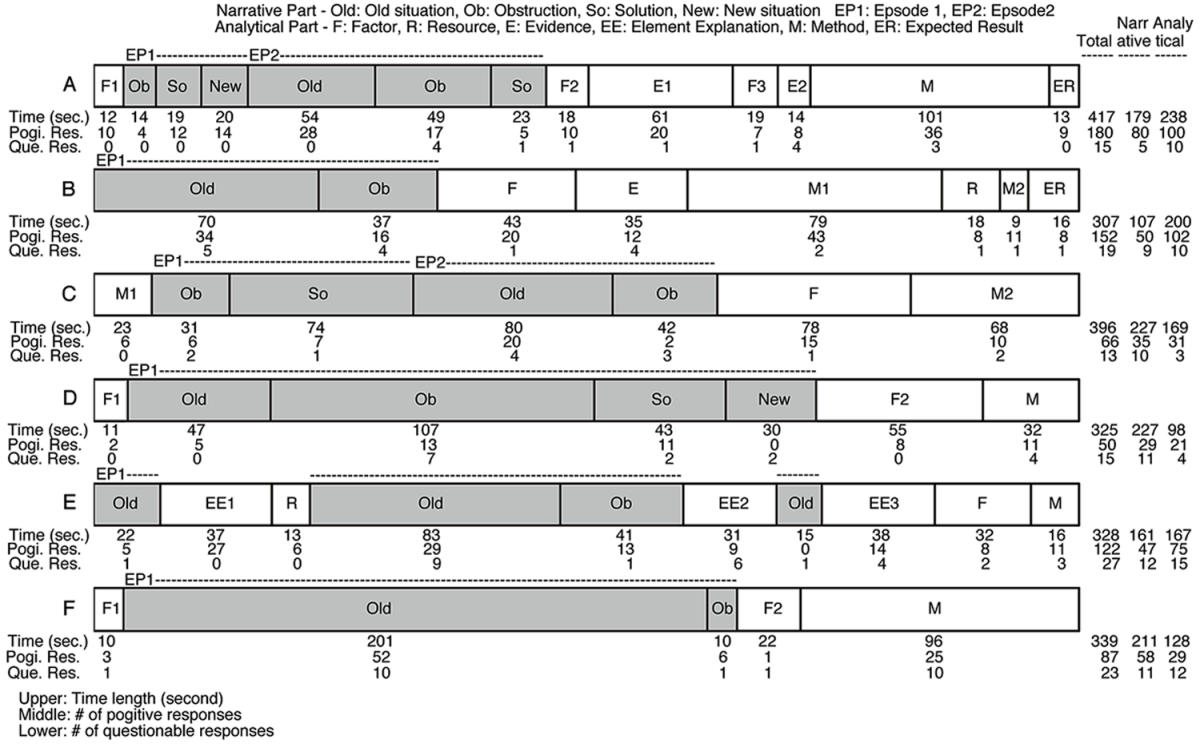
Work D	**Title: Consulting service supporting the service staff** **Time Length:** 325 sec, **# of Screens:** 9, **Music:** no, **Main Character:** Fictitious character **Author:** 50s, working
Narrative part	**Episode 1:** Tama (fictitious character) started a part-time job at a grocery store and loved the job **(Old)**. One day, a customer complained about the quality of the product. Tama apologized, but the customer said that she did not understand the problem. Tama was depressed and quit the job **(Ob)**. Later, Tama went to the store and knew that the customer wanted the store to investigate the cause of the accident **(So)**. Tama made up her mind to work at the store again **(New)**.
Analytical part	**F1 :** Support plan for service staff **F2:** Organizational support for staff, improvement of customer service skill **M:** Visualization and analysis of complaint, consulting to improve customer service skills and motivation of the staff
	
Work E	**Title: Promotion of chenpi, the specialty of a hometown** **Time Length:** 328 sec, **# of Screens:** 18, **Music:** no, **Main Character:** Storyteller **Author:** 20s, student with no working experience
Narrative part	**Episode 1:** I did not know the goodness of my hometown **(Old1)**. **Episode 1 (continue):** When I was a child, I did not love chenpi (a kind of herb), but I have good memories of eating chenpi with my family **(Old2)**. When I came to Japan to study, I was shocked that dishes tasted strange and noticed that chenpi was good for my health **(Ob)**. **Episode 1 (continue):** I also long for a memory of people in my hometown making chenpi **(Old3).**
Analytical part	**EE1:** Introduction and effects of chenpi **R:** The hometown is one of the largest producing districts for chenpi **EE2:** Production process of chenpi **EE3:** Application of chenpi **F:** Publicity for Japanese individuals to know about chenpi **M:** Exhibition of chenpi at the school festival
	
Work F	**Title: Networking between an illustrator and customers** **Time Length:** 339 sec, **# of Screens:** 12, **Music:** no, **Main Character:** Storyteller **Author:** 40s, working
Narrative part	**Episode 1:** I love to collaborate with and support my friends in business. I have a friend, an amateur illustrator who has been engaged in a number of volunteer activities **(Old)**. She is now thinking about working as a professional. I would like to support her **(Ob)**.
Analytical part	**F1:** Networking between an illustrator and customers **F2:** Networking of existing fans **M:** Communicating with fans on SNS, customer-made illustration service

Narrative Part: Old situation = **Old**, Obstruction = **Ob,** Solution = **So**, New situation = **New**
Analytical Part: Factor = **F**, Resource = **R**, Evidence = **E**, Element Explanation =**EE**, Method = **M**, Expected Result =**ER**

Work B starts from the old situation unit, "I moved recently, and wanted to exchange unnecessary goods," and then the character meets the obstruction, "I failed to exchange the goods because of the change in the counterpart's situation." The potential needs of a trusted and easy-to-use recycling system of the analytical part are indicated.

In episode 1 of Work C, the obstruction unit appears first, "I am depressed because I failed to enter the expected university," followed by the solution, "I met a handicapped teacher, and inspired by her, I made up my mind to become a teacher." As a consequence of episode 1, episode 2 starts from, "I went to teach Japanese to Chinese factory workers when I was an intern," as the old situation, and then the character encounters the obstruction, "I know that the workers faced learning difficulties," is indicated. Following the conclusion of the episodes, the success factors are indicated as analysis, that saves time for busy works, is interactive and facilitates practical learning.

Figure 3. Time length and number of responses of each work



Work E begins with the character's memory as the old situation, "I did not love the specialty of my hometown, chenpi (a kind of herb) when I was a child." Here the obstruction is, "I was shocked that the dishes tasted strange and noticed that chenpi was good for my health after leaving my hometown." The story is linked to the promotion of chenpi in the Japanese market in the analytical part.

Work F starts from the old situation, "I love to collaborate with my friends, and I have a friend, an amateur illustrator," implicitly indicates the obstruction by saying, "My friend is now thinking about working as a professional. I would like to support her." This episode has developed into an idea of networking between an illustrator and customers in the analytical part.

The second pattern of episode composition (Works A and D) was that the episode has a solution and, in one case, also indicates a new situation.

In Work A, the narrative part starts from the obstruction, "As a child, I was lonely in China," and a solution is presented, "My parents gave me a Japanese manga," and a new situation appears, "My personality became cheerful encouraged by Japanese animation." The new situation in episode 1 was connected to the old situation, "I came to Japan and encountered thoughtful Japanese services." In episode 2, the character again encounters an obstruction, "A small business of exporting animation character models, which I had started, failed because of the immaturity of the Chinese delivery service." This is followed by the solution, "I found a solution from Japanese home delivery service." This finding was linked to the key success factors for a new style of home delivery service in China in the analytical part.

Work D had one episode that starts from the old situation, "Tama (a fictitious character[4]) took up a part-time job at a grocery store and loved the job," followed by the obstruction, "One day, a customer

complained about the quality of the product. Tama apologized, but the customer said that she did not understand the problem. Tama was depressed and quit the job." The solution follows, "Later, Tama went to the store and came to know that the customer wanted the store to investigate the cause of the accident," and ends up in the new situation, "Tama made up her mind to work at the store again." (Figure 1 and 2)

Structure of the Analytical Part

The analytical part represented a very similar style of scientific presentation. The assumption of the key success factors for a business (the factor unit), the concrete methods to satisfy the key success factors (the method unit), the objective evidence for the supporting hypotheses (the evidence unit), the business planner's existing resources (the resource unit), the explanation of business element in detail (the element explanation unit), and the expected result from fulfilling the method (the expected result unit) were observed.

Only the factor and method units that commonly existed in all six works are considered essential for a business plan. In the factor unit, key success factors for a business derived include concepts related to the overall strategy and objective of a business, specialization, targeting of customers, important functions of the business, and important characteristics of a service. Examples of a concept related to the overall strategy and objective of a business include customer orientation, support for the service staff, and support for a friend.

Embodying the concepts of the factor unit drew concrete methods in detail, such as standardization of packet size, usage of closed networks, location of industrial accumulation in a Japanese company, visualization of complaints, exhibition in a school festival, and fans' SNS.

Element explanation units appear only in Work E because the storyteller had to explain the product, chenpi, that is not well known in the Japanese market. The resources that the storyteller (= business planner) already owns appear only in Works B and E. In Work B, the resource is the storyteller belonging to a university and having access to the university's internal network. In Work E, the resource is the storyteller's hometown being one of the largest producing districts of chenpi. In other works, clarification of business elements and resources tends to be weak.

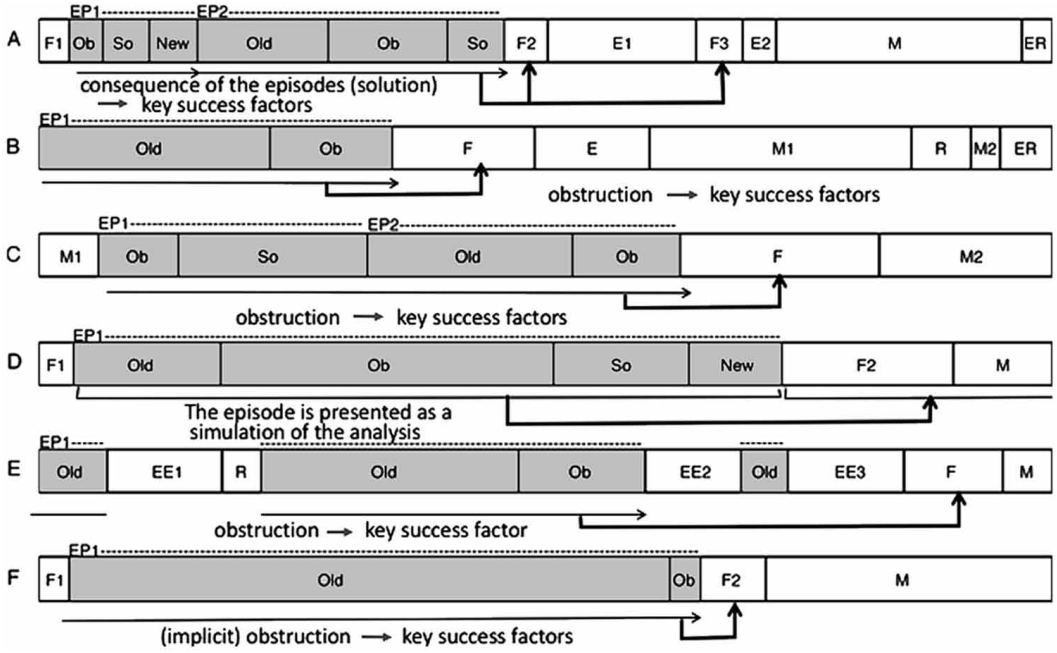
Notably, the evidence and the expected result appear only in Works A and B. The analytical part of Works A and B are said to be, relatively, a scientific presentation style, including theory (= clarifying factor), evidence, and forecast (= expected result). Objective evidence could be considered to reinforce the theory and the consistency with the narrative part in these works. (Figure 3)

Linkage between the Narrative and the Analytical Part

As mentioned in the section of the structure of the narrative part, we observed that the narrative parts of all works are connected to the logic of the analysis. The narrative part is not isolated from the analytical part in digital storytelling for business planning.

As seen in Figure 4, a typical pattern as observed in Work B, C, E, and F is that the storyteller starts the story to explain the old situation, and then the main character encounters the obstructive situation. The change from the old situation to the obstruction is a clue to derive the key success factors. In the pattern, which contains the solution or a new situation in the narrative part, the consequence of episodes

Figure 4. Linkage of the narrative part to the analytical part



of Work A suggests key success factors. In Work D, the narrative part was presented as if it were a simulation of the analytical part – the proposal of a consulting service, which will support the service staff.

Interestingly, these elements are viewed as similar to the narrative model of leaders' speech in Denning (2007): capture attention with a negative story (Obstruction) >> elicit desire with a positive story to achieve action (Solution) >> reinforce with reason as a neutral story to explain what, how, and why (Analytical part).

Both the logical and emotional linkages were observed between the narrative and the analytical parts. The narratives of all of the works contain an emotional expression. For example, Work A expresses loneliness in childhood and empathy with Japanese cultures, Work B expresses the emotion of avoiding wastefulness, Work C expresses respect for one's teacher and sympathy with learning enthusiasm of factory workers, Work D expresses the service staff's depression, Work E expresses the emotion of longing for one's hometown, and Work F expresses the love of supporting friends in business. These emotional expressions represent the motivations of the storyteller or promote the audience's empathy—although not always successful, as subsequently described.

EVALUATION OF EACH WORK

The audience provided an overall evaluation of each work, an attribute evaluation, and open-end comments using a questionnaire and real-time responses from the audience response system, as previously described.

Overall and Attribute Evaluation

As Figure 5 indicates, the overall evaluation rank is Works A, B, C, D, E, and F. Works A and B are in the top group and are significantly different from the other works. Work F was evaluated as the lowest among all works, followed by Work E. Works C and D were in the middle. Thus, we consider Works A and B to be in the top group, Works C and D to be in the middle group, and Work E and F to be in the lowest group.

In general, evaluation of the attributes was highly correlated with the overall evaluation (Figure 6).

Seeing the exceptional ranking of attribute evaluation compared to the ranking of overall evaluation, Work E in the lowest group received a relatively high evaluation for understanding the contents of a business plan, vision and motivation, description of personal experience, and point of view, but received a low rating in persuasiveness, similar experience with the audience, and overall structure. Although Work E has a good episode that communicates the storyteller's motivation, it is problematic to the entire structure, as subsequently described.

Work D received a relatively high evaluation in narration, but a low evaluation in the description of personal experience because the storyteller has narration experiences on the job and the main character in the narrative part is fictitious only in Work D.

Figure 3 indicates the number of real-time responses during each work presenting. The top group—Works A and B—received the most frequent positive responses. The lowest group, Works E and F, received the most frequent questionable responses. Real-time responses showed the same tendency as those of the overall rating from the questionnaire after the presentation.

Figure 5. Overall evaluation (N=74, 0-10 point)

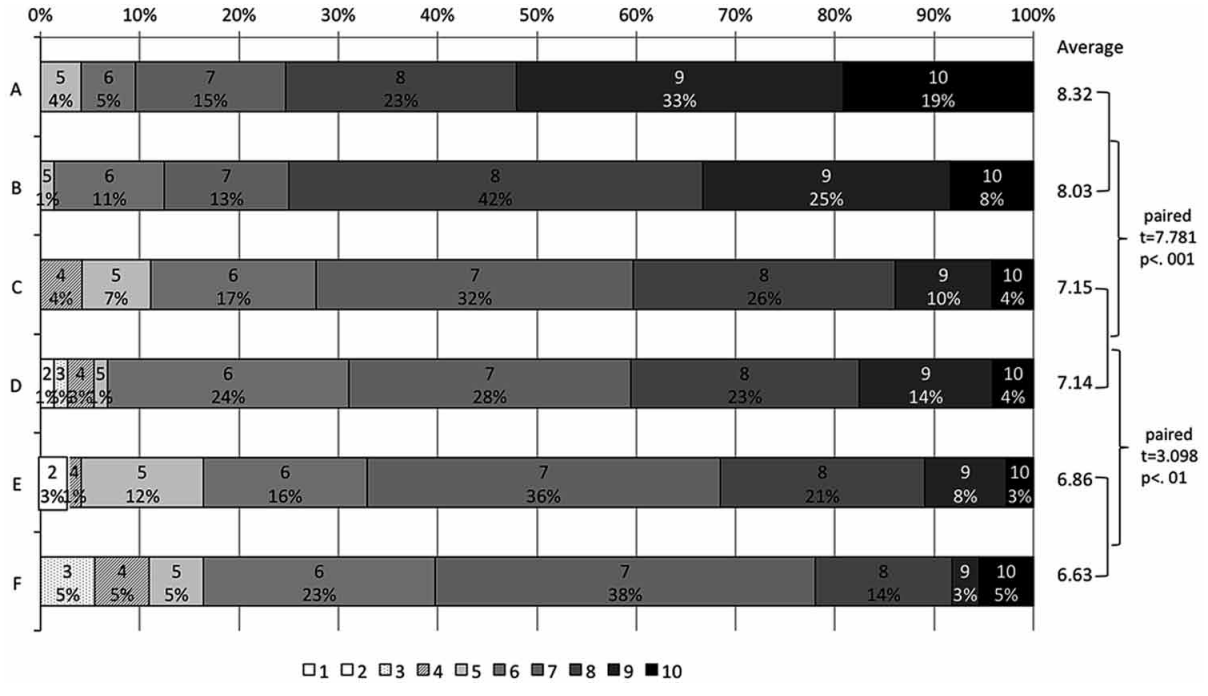
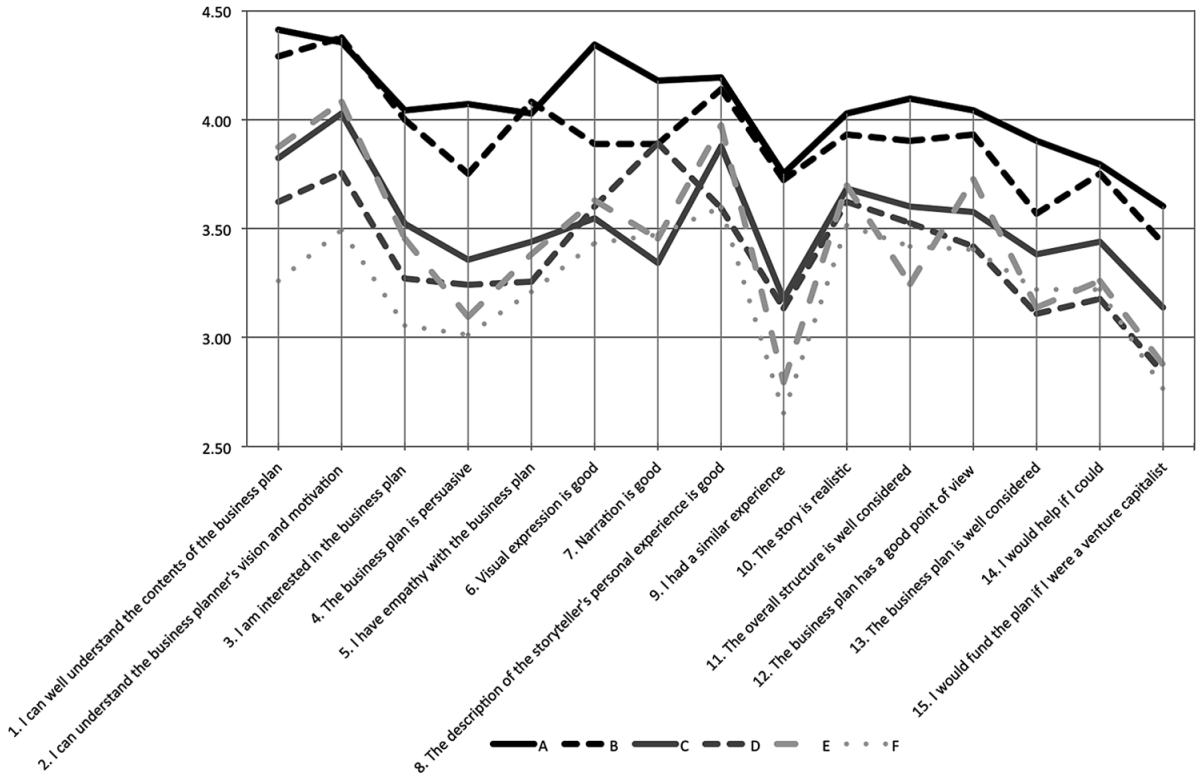


Figure 6. Average scores of attribute evaluation (N=74, 1-5 point) Real-Time Responses to Each Part of the Story



Open-Ended Comments

A total of 691 comments were gathered from the audience. The composition of categories is indicated in Table 1.

The comments tended to emphasize the rational side of the presentation, including the concepts of the key success factors for businesses, linkages with the episodes and evidence, explanation of business elements, the business method, and new points of view, over the emotional side, including sensory expression, simple empathy, and motivation. A total of 69% of all comments were on the rational side of the presentation. The strength of the rational side of the audiences' evaluation of the digital storytelling work is presumed to be a characteristic of the reaction to the business plan work compared with the work for other application fields, such as artistic expression and therapy.

Considering the characteristics of digital storytelling for a business plan compared with a scientific presentation for a business plan indicates that comments on linkage between episodes and key success factor concepts (12% of all comments) were very important. Interestingly, the positive comments (53 comments) on the linkage between episode and concept were very homogeneous; that is, 98% of the comments were similar to, "It is good because the business plan is drawn from the storyteller's personal experience/realistic story." (Most comments noted the "storyteller's personal experience"; however, for Work D, comments stated "realistic story" because the main character was not a storyteller but a fictitious character.)

Table 1. Open-ended comments

		Total
Positive/Negative	Base	691
	Positive comment	56%
	Negative comment	44%
Category	Concept of business plan	31%
	Business method	16%
	Linkage between episode and concept	12%
	Shortage of evidence and comparison	6%
	Explanation of element	2%
	New point of view	2%
	Sensory expression	18%
	Motivation	3%
	Sympathy	3%
	Overall impression	6%
	Others	1%
Composition of Large Categories		
Concept of Business Plan (Positive)	Base	**144**
	Mentioning about specific concepts	62%
	Concept is overall good	38%
Concept of Business Plan (Negative)	Base	**72**
	Concept is unclear/insufficient	100%
Business Method (Positive)	Base	**23**
	Mentioning about specific methods	83%
	Detailed/concrete description of method is good	17%
Business Method (Negative)	Base	**86**
	Mentioning about specific methods	41%
	Business method is unclear	37%
	Financial plan is not clear	20%
	Others	2%
Linkage between Episode and Concept (Positive)	Base	**53**
	Business plan is drawn from the storyteller's personal experience/realistic story	98%
	--> I also had a same/similar experience	(35%)
	Others	2%
Linkage between Episode and Concept (Negative)	Base	**30**
	Shortage/obscurity of linkage between episode and concept	100%

continued on following page

Table 1. Continued

		Total
Sensory Expression (Positive)	Base	**75**
	Photo, drawing	49%
	Narration	28%
	Music	12%
	Others	11%
Sensory Expression (Negative)	Base	**48**
	Photo, drawing	38%
	Narration	58%
	Music	4%

Furthermore, among the comments on drawing concepts from personal/realistic experience, 35% stated, "I also had a same/similar experience." The audience found such experiences not only plausible but also familiar. The plausibility and familiarity of the narrative part could become the foundation for the key success factors of business plans, although relatively more subjective than scientific evidence. This finding is critical in considering the function of a story when applied to businesses in general.

Negative comments about the linkage between episode and concept (30 comments) complained about the shortage or obscurity of the linkage (Table 1).

FACTORS THAT INFLUENCE THE EVALUATION

Influences of Structure on the Evaluation

The structure of the work is considered to influence the overall evaluation. An attribute evaluation of "Overall structure is well considered" of the top group is superior to that of the middle group (paired $t=4.727$, $p<0.001$, $df=70$), and the rating of the middle group was higher than that of the lowest group (paired $t=3.243$, $p<0.01$, $df=69$) (Figure 6).

As we have already seen in the section on the structure of digital storytelling works and a qualitative analysis of the audience's comments, the narrative part could become the foundation of deriving the key success factors. Typically, the contrast between the old situation and the obstruction units provides a clue to the reasoning for the factor unit in the analytical part.

A comparison among the proportion of the time length of the old situation unit, the obstruction units, and the factor unit of the top group for Work A is 33:38:30 (where the total time of these three parts is 100) and for Work B is 47:25:29. For the middle group, it is 35:32:34 for Work C and 21:49:30 for Work D. In the lowest group, it is 62:21:17 for Work D and is 86:4:9 for Work F (see also Figure 3.)

The proportion of the three units is almost equal in the top and middle groups, although the proportion between the old situation and the obstruction in the narrative part differs slightly for Works B and D. At least the proportion of the factor of the analytical part is typically at approximately 30% in these groups.

Apparently, the balance of these units is incorrect in the lowest group. Work E has a long old situation unit, obstruction is relatively short, and the factor unit is only 17%. Work F has a very long old situation unit that occupies 86%, the obstruction takes a very short time of 4%, and the factor is only 9%. Although identifying exactly the appropriate proportion of units is difficult, if only a long personal story and poor analysis exist, the audience may not find a connection between the story and the business plan.

Influences of Personal Episodes and the Feeling of "Something Like Me" on Evaluation

As was observed in the section on open-ended comments, 98% of the positive mentions on the linkage between episode and concept were "It is good because the business plan is drawn from the storyteller's personal experience/realistic story." Of these comments, 35% stated, "I also had a same/similar experience."

In the pre-fixed attribute evaluation, "The description of a storyteller's personal experience is good" was rated significantly higher in the top group than in other groups (paired $t=4.606$, $P<0.001$, $df=70$ between top and middle; paired $t=4.538$, $P<0.001$, $df=68$ between top and lowest). "The story has reality" had the same tendency (paired $t=3.692$, $P<0.001$, $df=70$ between top and middle; paired $t=4.393$, $P<0.001$, $df=68$ between top and lowest) (Figure 6). The number of comments that had the same meaning was larger in Work B (21 comments) and Work A (10 comments) than in other groups (average of five comments).

Regarding the attribute evaluation of "I have a similar experience," significant differences existed among the top, middle, and lowest groups (paired $t=5.253$, $P<0.001$, $df=70$ between top and middle; paired $t=4.666$, $P<0.001$, $df=69$ between middle and lowest). The ranking using the average score of this attribute was exactly the same as that of the overall evaluation: Works A, B, C, D, E, and F (Figure 5 and 6).

A relationship exists in which a higher evaluation of personal experience/reality results in a higher overall evaluation. The relationship is much stronger if the experience or realistic story is familiar to the audience. In another words, the feeling of "something like me" positively impacts on the audience.

The top group—Works A and B—well represents the storyteller's personal experience and reality of the story, and the audience perceived that they had a similar experience at the same time. Work C follows the top group in these aspects of evaluation. Regarding Work F, which had the lowest overall evaluation, the audience did not admire the representation of the storyteller's personal experience. Moreover, the reality and familiarity of the story also received a low evaluation, even though Work F presented a long emotional story. Work F's representation of the story was problematic (Figure 6).

Regarding Work D, although the attribute evaluation of personal experience was low because of a fictitious main character, the reality and familiarity of the story were the same as that of Work C, which followed the top group (Figure 6).

In contrast, Work E was rated at the same level as Work C for personal experience and reality, and received the lowest rating—similar to Work F—for familiarity to the audience (Figure 6). Although the storyteller's memory of his or her hometown is well described, the story was about a Chinese student. Therefore, a cultural gap may exist with a Japanese audience, which may have difficulty being empathetic.

These facts might imply that familiarity is more important to the audience than plausibility or reality. Thus, the episode need not necessarily be based on the storyteller's personal experience, but the degree to which the audience has a similar experience to the story is essential. For this reason, Denning (2007)

pointed out the story of the audience's problems, the story of who we are, and the common memory story as devices for effective leadership communication.

On the emotional side, plausibility might affect an audience's perception of storyteller motivation but it does not always improve the audience's empathy. Regarding attribute evaluation, in Work E, the storyteller's motivation and vision effectively describes the personal experience and was understood relatively well; however, familiarity, empathy and overall evaluation were low (Figure 5 and 6).

Influences of Concepts and Evidence on Evaluation

Regardless of the linkage with the narrative part, the quality of the concepts of a business plan is, naturally, essential. The largest share of open-ended comments was on the concept in general. The top group in the overall evaluation—Works A and B—received a larger number of positive comments on the quality of the concept. Moreover, the attribute evaluation of "The business plan has a good point of view" and "The business plan is well considered" was higher in the top group than in the other groups (Figure 6).

The excellence of the concept was considered the basis for the evaluation of the business plan; therefore, if the concept is of very poor quality, the overall evaluation will be low regardless of the quality of the narrative. However, in this research, the average attribute evaluation of the concept rated using these two questions ("a good point view" and "well considered") was higher than at the middle point of the measurement (3.0). The concepts of all of the works are good or average, enabling the narrative part to play the role of enhancing the foundation of the concept.

Regarding the foundation of the concept, only the top group also provided objective evidence in the analytical part. The evidence unit appears twice just after the factor unit in Work A and once in Work B (Figure 3). Objective evidence enhances the accompanying logic deriving factors, in addition to the linkage of the narrative part.

Influences of Visual and Auditory Expression on Evaluation

Visual and auditory expression techniques are also important for overall evaluations. The number of comments about the techniques of expression was the second largest, following comments on the concept (Table 1). The top group—Works A and B—tended to receive more positive comments than negative comments. The attribute evaluations of "Visual expression is good" and "Narration is good" of the top group were also rated higher than that of the other groups (Figure 6).

The top group used a larger number of screens of pictures compared with the lower group (Figure 1 and 2). As was noted in the section on open-ended comments, in general, the amount of visual expression was positively perceived.

The volume of the narration is important. The recording level of Works C, E, and F was problematic and numerous complaints were received for these works on the level of narration.

Regarding the quality of the narration, the narration of Work D was eminently frequent and some audiences said, "It is professional-like." Actually, the storyteller of Work D has experience with making public announcements for her job. The fluency of the narration tended to be evaluated in a positive manner; however, interestingly, some audiences perceived the narration as somewhat negative, with comments such as "The frequency is too high" The fact that too much frequency of the narration was negative at some point is related to the fact that a familiar experience for the audience affected the overall evaluation. A story told by a professional narrator may be perceived as less familiar than a story told by an amateur.

The impact of music is relatively less compared to the visuals and narration (Table 1). Overall, preference was given to the kind of music that provides a good atmosphere but does not disturb the narration.

DISCUSSION

Consistency and Balance of a Story

In the context of application to business planning, digital storytelling has two faces: the narrative and scientific logical analysis. The two faces are not separate, but have a mutual relationship. The works we researched started telling stories from an episode and ended at analysis. The function of the narrative part reinforces the analysis part both rationally and emotionally.

The rational side of the link between the narrative and analysis is that, first, a narrative points to the start of the business. In other words, the narrative represents the problem to solve. The inspiration for the initial concept of a business cannot be deducted from a theory or inducted from objective data. Finding problems is the most appropriate function of the narrative. It means that the business planners not only find problems, but also make other stakeholders understand where the problem lies – in consumer needs or unrevealed market potentials. In particular, obstruction plays a most critical role in finding problems. An incidence of trouble or the lack of something represents problems, and a number of entrepreneurs frequently start a business from an obstruction experience.

Second, a narrative provides rich explicit or implicit hints to derive key success factors, resources, business methods, and expected results. People can guess at the factors from a contrast between the old situation and obstruction, and by following the progress of the episode. Hints of resources are often implicitly indicated in the episode's background. In some cases, the main character gets new devices in an episode, which become hints of the business methods. The scenario is similar to folklore in which magical agents are given by a donor. The end of an episode(s) implies the expected result.

Problem solving and forecasts can be done through analysis; however, new alternatives from new points of view are difficult to find through strict analysis. The narrative is also good at finding new alternatives, similar to finding problems.

The narrative is also good at emotional representation. Although rationality tends to be more important than emotion in the context of business planning, the emotional side functions to enhance the entire consistency of the story.

The emotional side of the link is that, first, a narrative conveys a business planner's motivation and commitment to the business. The motivation and commitment of the entrepreneur are quite important for other people who may cooperate with him or her. A high possibility exists that the business will fail if the entrepreneur is not well motivated and committed.

Second, a part of the audience's empathy for the business plan can be brought from the empathy for the narrative. An audience's empathy is different from the storyteller's motivation. Even the audience sensing the business planner's motivation from the narrative does not always spur their empathy if the narrative is not empathetic enough, such as Work F.

Mixed links exist on both the rational and the emotional sides to form a bridge from the narrative to the analysis: problem finding, alternative finding, conveying the business planner's motivation, and spurring the audience's empathy. Regardless of the quality of the links, every unit should always be linked with other units to make the work effective for the audience. At least one path from one unit to another

unit is necessary. The comments show that audiences are very sensitive to how every unit is connected to other units. People do not like inconsistencies in the story (Bruner, 1996).

In addition, the entire structure of a work should be balanced. Too short length of important units, such as obstruction, factor, and method, and too large length of complimentary units, such as element explanation cause an imbalance in the logic of the story, and make the work ineffective.

Consistency[5] and balance of the narrative and analysis represent a kind of logic of digital storytelling for business planning. An audience mentioned the feeling of the logic as follows:

There is logic in the way of telling a story. When I listen to the story, I felt that my questions were answered one by one (comment for Work C).

Power of the Story of "Something Like You"

Another key point in making a narrative effective is familiarity of the episodes to the audience. If the audiences sense, "This story is something like me," the narrative makes the storyteller's message understandable and improves its persuasiveness and empathy. The story need not be exactly same as the audience's experience, and it is adequate if audiences find some essential commonality between episodes and their experience. Although episodes of the personal experiences of the storyteller are generally effective, it is a fact that "Me story" (Lambert, 2013) often has some essential commonality with other people. If the story is heterogeneous to the audience, even a storyteller's experience will not convey the message well.

Conveying the message is more difficult if audiences have divergent experiences. If the characteristics and background of the audience are homogeneous, the storyteller can prepare the story relatively easily. However, in reality, individuals' backgrounds are typically divergent, even if they belong to the same organization or environment.

An excellent presenter is skilled at telling a story that is "something like you," regardless of the audience. Such a presenter might understand the general and essential commonalities among human beings. If a person is skilled at telling a story that is "something like you," telling personal experiences and using the first person is not necessary. Creators such as novelists and filmmakers have made a number of works that enables readers or audiences to sense a commonality with themselves, even when using fictitious characters in a fictitious situation.

Digital storytelling is compatible with broad worldwide social networks. The broadening of the network increases the diversity of the audience and the corroborative team members. Finding commonality among individuals has increased in importance. An education system that teaches the development of a story that is "something like you" is needed, although teaching balance and a mix of links between the narrative and analysis is more difficult. These more general issues face digital storytelling in the era of worldwide networking.

FUTURE RESEARCH DIRECTIONS

This research is an explorative and qualitative study to find problems rather than to solve problems. A larger amount of data that is objectively measured, and a controlled research design, are necessary to verify the findings of this research.

Furthermore, this chapter does not address certain important points of view, such as the influences of digital storytelling on the storyteller and its influence on the concept of a business plan.

Digital storytelling is broadly known to change the storyteller (Hartley & McWilliam, 2009; Lambert, 2013). Rather, an important objective of digital storytelling is recognition of selfhood and a self-revolution, particularly in the application areas of therapy and education.

Reflection is the critical process of recognition and change of selfhood. Generally, a narrative reflexively provides structure to our very sense of selfhood (Murray, 2015). Seeing personal photographs and listening to the narrations of storytellers through digital storytelling may arouse richer images of selfhood and may induce reflection. Moreover, the workshop system of digital storytelling explicitly enhances the reflection process by enabling discussion with other participants. Observing the reflection process on how stories are developed by participants in the workshop provides clues to the influences of digital storytelling on the storyteller.

In addition, the narrative has the character to bring new points of view to people. Finding problems and alternatives, which was pointed out in this chapter, is the result of the function of expanding viewpoints, and some members of the audience mentioned new ideas for a business plan in the open-ended comments. The business plan itself may have changed because storytellers found new points of view during the process of developing stories. Changing an idea and its factors could be also clarified by observing the process of the workshop.

CONCLUSION

Digital storytelling for business planning has the unique trait of two different modes of perception, thinking, and communication at the different locations of the work: the narrative and the logical scientific. This chapter pointed out how the structure and contents of the work influence its effectiveness through examination of the works and the audience's evaluation of real-time responses, and prefixed and open-ended questions at the end of each presentation of work.

The consistency and the balance of the narrative and analytical parts were considered to relate to the audience's evaluation. The obstruction unit in the narrative part and the factor and the method units in the analytical part were critical for digital storytelling of business planning. The most important link was from a contrast between the initial situation and obstruction in the narrative part, to key success factors deriving in the analytical part, although all units need at least one connection with other units. Isolated units create a sense of inconsistency for audiences.

Regarding the contents of the narrative, if a narrative is familiar to the audience, and helps them relate to the narrative, i.e., "something like you," it is effective in understanding, persuading and creating an emotional effect on the audience.

The findings of this research show that a narrative creates new value in helping audiences relate to it, "something like you," and has a synergistic effect by creating logical and emotional links between a narrative and traditional analysis.

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KEY TERMS AND DEFINITIONS

Analytical Part: A part of the digital storytelling that was told in the logical scientific mode. In this chapter, the researchers identified the analytical part on whether it was told objectively and scientifically, i.e., from a point of view of God.

Digital Storytelling: A short digital work that combines narration and visual-auditory material, such as photographs, music, and movies, produced by an individual as his or her own story.

Element Explanation Unit: A unit of the analytical part, in which an unfamiliar or a peculiar business element such as a product, a method, an environmental factor is explained in detail.

Evidence Unit: A unit of the analytical part, in which objective evidences for examining the hypotheses in the factor unit are indicated.

Expected Result Unit: A unit of the analytical part, in which the expected result from fulfilling the business method in the method unit is forecasted casually.

Factor Unit: A unit of the analytical part, in which the key success factors of the business are derived as the hypotheses objectively and analytically.

Logical Scientific Mode: A cognition style of human being to explain something causally advocated by Bruner (1996). Interpretation does not depend upon the specific contextual setting.

Method Unit: A unit of the analytical part, in which the business methods to satisfy the key success factors are proposed concretely.

Narrative Mode: A cognition style of human being to understand something through an interpretation process advocated by Bruner (1996). Interpretation depends upon the specific context and personal and/or communal history.

Narrative Part: A part of the digital storytelling that was told in the narrative mode. In this chapter, the researchers identified the narrative part on whether it was told from the viewpoint of a personal character (including the storyteller).

Narrative: A sequence of events told by people with oral communication, text, movie, comic, digital presentation, and other devices. A narrative is open to interpretation for the storyteller and the audience.

New Situation Unit: A scene(s) of the narrative part, in which a character finds a newly appeared situation after the problems were solved in the solution unit.

Obstruction Unit: A scene(s) of the narrative part, in which a character encounters a trouble or shortage of a critical thing.

Old Situation Unit: A scene(s) of the narrative part, which represents the initial or the ordinary situation before a character encounters an obstruction.

Resource Unit: A unit of the analytical part, in which the business planner's internal resources such as human network, existing facilities, and financial situation are presented.

Solution Unit: A scene(s) of the narrative part, in which a character struggles and solves problems that were found in the obstruction unit.

Story of "Something Like You": A story making audiences sense some essential commonality with their experience.

ENDNOTES

1 In this chapter, a "story" denotes a causal sequence of events directly related to a character who is seeking to solve a problem or to achieve a goal. This refers to the fourth definition of "story" of Prince (2003). Then, an "episode" is a series of mutually related events that have distinctive characteristic(s) (Prince, 2003). A story contains one or more episodes.

2 The audience response system used in the offline study was a "clicker" system, which is widely used for teaching assistance. The main function of the clicker is to aggregate the number of clicks by participants, in real time. The audience response system used in the online study was developed as part of the study, and is original. The system adds up the number of clicks in real time while the movie is shown online.

3 The narrative and analysis were determined by whether the point of view is that of the main character (subjective) or God's eye (objective). Events are divided by the appearance of a solution (and result) of an event. The analysis of the structure of a work is based on a discussion by researchers. Thus, a weakness of this study is that the analysis methodology is subjective. An objective methodology should be developed in future research. (The texts shown in Figures 1 and 2 were summarized by the researcher, owing to space restriction in this paper. However, the analyses was conducted on the original movies.)

4 In an interview with the author of Work D, she confirmed that the narrative part of the work is fictitious, based on her experience. In all other works, the authors stated that they were the main characters, and that the contents of the narratives were real-life accounts.

5 The effectiveness of a story does not always improve when the consistency of the story is high. Defamiliarization—a representation that causes feelings of strangeness or a lack of familiarity in the audience—is sometimes used in movies, plays, and novels (Kanai, 2005). Although there is no work that uses defamiliarization in this study, its existence and the mechanism of its effect in the context of business planning should be examined in future research.

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Chapter 41
Reasoning Qualitatively about Handheld Multimedia Framework Quality Attributes

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ABSTRACT

Today's mobile handheld devices, such as smartphones and action cameras, are well equipped for a wide range of multimedia and context-aware tasks. Such tasks can leverage traditional services like streaming audio and video as well as newer services like sensor fusion. Ubiquitous network access, coupled with an increasingly sophisticated mixture of device-based hardware and software, is enabling context-aware applications at an unprecedented rate. The objective of this chapter is to discuss specific quality attributes with respect to device-side software architectures providing these multimedia and sensor capabilities. This chapter focuses specifically on device-side client architectures rather than network or server architectures. Specific domain requirements and quality attributes are first derived through a synthesis of current research and industry trends, and subsequently analyzed. The analysis reveals some qualitative results that seem unintuitive at first glance but that become more understandable when provided with rationale relative to the handheld domain context.

INTRODUCTION

Today's non-tablet, mobile handheld devices (i.e., smartphones) are well equipped for a wide range of multimedia and context-aware tasks (e.g., augmented reality). Already, current wireless and cellular technologies like Wi-Fi (802.11), 4G LTE, and HSPA+ enable streaming audio and video content to a wide range of mobile devices (Choi, Choi, and Bahk, 2007). Applications such as audio or video streaming, video conferencing, video surveillance, and web browser applications are migrating from PC/notebook computers to their handheld counterparts (Kim and Nieh, 2006). In addition, the complex mesh of sen-

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sors on many of today's smart phones, combined with mobile data, enable completely new applications such as augmented reality (Wagner, 2012). The wide availability of sensors such as barometric altitude, gyroscopic rotation, and GPS sensors also enable new context-aware applications and usage modes. With handheld computing devices outnumbering conventional desktop systems in much of the developed world (GSMA Intelligence, 2014), both manufacturers and developers would do well to consider the special limitations inherent in the handheld domain. By giving careful consideration to quality attributes and their corresponding impact within this domain, manufacturers and developers are more likely to develop applications that work intelligently to mitigate shortcomings imposed by small-screened devices with limited battery life. The objective of this chapter is to discuss architectural attributes of multimedia frameworks on client-side mobile devices such as mobile phones and other handheld computers.

Our goal is to consolidate handheld factors such as power and screen size limitations in order to stimulate deeper consideration during software specification and design, particularly with respect to multimedia and contextual computing frameworks. The following sections further explain the motivation behind this objective and provide an overview of the chapter's organization.

Currently, there is a lack of a standard approach to architectural evaluation for device side multimedia architectures in the handheld domain. This implies that handheld multimedia frameworks must be assessed more through trial and error than through a fitness assessment of some kind. Ultimately, this may lead to inflexible architectures that are difficult to modify later in the software's lifetime. Not only that, but these architectures and the software built on top of them may not adequately address the availability, testability, and performance needs of software operating in the handheld domain. This problem, and its more specific incarnations are addressed in the research and observations section.

Motivation

The motivation for addressing architectural issues on the device-side, or client side, is in reaction to steadily growing body of literature and research in server-side middleware, wireless network protocols, and network infrastructures. Many challenges must be overcome with regard to these network and server-side aspects of ubiquitous computing, but at the same time, the impact of these evolving technologies on client devices must not be overlooked. The motivation for discussing software quality attributes stems from the need for greater awareness of the impact of the multimedia software architecture on the device itself, and its development as a whole

Software architecture is of course essential to the success of the developing organization as it largely determines the success of the organization's software on many levels. Bass, Clements, and Kazman (2012, p. 25) enumerate more thirteen reasons why software architecture is important. Of those, we find the following reasons especially key:

1. An architecture will inhibit or enable a system's driving quality attributes,
2. The analysis of an architecture enables early prediction of a system's qualities,
3. A documented architecture enhances communication among stakeholders,
4. An architecture can be created as a transferrable, reusable model that forms the heart of a product line

We believe the architectural considerations discussed in this work will benefit developing organizations by providing a basis for reasoning about candidate multimedia architectures (i.e. facilitating com-

munication). Similarly, early design decisions can be made on a more informed basis if developers are better informed about the ways that early design decisions impact quality attributes of the final product. Additionally, we hope that this work may be a step towards a consensus about what factors need to be considered in this domain in order to derive standards on top of which future work may build (i.e. the transferable, reusable abstraction). For additional discussion, we encourage a reader to consult (Taylor, Medvidovic, and Dashofy, 2010).

Scope and Organization

The objective of this chapter is to provide a synthesis of the mobile handheld domain with respect to current and future mobile applications, and through this understanding, discuss quality attributes for architectural evaluation. To this end, the chapter is organized by first providing background on handheld computing, the role of multimedia, and handheld capability evolution. Note that by "handheld", we intend to report on devices easily held in one hand, and explicitly exclude notebook and tablet computers. Following the background section, the research and observations section identifies both essential runtime and non-runtime quality attributes to address needs identified in the background discussion. The research and observations section also discusses the interdependencies among quality attributes and their impact within this domain. Finally, the future research section provides suggestions for future work.

BACKGROUND

This section is provided to gain an understanding of the handheld domain. An understanding of the domain and its characteristics is essential to calling out architecturally significant requirements (Laine, 2001). Such requirements are needed to begin evaluation of a software architecture, or as in this work, to better understand quality attributes in the handheld context.

The following sections provide a synthesis of the mobile domain, multimedia capabilities in this domain, and speculation regarding future advances in this area. These sections are provided to show the forces that influence the architectural business cycle (Bass, et al., 2012). A key theme permeating this section is a practical look at the types of applications best suited to handheld mobile devices given their inherent constraints. Finally, some background information on quality attributes is presented.

Handheld Computing Trends

Handheld computing has evolved greatly in the last decade. A large shift in handheld capabilities has been enabled largely by lower hardware costs, and to a lesser degree, better power conservation techniques. In the late 90's, handheld Personal Digital Assistants, or PDAs, were growing in popularity in consumer markets but their sound and display capabilities were still quite limited. Typical displays were either a 4 shade grayscale or limited to 256 colors. Sound capabilities consisted of simple frequency/duration tones for making simple "beeps". Users of such devices used PDA functions primarily for personal information management, such as calendaring, contacts, memos, and task lists.

Over the last decade, PDA functions have been integrated almost entirely into mobile phones as personal information management (PIM) applications. Today, handheld computing capabilities in mobile phones approach their desktop counterparts, largely due to advances in hardware in terms of reduced

size and power consumption. Larger video memory capacities and LCD technologies have resulted in hand-held displays with high resolution, photo quality display capabilities. Today's displays are a mix of 16 and 24-bit per pixel, capable of simultaneously displaying between 64 thousand and 16 million colors. Display resolutions vary widely, but the upper end are well represented by iPhone and Android devices which are often increasingly full high definition, at 1920x1080 pixels, with pixel densities approaching 500 PPI. Sound capabilities have increased in parallel with these display advances. Handheld computers and mobile phones increasingly incorporate software and DSP hardware for playing CD-quality, stereo sound (44 KHz, 16 bit left and right channel samples).

We argue that while such advances now enable audio and video playback, the power and size constraints on handheld devices will continue to limit multimedia use on these devices. Notice that hardware technology will continue to advance making previous concerns like memory size and processor speed less of a limitation (in terms of multimedia capability) than in the past. However, power limits on the rate and duration that new processors can be clocked with respect to limited handheld power supplies will be less likely to change as rapidly. Likewise, the relatively standard and small size of handheld computer displays limits the types of applications users will desire to use in this environment.

Power Constraints

Conventional wireless phones are powered by a rechargeable battery that is recharged by periodically plugging the device into a "brick" or charger. Because these devices are mobile, battery life provided while away from the recharging brick is a key concern.

Although actual numbers vary from product to product, we'd like to see the battery life hold up for several days under typical use (Nemits, 2003). The idea of typical use is a bit vague, but most batteries cannot handle continuous drain for much longer than 4 hours (Nuccio Michaud and Gentile, 1997). Power consumption and battery life is therefore a major concern for overall handheld design and is also one area where intelligent software and efficient algorithms can make a big impact. For example, (Lin, et al., 2007) demonstrated that XviD codecs used less power than MPEG-4 and that it was more power efficient to increase bit rate than to increase resolution. Additional advances in near-threshold computing seek to dynamically reduce the power supply voltage near the threshold voltage of a device's transistors to extend battery life anywhere from 5 to 10 times that of current lifetimes (Dreslinski, et al., 2010). As we'll see later, this implies that our architecture must be flexible enough to leverage such power conservation discoveries.

While many handheld devices feature a fairly stout 2000-3200 mAh internal battery, increasing processor clock speeds and the addition of ASICs in the support of peripheral functions increase power demands. In fact, Weiser, in his 1993 paper on the challenges of ubiquitous computing gave the fundamental equation relating power consumption to processor clock speed as follows (Weiser, 1993, p. 78):

$$\text{Power} = C_L * Vdd^2 * f$$

where

- C_L is the gate capacitance;
- V_{dd} is the supply voltage; and
- f is the clock frequency.

Although as phone users, we may now have the capability to run multimedia applications on the device side, we may not actually want to do so for a very long period of time in order to conserve power. This might especially ring true if we are away from our recharging station for an extended period of time. Of course, this also depends on the multimedia applications themselves. For example, decoding an MPEG-4 video stream over a wireless network connection is likely to drain battery power very quickly. Not only do we have to run the processor (or dedicated decoding chip) for MPEG-4, but we also have to run our LCD, its backlight, audio amplification/filtering circuitry, and the RF circuitry for our wireless connection. On the other hand, listening to streaming audio on its own might be less taxing on the battery because our wireless connection could 1) run slower, and 2) we could turn the backlight off while still playing sound.

Size Constraints

The form factor for handheld computers is fairly fixed and is not likely to get much smaller. There is a point in size (about 10 cm x 18 cm) above which the device becomes too large to be conveniently portable and can no longer be considered a handheld; devices above this size are usually classified as tablet or notebook computers (Kärkkäinen and Laarni, 2002). Conversely, human usability factors for handheld devices limit how small such a device can get.

The last several years have witnessed the creation of tailored web experiences through dedicated "Mobile" sites where the Web browsing experience has been tailored to the display area limitations of smaller handheld devices. However, there is a point beneath which we cannot feasibly shrink the display area and still provide a good user experience (Polta, et al., 2012). In particular, form factors below 6 x 9 cm are not common for touch-screen based handheld computers. Smart phones and handheld computers typically become unusable below this point. Displays beneath this size threshold severely limit touch screen input ability; to compensate, such devices are commonly augmented with buttons. Additionally, when going below this size, traditional PIM applications, along with Web content become cumbersome to use because extensive scrolling is required to view all of the relevant information (Borodin, Mahmud, and Ramakrishnan, 2007).

Role of Multimedia on Handheld Computers

Different types of multimedia content meet different user needs. Until now, the term multimedia has been used rather loosely to mean audio, video, and web content. These different forms of multimedia can achieve different levels of usability on a handheld device (Kärkkäinen and Laarni, 2002). The following lists enumerate the role of audio, video, and web content (hypermedia) in a handheld environment.

Audio capabilities serve the following roles in a handheld environment:

1. Appointment notification through audible alarms and ringtones.
2. System sounds to augment the user interface.
3. Digital dictation, or voice recording capability for personal information management.
4. Streaming audio (locally or over a network) as a viable entertainment appliance.

Video capabilities serve the following roles in a handheld environment:

1. Still video capture or camera/snapshot functionality.
2. Dynamic video capture or digital video recording of short segments.
3. Video streaming for entertainment and information retrieval.
4. Sensor fusion for augmented reality.

Web content/connectivity in a handheld environment:

1. Retrieval/composition of email.
2. Limited information lookup (e.g. reading news, checking stocks, price comparison, etc).
3. Position indexed information retrieval for navigation and augmented reality.

Capability Evolution

Mobile phones are convergent devices, combining phone, PIM, camera, and myriad sensor functionality in a single unit. Combinations of these capabilities on a single platform have enabled a whole new breed of applications. For example, intelligence built on top of sensor fusion can enable new modes of operation, such as adapting power modes when sensing motion contexts: standing still, jogging, riding a chair lift, or sking downhill. Additionally, sensors combined with live camera feed enable augmented reality composites where virtual data are superimposed on real-world objects. For example, a motorist could locate engine components under the hood of their car by viewing a virtually annotated view of their engine compartment by looking at it with their phone.

Although online video and music streaming is commonplace on modern wireless networks, and many of the server side protocols already account for the wide variability in mobile device capabilities, performance is not always ideal. Presentation languages like HTML5 exist to automatically tailor information presentation ``on the fly'', but require the CSS handling and rendering capability equivalent to browsers on a desktop machine. It is the authors' opinion and experience that HTML5 seems impractical for applications such as 3D gaming where quick redraw and low latency responsiveness is required. Nevertheless, specialized silicon such as multi-core processors, DSP chips, and vector processors (e.g., NEON™ SIMD coprocessor) will continue to drive the need for new driver support.

Additional driver support will be required on the communications and compression front. The evolution of wireless communication technologies have resulted in increasing adoption of 4G LTE and HSPA+ in addition to a multitude of compression/decompression (CODEC) formats like MPEG-4 and H.264. All of these technologies must now be supported by handheld devices wishing to access streaming content over a wireless connection (Choi, Choi, and Bahk, 2007). The future will no doubt hold even more formats to be supported.

Quality Attributes

Quality attributes do not offer a hard and fast method for evaluating architectures, but provide a set of high-level objectives for the software as a whole. Quality attributes maybe used in conjunction with qualitative review techniques like the Software Architecture Analysis Method (SAAM), where stakeholders and system designers meet to discuss various software evolution scenarios and assess how the architecture would accommodate these scenarios. The quality goals drive the development of the various scenarios. Such techniques rate the architecture fitness against scenarios, and consequently, their underlying quality

attributes on a high, medium, low type of scale often indicated with a (+, 0, -). Note that SAAM does not constrain software evaluation to functionality or product requirements alone. Evaluation against quality attributes extends above and beyond functionality to encompass fitness for modifiability, availability, portability, etc. As stated by Bass et al. (2012), many "systems are frequently redesigned not because they are functionally deficient—the replacements are often functionally identical—but because they are difficult to maintain, port, or scale, or are too slow, or have been compromised by network hackers." Determining how these various quality attributes should be established is a delicate balancing act. No quality can be maximized without sacrificing some other quality or qualities'' (p. 63).

When considering quality attributes, we can focus on runtime quality attributes or non-runtime quality attributes. Runtime quality attributes represent those qualities observable at runtime operation of the software. Example qualities include, but are not limited to availability, performance, security, and usability. These attributes are likely to matter most to users of the software when actually using their mobile phone because these run time attributes largely dictate externally observable attributes (e.g. fast/slow, stable/unstable, easy to use/complicated). Conversely, we can choose to focus only on those attributes of the software mattering more to the development organization. The development organization is likely to be more concerned about the cost of developing and maintaining its software and is therefore more interested in non-runtime attributes such as reusability, portability, modifiability, integrability, and testability. Typically, it takes longer to recover value from the efforts spent on designing the architecture to achieve non-runtime quality attributes, but over time and through several product releases, the returns are often well worth the effort (Bosch, 2000).

RESEARCH AND OBSERVATIONS

This section builds on the preceding sections to callout architecturally significant requirements for a handheld multimedia architecture (Laine, 2001). Next, the general problem outlined in the introduction is probed in greater detail. Following the problem definition, the quality attributes role in the handheld domain is discussed. Finally we discuss considerations among run time and non-runtime attributes.

High Level Requirements

Change is inevitable and potential handheld applications for multimedia and sensor fusion differ significantly from desktop use. Software architectures in support of multimedia on the device side need to address these very important points. In order to begin evaluating the fitness of software architectures towards these ends, it is important to summarize high level software requirements that may be derived from the earlier discussion and that are likely to apply to a wide range of handheld devices. A few key, but very broad requirements are listed below:

- The multimedia and sensor fusion functions must be able to coordinate with power control functions on the device so that power consuming hardware resources and software services can be disabled when not needed. Architectural mechanisms must be in place to facilitate this communication.
- The architecture should have a well-defined plug-in interface for extending the device's repertoire of media formats. Encoding formats will change. New, more power efficient compression techniques will be developed (Lin, et. al., 2007). A maintainer of the multimedia software should be

able to `easily' add a new CODEC to the platform. Based on our development experience, `easily' would translate to 1-3 days, assuming the core algorithms are already proven on the target processor.

- There should be some type of abstraction for sources and sinks of data such that data access interfaces look universal to client player and recorder applications. Such interfaces would be capable of reading from/writing to a micro SD card, internal nand, RAM, or from/to a network connection albeit UDP, TCP, or other protocol. This implies an architectural portability layer. To what degree the OS already provides these services may change the emphasis given to both portability and security within the multimedia framework itself.
- There should be some type of priority negotiation scheme for making the best use of limited handheld resources for concurrently running multimedia applications. For example, a digital voice recorder application might require use of the same hardware currently being used for audio playback. The digital voice recorder should be able to issue requests to the multimedia framework such that the audio playback is suspended while the recording is created. After recording creation, the multimedia framework could restart the audio playback.
- The software must be reliable with high availability such that the user can access information on demand. Mobile phones are heavily used items. Users depend on these devices to function when needed. Designers must strive for both high availability and reliability. This final requirement, along with the previous one regarding priority negotiation, necessitate that the architecture must have well defined control over component interaction.
- The software must provide security. One element of security for a multimedia framework could be the secure online purchase of digital media (e.g. downloading a song or movie). Another element to consider is providing digital rights management DRM. Recording labels and content providers are increasingly demanding that devices provide protective controls enforcing distribution and copying policies established for digital media. Supporting DRM would be advantageous for maintaining interoperability and compatibility with content vendors.

With these high level requirements and their architectural implications in hand, we could start developing various solution architectures. However, there will be solutions that are more optimal than others, especially when consideration is given to the desired architectural attributes outlined above and the constraints outlined previously. There's no one-size-fits-all approach. In fact, the adoption of a, or constraints imposed by a turn-key solution could keep a vendor from providing benefits tailored to its specific market segment or niche area.

Specific Problems and Quality Attributes

As stated earlier, there is currently a lack of a standard approach to architectural evaluation for device side multimedia architectures. These architectures and the software built on top of them may not adequately address the availability, testability, and performance needs of software operating in the handheld domain. As implied through our earlier background discussion, failure to adequately address these needs could result in effects ranging from unnecessary power consumption to poor user experiences.

There are currently a number of more specific problems that result from the absence of some standard method of architectural comparison for multimedia frameworks in the handheld domain. The following constitutes a short list of key problems in this industry and their related architectural issues:

1. Currently, multimedia architectures used on handheld computers are increasingly ported from PC platforms. These often do not address the high availability concerns of the handheld environment; PC users are used to rebooting, but are likely to be less forgiving of unstable PDA or phone software.
2. The mobile industry as a whole is highly competitive and is characterized by very short development cycles. Handheld multimedia architectures should provide a highly testable, easily modifiable, and integrable base; a base on top of which further development may take place as needed to meet changing requirements driven by competition and technology advances.
3. Software memory footprint, software memory access patterns, and software structure has been shown to be important to power consumption on electronic computers in general. With the number of handheld computers growing, the energy consumption of these devices and their environmental impacts are becoming an increasing concern (Ravi, J., and Wullert, 2002). Proper architectural integrability would allow software components to be swapped in and out of a system as needed to tailor its memory footprint.
4. Current handheld device platforms are currently fragmented in their degree of multimedia support and services provided. Our discussion provides a step towards qualitatively evaluating ubiquitous device-side multimedia frameworks such as the Helix DNA, GStreamer, and OpenMAX (OMX).

Quality Attribute Analysis for Handhelds

This section compares and contrasts quality attributes considering their interrelationships. The discussion in this section builds on our previous characterization of the handheld domain. In particular, we first suggest that portability and usability are not key attributes weighing on a handheld multimedia *architecture*. Next, we cover security discussing its relevance. Finally, we end by discussing testability, integrability, modifiability, and reusability. Keep in mind that all of these attributes are important at some level, but this chapter is focusing on explicitly showing why some attributes are more important in the handheld domain as they relate specifically to multimedia frameworks:

- **Runtime:** Availability, Performance, Security, Usability.
- **Non-Runtime:** Testability, Integrability, Reusability, Modifiability, Portability
- **Runtime + Non-Runtime:** Availability, Testability, Integrability, Modifiability, Reusability, Security, Performance, Portability, and Usability.

We begin our analysis by focusing on items we don't feel are as relevant in an architectural sense, given the domain and pre-existing elements. The first of these is portability and usability.

Portability

It might be argued that portability should be a primary consideration due to the need to adapt to changing hardware. While this concern is valid, especially for organizations wishing to adopt a product line approach, not as much emphasis and attention is required in a multimedia architecture as the other attributes. There are two reasons for this. First, portability is one of the more mainstream aspects already addressed by handheld operating systems and newer operating systems in general. Android, for example, supports OpenMAX Development Layer which provides a common API for processor abstraction. Most modern operating systems, handheld or otherwise, have a hardware abstraction layer (HAL), kernel, or board

support package (BSP). This means that the multimedia architect is freed from many portability concerns and can instead build on available operating system hardware abstractions. Secondly, due to rapidly advancing hardware technologies, considerable work will have to be performed for each different display or audio controller. In other words, we don't spend effort designing portable device drivers when we'll be likely to design them from scratch as the silicon changes. Depending on the operating system's level of support for multimedia, satisfying portability becomes more about the cross-compilation portability of the implementation language than an architectural consideration. Likewise, usability is not a key focus because the usability of the device is less impacted by the architecture than are other quality attributes.

Usability

Although a successful handheld must be very usable, as a device lending itself to quick entry and retrieval of information on the go, this quality is less of an architectural concern than it is a design and implementation concern. Making a system's user interface simple, efficient, and easy to use requires the correct application of interaction and communication protocols. With regard to architecture, communication paths must exist such that user-level applications can retrieve and display information for the user and so that user commands get to the correct destination. As an example, a multimedia architecture evaluated against usability would give a higher usability mark if the architecture provided communication paths affording user-level applications control over low-level hardware settings for audio/video playback. However, using this same example, the device vendor may pre-establish such hardware settings for ``optimum'' quality, obviating the need for direct user control.

Security

Increasingly, the market is considering security as an extremely important quality attribute, especially for enterprise-wide mobile applications. The attention given to security (in an architectural context) may move up or down depending on stakeholder objectives and business motivation. As mentioned earlier, a key motivation for security may be to protect the customer and content vendor during an online transaction (such as a song download). Another objective may be to provide an interface for applying security patches and updates. Providing customer protection in online transactions is simply standard practice in the industry. Providing an interface, or ``auto-update'' for applying security patches is also widespread. When boiled down to their driving motivations, both customer protection and auto-update functionality are most likely motivated by competitive pressure (we do it because our competitor does it). If the developing organization does not provide these security features, they are likely to lose customers to their competitor.

Architecturally speaking, security for multimedia purposes should allow us to integrate new "security-conscious" protocols and data encoding/decoding schemes into our platform. Additionally, we should consider applying classic security policies/notions such as least-privilege and defense-in-depth into our software design. Security considerations are likely to impact internal communication pathways in that those pathways need to be capable of passing around user credentials and/or handling privileges and permissions. Additionally, appropriate communication mechanisms must be in place to coordinate with security services in the OS, especially as they relate to encrypting sources and sinks of streaming multimedia data. Finally, we must design our error handling architecture such that we don't go into an unsecure state when handling errors.

Security is often in direct conflict with usability and performance in non-architectural areas of design and implementation. For example, security typically conflicts with usability because it requires extra steps for the user, often entailing password entry. Password entry can be quite difficult on a handheld computer given the limited input methods. Passwords can be cached, but overall security is reduced because the password is kept around. These concerns are not architectural in nature since usability and security can often be balanced through intelligent UI design and compromises in the level of security required. However, security and performance may be architectural in nature.

Security considerations in the architecture are likely to lead to additional layering and compartmentalization to reduce internal exposure to external threats. Additional layering and added security-based operations are likely to add overhead to when compared to a less-secure, more efficient design.

Hopefully, the reader now understands the rationale behind the lower weight given to the portability and usability, as well as some key security considerations. We now turn our attention to performance.

Performance

Performance, as classified here, is concerned with runtime efficiency. Performance can be thought of as responsiveness of the system to some stimuli, or as the number of transactions processed over some time quantum. Performance is directly and significantly impacted by the architecture since communication in computing systems often takes longer than computation. Since the choice of architecture dictates the number and type of communication interfaces among components it is clear that a poorly designed architecture with extraneous communication mechanisms could easily lead to a very inefficient system (Bass et al., 2012).

Although the performance attribute is critical to the operation of a handheld device, especially one with limited resources, it is less of a concern than the other quality attributes with which it is in direct conflict which is pretty much every other quality attribute listed. Attributes like security, integrability, modifiability, and reusability for example, all require extra communication paths to allow components to be broken away from the framework as their own independent entities. In the handheld multimedia domain, performance is a mid-level priority because it costs less in terms of the hardware than the software needed to drive that hardware (Boehm, 1987). Qualities like security, availability, and testability become more important, especially when one considers delivering reliable software with support for convergent features, in the very short time-to-market that spurs on the mobile industry (Bosch, 2000). Meeting non-runtime attributes like integrability and testability help to ensure that an adequately tested and highly available product is delivered to the market within the allotted time. Greater emphasis on modifiability and reusability means that less development effort is likely to be required for future products.

Note however, that we don't just throw consideration for performance out the window altogether. As stated, much of the rationale for its priority placement comes from development cost and time to market pressures. However, at the end of the day, a handheld vendor still needs to produce a working device and within a multimedia framework, this means meeting real-time deadlines for performing audio or video frame decodes while conserving as much power as possible, or at least degrading gracefully when these deadlines cannot be met. The power concerns are largely implementation related and concern algorithms used along with overall processor use (Issarny, et al., 2000). On the other hand, meeting real-time deadlines means that hot-spots for performance optimization have been identified and isolated within the architecture and that communication to and from these hot-spots are optimized

Integrability, Modifiability, and Reusability

Integrability, modifiability, and reusability all reinforce each other in similar ways since they all require a clear separation of concerns, well-defined interfaces for communication, as well as identification and isolation of points of change and variability. Therefore, since we've already established the validity for choosing these attributes over performance, we lump them all together. As mentioned before, because hardware is less expensive than the cost of developing software, we would like to capitalize on efforts already put toward developing a multimedia framework by making sure it is reusable in other devices. In addition, due to the rapid development cycles and competitive pressures facing PDA vendors, it is advantageous to make sure that the software is easily modifiable, allowing features to be added or removed in order to tailor various products to different target markets and development budgets (Bosh, 2000). Again, due to the rapid development cycles and large changes likely to take place during product development, the software must be highly integrable, such that the entire system is not disrupted by the addition of a new component (perhaps offering a product differentiating feature).

A multimedia framework maximizing integrability, modifiability, and testability attributes would allow agile software development processes like extreme programming to be used. Using such software development practices could greatly aid the speed of development. For example, clearly specified extension and integration points would help with extreme programming regression testing and refactoring practices.

Testability

Testability also aids with the ultimate attribute of availability. Testability helps ensure that the product is able to be adequately tested at its various levels through execution based testing. In addition, testability greatly aids incremental development as mentioned above. Testability is often complementary, either reinforcing, or being reinforced by, integrability, modularity, and reusability.

Availability

Finally, we are ready to describe the importance of availability. This quality attribute is based on the type of device that we are working with. It is not acceptable for a PDA to suffer from the same availability problems that have plagued PC users for years. A PDA is first and foremost a personal information device. In the case of a mobile phone, the device is first and foremost a communication device. These devices need to be accessed when needed and provide requested information or record information without fail. The added multimedia capabilities must not adversely affect the availability and reliability of the handheld device with respect to its primary purpose. Furthermore, given the inherent expectation for these devices, the multimedia framework must be robust and cleanly isolate control paths so that availability can be reasoned about at design time in order to "prove" and reason about system availability. Furthermore, extending computing ubiquity requires highly available components in order to provide a solid basis for experimentation and adaptability.

Due to the physical and power limitations of typical handheld computers, it is not feasible to provide redundant components, either hardware or software to assure availability. However, availability can be achieved through careful attention to error reporting and handling. Such attention requires that the interaction patterns among components be clearly defined and appropriately constrained. Constraining interaction patterns in this way, while tending to help security, may conflict with most directly with

modifiability, preventing the degrees of freedom in which the software can be extended. Interestingly, this implies that object-oriented development and deployment of multimedia frameworks will probably require special attention since object interaction/communication patterns are often very unconstrained and free-form (Laine, 2001).

FUTURE RESEARCH DIRECTIONS

This work has presented general ideas for architectural multimedia analysis in the handheld domain, but it is still largely qualitative. More work remains to be done in this area, as in the area of software architecture as a whole, in order to establish more quantifiable measures between specific architectural unit operations, design patterns, and quality attributes being emphasized (Shaw, 2001). This work has hopefully brought this specific domain closer to this goal by providing a more detailed context for quality attribute consideration within the handheld domain. Two more specific and interesting avenues for further research include the following:

1. Establishing a ubiquitous, platform independent, device side multimedia framework. OpenMAX currently seems like an ideal candidate. Our analysis could be used to guide modifications to the core framework such that it could be ideally tailored to the handheld environment. Appropriate modularization concerns would be important in providing various levels of multimedia capabilities commensurate with host device hardware.
2. Quantifying architectural impact on the ability to configure multimedia systems to reduce power consumption. The key work here would be to experimentally derive power savings and/or tradeoffs against architectural patterns at runtime. For example, does the communication overhead, or spatial memory accesses inherent in various patterns add significantly to the power consumed by the device over time? What abilities do these patterns allow us in terms of reducing the size of our software and our corresponding memory footprint? How does the runtime power savings of different patterns compare with power savings realized by reduced memory footprints? Again, our analysis can be used here to initially narrow the field of study to patterns only applicable to handheld devices.

CONCLUSION

This chapter has discussed an architecture centered quality attribute analysis for device-side software Qualitative arguments used in our analysis included intended use, domain constraints, and the needs of developing organizations operating within a market environment characterized by rapid change. Through our analysis, we highlighted several quality attributes that are often at odds with each other as the architect attempts to balance them in the overall software architecture. It is therefore important to have a qualitative understanding of the domain and the needs of the developing organization. For example, performance was discussed in contrast to many other architectural attributes such as integrability, modifiability, and reusability. As discussed earlier, it might seem counterintuitive to give performance second-hand consideration to testability, integrability, modifiability, and reusability. Only when one understands the factors affecting the bottom line, can one begin to understand the rationale. In the

mobile domain, such factors include time-to market pressures and the drive for added features. Such factors motivate an architecture that is more easily testable, integrable, reusable, and modifiable than it is efficient. Performance can often be improved via faster hardware. The other attributes cannot be improved in a similar manner, purchased after the fact. Finally, such hardware improvements can often be purchased more economically than incurring costs associated with maintaining software based on a poorly testable, reusable, modifiable architecture.

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KEY TERMS AND DEFINITIONS

Domain Engineering: Engineering systems intelligently based on intended use, incorporating considerations and constraints from the deployment environment.

Handheld Computing: Computation domain concerned with small portable devices, encompassing both mobile phones and personal digital assistants.

Middleware: Software often containing control and business logic residing below the user interface, but above the interfaces provided by the operating system in a layered architecture.

PIM: Personal information management; a class of handheld computing applications used for managing personal information such as calendar/datebook, memo, and contacts.

Requirements Engineering: Process of collecting and analyzing (often conflicting) requirements in order to define a product and to facilitate its evaluation.

Software Architecture: Organization of components and component inter-connections in a larger software product.

Software Quality Attributes: Various attributes of a software product that may refer to qualities observable by an end user (e.g., reliability) as well as developers (e.g. maintainability).

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Chapter 42
QoS Routing for Multimedia Communication over Wireless Mobile Ad Hoc Networks: A Survey

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ABSTRACT

A lot of intensive research has been carried out in the direction of providing multimedia communication over wireless mobile ad hoc network (MANET). In MANET, various QoS problems exist such as inefficient routing, handling node mobility, power conservation, limited processing capabilities of network devices, high error rates. Wireless routing introduces new challenges as applying basic routing algorithms directly on MANET could lead to large power consumption, interference, and load-balancing problems. Many routing algorithms have been proposed as extensions to the basic routing algorithms to enhance their performance in MANETs. This paper summarizes existing solutions on QoS routing and resource reservation mechanisms in order to provide multimedia communication over MANET. It also considers the limitations of existing QoS models with regard to satisfying QoS in serving multimedia over MANET. The newest QoS architectures give much better results in providing QoS support. However, more refinements must be proposed in order to enhance further their performance in MANETs.

INTRODUCTION

Delivering multimedia data over wireless MANETs has its own application domain, and also has its own challenges (Loo et al., 2012). Wireless MANET is a prominent solution in diverse emergency situations that require rescue operations, when disasters have destroyed the network infrastructure. There is no need to deploy any infrastructure to make MANET nodes to communicate with each other. The IEEE 802.11 wireless LAN can be implemented without any infrastructure or central controller (Crow et al., 1997). In ad hoc mode, all nodes participate in both data processing and routing task. The network also

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relies on the multi-hop type of routing for their data transmission. The concept of wireless MANET can give a new bloom to the multimedia industry because in MANETs we can provide the same without deploying any additional infrastructure. So, such networks can work in collaboration rendering services either without paying anything or paying a tiny share of revenue charged. In addition, we can define Quality of Service (QoS) models that will be used to provide the desired QoS efficiently (Nyambo et al., 2014). Existing high-speed networking and effective compression techniques utilize available bandwidth to serve a large number of connections, resulting in various multimedia applications. Basically, three types of multimedia services have been developed: accessing stored data, accessing live data, and accessing interactive data.

The diverse nature of networked multimedia applications causes various problems because each application has its own requirements (Rao et al., 2002). An application might demand better quality data and can tolerate some acceptable amount of delay, while another application may be more sensitive to delay by compromising the quality of data. Every data flow of packets from a source to a destination in the network needs certain and prerequisite resources in order desired QoS to each individual flow to be provided. Obviously, the transfer of continuous media data (e.g. video and audio) need much more bandwidth than the transfer of discrete media (i.e. text or images–i.e. lightweight data). Also, a decision must be made in order to allocate proper bandwidth to each flow available in the network. For example, Vaidya et al. (2005) have proposed a distributed fair scheduling scheme that ensures that all packets will get a proper bandwidth of the wireless channel.

Multimedia applications can be categorized as per their delay requirements (Rao et al., 2002). Non real-time applications (e.g. image transfer) have no delay requirements, while real-time applications have delay requirements, and can be classified into hard real-time and soft real-time applications. Hard real-time application has very strict delay requirements and failure in satisfying them might result in hazardous side effect. It includes various applications like nuclear-reactor control system, missile control system etc. Soft real-time application has some delay requirements, but that are somewhat less strict than hard real-time application, where failure in satisfying the delay requirements would not result in any hazardous side effects. Examples of soft real-time applications are video-conferencing and video on demand. There is also an extra categorization. Non-interactive applications (e.g. video-on-demand) do not need any type of feedback from the receiver in order to continue application function. There is only the requirement of handling one-way traffic. On the contrary, interactive applications (e.g. gaming and video streaming) require some kind of feedback or commands from the receiver, so that application can proceed further. An interactive application requires two-way traffic, each of which is very much delay sensitive. In interactive applications, one single path may lead to network congestion ultimately affecting the overall network throughput and especially QoS (Rao et al., 2002).

In audio/video transfer, user may either download it or may allow for streaming. Audio/video streaming is preferable as it eliminates the end-to-end delay for user. However, streaming is more difficult to handle than simply downloading the contents, and the QoS may differ with the change of application raising to more difficult challenges. Different types of standards and techniques to successfully transmit multimedia over networks constitute the basic issues related to multimedia transmission. These research issues cannot be ignored, as they can also occur in wireless multi-hop networks. In addition, the wireless medium is very often influenced by the physical obstacles like noise, shadowing, interference and multipath fading. During the transmission of text/images, these problems are insignificant, but for the audio/video transfer, these should be addressed properly. Actually, audio/video transfer demand better control over the end-to-end delay and minimum jitter (i.e. variation in delay). Moreover, if video or audio is

live, these requirements are much more delay sensitive and should be handled strictly. Depending upon the type of access i.e. whether it is a point-to-point or multicast or even broadcast, the issues vary. For point-to-point communication, the network can provide better bandwidth to both end-points. However, in multicasting mode multiple nodes compete for the same wireless channel, resulting in interference. Broadcasting makes it worst, where every node is trying to get access to medium, which finally increases the interference levels of signal. The IEEE 802.11 uses distributed coordination function (DCF) as the basic medium access control (MAC) protocol or optionally it uses point coordination function (PCF). DCF makes use of the carrier sense multiple access with collision avoidance (CSMA/CA) scheme as a mechanism to deal with collision, and it increases the medium access delay in proportion to the load on the network (Wu et al., 2002). PCF uses a polling technique that aims towards providing the contention-free services.

Providing multimedia services over wireless MANET has many challenges:

- Wireless MANET devices have small size for supporting mobility. This imposes them to work with limited CPU processing capabilities, limited battery life, limited bandwidth support, limited storage etc.;
- It is not an easy task to handle multimedia. New difficulties arise, as we have diverse set of coding and decoding techniques for audio and video, different resolutions of images, and higher data rate demands for video transmission. Also, we have the stringent delay requirement of real-time audio/video transmission or even more reliable and secure transmission demands of security applications (Lian et al., 2009);
- The wireless links make it more complex due to higher error rate, fading, interference of signals etc.;
- Last but not least, the dynamic nature of wireless MANETs makes routing more difficult because of the frequent route change/route break leading to loss of connectivity. New challenges for multimedia transmission are imposed as the mobility of nodes (making frequent route breaks) adds an extra overhead. The routes have to be updated frequently. This situation even becomes worst in live streaming. If a node moves suddenly, then a few packets might take route having 'dead ends' and as the transmission is real-time, the time till which it will be detected and corrected using retransmission, the deadline would have been crossed already. This ultimately affecting the overall performance. Once more, after getting new route, the receiver might get out of order packets. In live streaming, it is just useless to retransmit the packets once the time has passed. Also, it becomes difficult to resynchronize the video or audio. Audio/video transfer suffer from the higher error rates occurred in wireless links. In real-time audio/video, there is no concept of retransmission as real-time media can't even tolerate loss of few frames. Thus, the loss of few frames would result in degradation of quality. As the nodes, which are part of the path, should be capable of processing the data it is going to transfer along with the routing, the paths should be chosen intelligently. Finding node capability in advance is vital in order to transfer data efficiently. As this might happen, that node suddenly moves out of order and less capable or even non-capable node becomes part of the network, finally resulting in degradation of quality. Again, it must reroute, and then start transmitting again. This is rather acceptable in stored video, but in live streaming this won't be entertained. Consequently, we must develop dynamic routing algorithms, those are able to change their behavior according to the network characteristics and are able to predict the node capabilities and node mobility.

In source routing algorithms, each node maintains global state allowing computation of the end-to-end path at the source. The Dynamic Source Routing (DSR) route discovery and route maintenance protocol is effective for the transfer of text and images (Johnson et al., 2001). But, let us examine what happens in real-time audio/video streaming. The route breaks, a number of retransmissions has to be attempted over the broken link, and the new route must be established resulting in delay. Rerouting is a spendthrift process because it must be well-confirmed before initiating it. It causes additional delay, and thus it is unsuitable for real-time streaming. We must check when the route is likely to break, and as we will get to know that route is possible to break soon, we can take decisions on rerouting or finding of any alternative root available (Hu & Johnson, 2002). A possible solution it to measure the Signal-to-Noise Ratio (SNR) parameter for received packets, as SNR indicates if the route is likely to break.

To achieve QoS provision in MANETs, the traffic-engineering approach is applied where available resources are used efficiently to meet the QoS requirements. This approach includes implementing different QoS models, QoS routing and resource reservation protocols, channel access mechanisms etc. And all these protocols associated with different sub-layers such as MAC, routing, resource reservation must work in synchronization in order a QoS model to guarantee the desired multimedia services.

This survey considers existing problems and issues that are currently present in providing multimedia communication over wireless MANET. It focuses on two modules of a QoS model: QoS-based Routing and Resource Reservation for providing multimedia communication over wireless MANET. These different modules work together to meet QoS. QoS-based Routing protocol tells on which particular paths, nodes can provide resources sufficiently to meet QoS (Crawley et al., 1998). Resource reservation protocol ensures how these paths or resources could be made available, when required. The survey gives an overview of the different techniques and solutions proposed in QoS routing and resource reservation in order to make efficient the multimedia communication over wireless MANET.

The paper is organized as follows: The next section highlights the wireless MANET characteristics. It also elaborates QoS models and frameworks, as well as routing and resource reservation schemes for wireless MANET. The third section presents advanced QoS routing protocols that can guarantee various QoS parameters. The fourth section presents recent advancements in QoS routing protocols, while the fifth section discusses novel approaches and techniques that resolve important problems of multimedia over wireless MANET. Finally, the last section concludes the paper.

MULTIMEDIA COMMUNICATION OVER WIRELESS MANETS

Wireless MANET is an IP-based network that works on the best-effort delivery concept. Although network components will try their best, this network won't guarantee that required QoS will be achieved. However, real-time applications need a guarantee that all the QoS requirements should be achieved irrespective of the network conditions.

QoS in Wireless MANETs

QoS is a set of service requirements to be met by the network, while transferring a flow (Kanellopoulos, 2011). Certain metrics such as bandwidth, delay, jitter and packet loss rate (PLR) can be used to measure and achieve the required QoS by any particular application. In wireless MANET, hop count and

path reliability may also be considered. To provide better QoS services, we must consider the following characteristics of a wireless MANET:

- **Lack of Central Authority:** In wireless MANET, there is no central controller available. Also, there is not an analyzer which makes a decision, whether or not, the link and protocols currently being used are capable of providing desired QoS;
- **Limited Resource Availability:** There is a limited amount of memory, limited processing capability and limited battery power etc. So, the resource availability in wireless MANET is very much limited. All these limitations cause problems in providing the required QoS, as we cannot easily increase the node capacity. Therefore, we have to manage the available resources efficiently so that maximum throughput can be achieved;
- **Error Prone Shared Radio Channel:** The availability of bandwidth becomes very scarce to every node because the network uses the shared radio channel in broadcast mode. Again, the wireless medium gets badly affected by the channel properties like interference, attenuation etc.;
- **Variable Network Topology:** Without any notification, the nodes make moves very frequently. These moves may result into the different topologies causing frequent path breaks and establishment of new paths. It also requires some delay and still after investing the time it is not guaranteed that the required path will become available;
- **Insecure Medium:** The network shares one common radio channel in a broadcast mode. Consequently, everyone can get an easy access to the data being transferred among the devices. This issue is not bearable by the applications, which have privacy as their main concerned issue. For example, military applications, private video conferencing and some kind of banking transaction cannot bear this issue. Also, simple attacks such as denial-of-service, message tampering, impersonation etc. can be performed very easily (Lian et al., 2009);
- **Deficient State Information:** Most of the protocols and mechanisms in wireless MANET force nodes to maintain some kind of state information, which may be related to link or related to flow. However, the network devices have limited memory capacity. This limitation makes this task more challenging of maintaining a relevant information, and old information has to be vanished to make space for new information. Even, if we succeeded in maintaining all this state information, this information might become irrelevant just after an interval, as the dynamic nature of MANET might cause the network topology to change and all the information maintained so far will become irrelevant.

Video transmission requires higher bandwidth, and this requirement imposes some nodes to stop their transmission so that desired QoS can be achieved. In interactive communication, traffic also becomes two ways and might follow the same path both ways. And this might need external synchronization to avoid interference. Existing protocols and standards for audio/video transmission in wired environments have been evolved from years and have undergone many refinements. However, we cannot apply these protocols and standards to wireless MANET because:

- In the case of wireless medium, signal is transmitted through air in all directions, which ultimately requires higher transmission power to cover more distance;
- The transmission range or interference range is not visible and more efforts are required, while dealing with congestion, collision, packet colliding etc.;

- In the wireless medium, the problems of reflection, diffraction and scattering are present;
- Finally, the wireless medium is more error prone and problematic. Still, it becomes worst, when it comes to multi-hop networks. The packet drop ratio (PDR) drastically goes up, while delay increases in proportion to these, and ultimately it affects the QoS.

Conclusively, existing protocols and standards for audio/video transmission need extra refinements for wireless MANETs.

QoS Models and Frameworks

In MANET, QoS is characterized by the node resource constraints while the QoS provisioning needs the consideration of various issues (Bheemarjuna Reddy et al., 2006). So, some QoS models and frameworks have been proposed and work along with different protocols and mechanisms to fulfill the application QoS requirements. Such protocols and mechanisms address: QoS PHY (i.e QoS at the Physical layer), QoS MAC, QoS Signaling, Admission Control, Scheduling, QoS Routing, QoS at the Transport and Application layers. Its beyond the scope of this survey to present all these protocols and mechanisms. The survey aims only to analyze QoS routing issues that involve routing protocols and resource reservation mechanisms. Hereafter, we present the most important QoS models and frameworks.

IntServ

Integrated Service (IntServ) (Braden et al., 1994) is the earliest model used for providing QoS on the Internet. In IntServ, QoS is guaranteed on per flow basis. For each flow, proper amount of resources is reserved to meet QoS requirements. IntServ is an architecture that specifies the following modules for achieving QoS guarantees in each flow:

- A QoS specification mechanism in order each flow to specify its requirements;
- Admission control to determine if a new flow should be admitted without affecting the QoS of other ongoing flows;
- A QoS negotiation process so that as many flows as possible can be served. During the QoS negotiation phase, each peer computer/node must determine, if it can support the desired QoS. If so, certain resources are reserved for this session. If the user is satisfied with the suggested QoS, the session is established. Otherwise, the session is rejected;
- Resource allocation and Scheduling to meet the QoS requirement of accepted flows;
- Traffic policing to make sure that flows generate the correct amount of data within the agreed QoS specification;
- A QoS re-negotiation mechanism is required so that flows can request changes in their initial QoS specifications. The actual QoS provided to the ongoing sessions should be controlled, so that suitable actions can be taken in case of any problem in providing specified QoS guarantees. Media scalability and graceful quality degradation techniques should be used together with the above mechanisms to provide efficient services to flows;
- Traffic-shaping schemes. Traffic shaping refers to the act of delaying the packets in the flow so that packets conform to certain defined rules. Traffic shaping schemes are used, when the traffic pat-

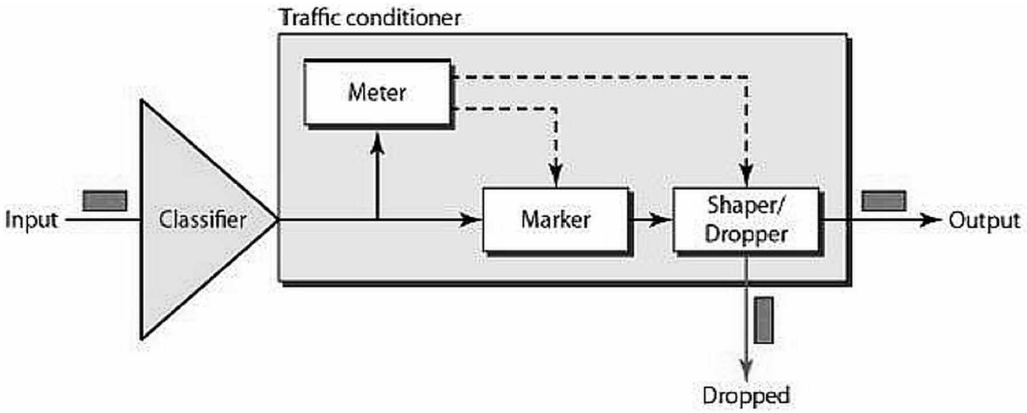
tern is too complicated to describe or the traffic is unsuitable for networks to support directly. For example, when video is variable bit rate coded, it may be hard to characterize the coded bit stream;

- Resource reservation protocols. IntServ uses RSVP (Braden et al., 1997) to make per-flow reservations at routers along a network path. While this allows the network to provide service guarantees at the flow level, it suffers from scalability issues. In IntServ, there is a potentially infinite number of different types of traffic, so each router has to store heavy information about each flow in order to provide QoS guarantees to each type of traffic. RSVP is a soft-state protocol, which implies that the router's state has to be refreshed at regular time intervals, and this adds to traffic overhead. The limited CPU processing capability and the limited storage capacity of wireless MANET devices enable IntServ unsuitable to maintain heavy information related to each flow.

DiffServ

Differentiated Services (DiffServ) model (Blake et al., 1998) takes a middle ground between the best-effort service and IntServ. It defines a fixed number of packet classes (Figure 1). All traffic types/packets are aggregated into these classes, and the network/routers provide different services to different packet classes. But how service classification works? The IPv6 protocol has a header byte called traffic class. In DiffServ the type-of-service (traffic class) byte is re-defined as a Differentiated Services (DS) field. The first six bits of the DS field is called DiffServ Code Point (DSCP) field, which indicates the behavior each router is required to apply to the individual packet. Packets with the DSCP set to 0 receive the same service as they get in the best-effort service. Values between 1 and 7 are defined to be backward compatible with the original IP precedence mechanism, to ensure that DiffServ technology can be deployed in the operational Internet progressively. The DS filed can be assigned by the end-user to indicate the desired service. Alternatively, the ingress (source) router marks the DS field based on the MultiField (MF) classification. MF classification classifies packets based on the contents of multiple fields e.g. source address, destination address, type-of-service byte, protocols ID, source port number and destination port number. As a packet moves from one Internet service provider to another, it may be re-classified. Many service classes can be defined. However, DiffSev is designed for fixed networks, and it cannot be adopted in wireless MANETs (Xiao et al., 2000).

Figure 1. DiffServ model



FQMM

Xiao et al. (2000) have proposed the Flexible QoS Model for Mobile ad hoc networks (FQMM). It is a hybrid model that provides both fine-grained behavior of IntServ and coarse-grained behavior of DiffServ. This hybrid model is shown in Figure 2, as it was depicted by Bheemarjuna Reddy et al. (2006). The traffic of highest priority will be given per-flow provisioning, while other priority classes will be given class-based provisioning. The FQMM model defines three different types of nodes: ingress, interior and egress nodes:

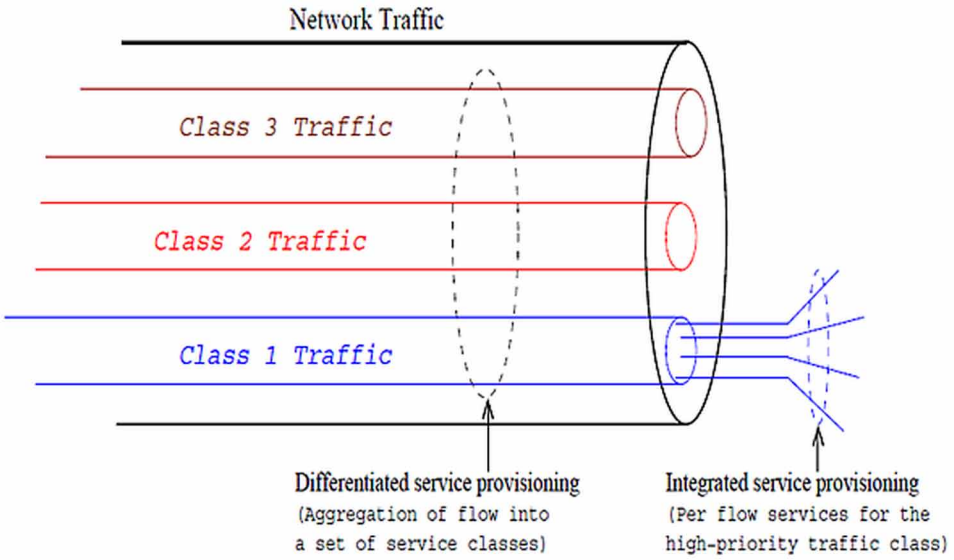
- An ingress node (i.e. source node) generates the traffic and performs also traffic shaping;
- An interior node is responsible for routing the packets towards desired location. It just forwards the packets towards desired locations, as directed by the traffic profile;
- An egreess node receives the traffic generated by the ingress nodes.

In MANET, the roles of mobile nodes change frequently as nodes move. For example, the node which is currently idle may in the next movement get the responsibility of forwarding packets. Similarly, the node which is currently acting as a packet forwarding node may become idle at very next movement. FQMM is unsuitable for wireless MANET, where nodes change their role continuously. This is why FQMM was originally defined for small to medium size wireless MANETs with less than 50 nodes (Xiao et al., 2000). Anyway, the FQMM model seems to be better approach than using IntServ or DiffServ alone.

INORA

Dharmaraju et al. (2002) have proposed the INORA QoS framework for wireless MANETs. INORA is based on the interaction of two subsystems: (i) the INSIGNIA in-band signaling system (Lee et al., 2000);

Figure 2. The FQMM model



and (ii) the Temporally-Ordered Routing Algorithm (TORA) (Park & Corson, 1997). The interaction of these subsystems aims to deliver the finer QoS. INSIGNIA supports fast reservation, restoration, and adaptation schemes to deliver the adaptive services. These services support applications that require only a minimum quantitative QoS guarantee (e.g. minimum bandwidth).

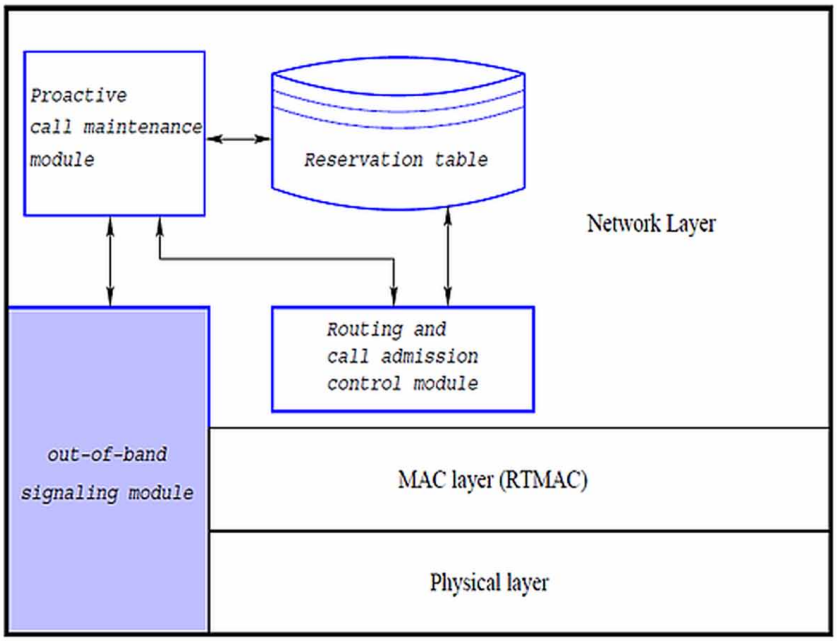
INSIGNIA is light-weight and responds rapidly to changes in the network topology and end-to-end QoS conditions. However, the drawbacks of INSIGNIA are: (1) its scalability problem due to the flow state information (which is kept within the nodes of a certain path) and (2) the inefficient bandwidth usage. Both drawbacks are inherited in the INORA architecture. TORA routing protocol is used because of the data structure it uses (i.e. Directed Acyclic Graph) and also because of the TORA's property that provides multiple paths between source and destination. TORA also limits its control packets for route reconfiguration to small regions. So, TORA does not cause unnecessary network traffic. INORA basically operates into two different schemes: coarse feedback scheme and class-based fine feedback scheme. The main benefit of INORA is that it can search for multiple paths. However, INORA cannot be used for hard real-time applications, since no resources are reserved before actual data transmission starts. This enables INORA inappropriate for providing QoS in hard real-time applications over wireless MANET.

PRTMAC

Vishnumurthy et al. (2004) have proposed the Proactive RTMAC (PRTMAC) QoS architecture (Figure 3) that supports differentiated service classes. Three types of classes provide service differentiation:

- **Class 1:** This class has the highest priority. PRTMAC ensures that the calls for this class do not get disturbed, because of the calls belonging to other lower priority classes. If the situation arises

Figure 3. PRTMAC architecture (Bheemarjuna Reddy et al., 2006)



that call could not be carried out further, then any on-going call from low priority class can be dropped in order to keep this call awake;

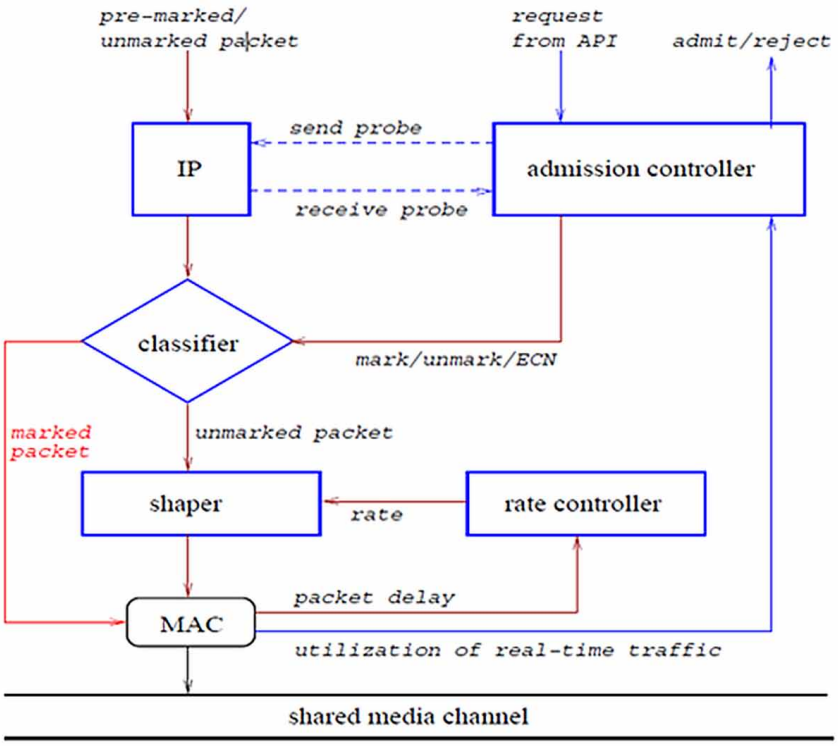
- **Class 2:** This class has somewhat low priority than class 1, but not the least one. The calls belonging to this class can only be dropped, if the network needs to serve the call belonging to class 1. The calls belong to class 2 are also real-time calls. However, class 2 accepts calls only, if end-to-end bandwidth is reserved for the call it is trying to accept. Otherwise, the call won't be accepted;
- **Best-Effort Class:** This class has the least priority. Under the best-effort class, non-real-time traffic falls. This type of traffic does not need any type of service guarantee and calls belonging to this class can be dropped without any notification, if the need arises to serve the higher priority classes.

PRTMAC includes an enhanced real-time support scheme that uses an out-of-band signaling mechanism to predict future mobility patterns and take corrective action when needed. This helps mobility affected nodes to take proactive measures so as to offer better real-time services to bandwidth critical applications. PRTMAC adopts a cross-layer designing approach. In such approach, optimization is achieved by permitting one layer to access the data of another layer; to exchange information and enable interaction (Bin-Salem & Wan, 2012). In PRTMAC, some significant parameters are shared among the Network and MAC layers. At MAC layer, PRTMAC framework uses Real-Time MAC (RTMAC) protocol (Manoj & Murthy, 2002), while at Network layer, it uses a DSR routing protocol. PRTMAC demands the bandwidth reservation and bandwidth availability estimation from the RTMAC protocol. By using the out-of-band signaling channel, RTMAC collects the information about current real-time traffic. RTMAC can handle the link breaks and node failures, which makes it more robust. The PRTMAC is a better option than FQMM and INORA for providing the real-time support and service differentiation in high mobility MANETs (e.g. military networks formed by high speed combat vehicles). However, PRTMAC is not a reasonable solution because it makes use of narrow-band control channel as the out-of-band signaling channel. But having another channel in MANET (which is already struggling to make better use of available bandwidth) may not be an economically viable solution.

SWAN

Ahn et al. (2002) have proposed a Stateless Wireless Ad hoc Network (SWAN) model that is a QoS model for wireless MANET. SWAN supports both real-time UDP and best-effort UDP and TCP type of traffic. User Datagram Protocol (UDP) uses a simple connectionless transmission model with a minimum of protocol mechanism. UDP is often used by multimedia applications (e.g. voice over MANET) because dropping packets is preferable to waiting for delayed packets. SWAN supports real-time applications by using distributed control algorithms and also service differentiation. In distributed routing algorithms, the path computation is conducted in a distributed manner by intermediate nodes comprising an end-to-end path. As shown in Figure 4, the Classifier classifies real-time and best-effort traffic. Then, the Shaper (leaky bucket) gets best-effort traffic, which is processed at calculated rate by the Rate controller. The local Rate controller algorithm is used to control the traffic entering into the network. The real-time packets (marked) directly travel towards MAC protocol. So, these packets are getting channel fast, and thus improving QoS. The Rate controller decrements the rate of Shaper, when excessive delays are

Figure 4. SWAN model adapted from (Bheemarjuna Reddy et al., 2006)

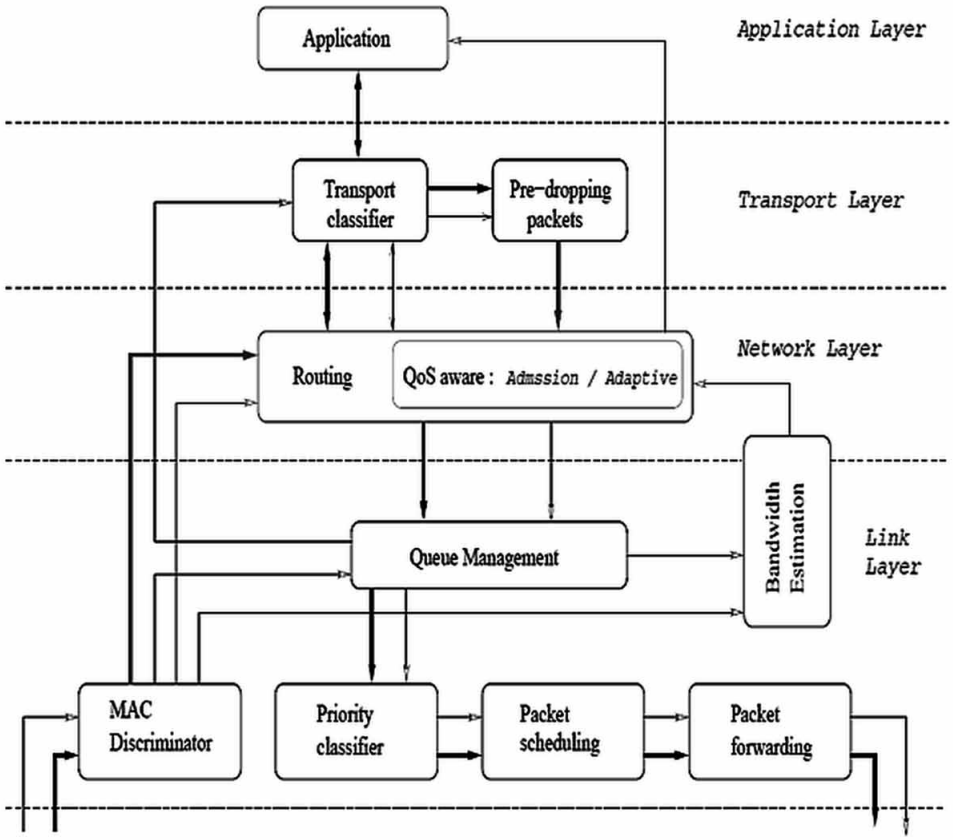


observed. SWAN does not get affected by the dynamic behavior of topology, as intermediate nodes do not maintain the per-flow or aggregate state information. However, SWAN fails to entirely utilize the DiffServ field that is used only for two classes of traffic. It would be more realistic if full advantage had been taken of differentiating the traffic into a variety of classes that exist in practice.

Network Architecture

Chen and Heinzelman (2004) have proposed a Network Architecture that is based on a cross-layer approach. The Network Architecture (Figure 5) supports QoS in wireless MANETs considering real-time traffic. This architecture considers QoS Transport layer protocol, QoS routing protocol, queue management, and priority MAC protocol. Narrow lines indicate the control flow while bold lines depict the data flow. Application layer manages two types of traffic: real-time and non real-time. Transport layer demands for information from the Packet queue and from the Network layer for achieving desired QoS. Network layer forwards the current network status to the Application layer. While MAC layer and Link layer provide appropriate information to the Network layer, so that performance can be improved. Link layer does the task of bandwidth estimation, which can be passed to Network layer to take appropriate routing decisions. The Queue Management unit does the task of scheduling different priority packets. The MAC Discriminator unit does the task of differentiating data packets and control packets that it has received from the wireless channel. The Priority Classifier classifies different data packets (real-

Figure 5. The Network Architecture (Chen & Heinzelman, 2004)



time or non real-time) which it has received from the Queue Management unit. The Packet Scheduling unit handles the task of scheduling packets according to appropriate priority of packets. The Network Architecture can be efficiently used for achieving better video quality and to obtain lesser packet delay.

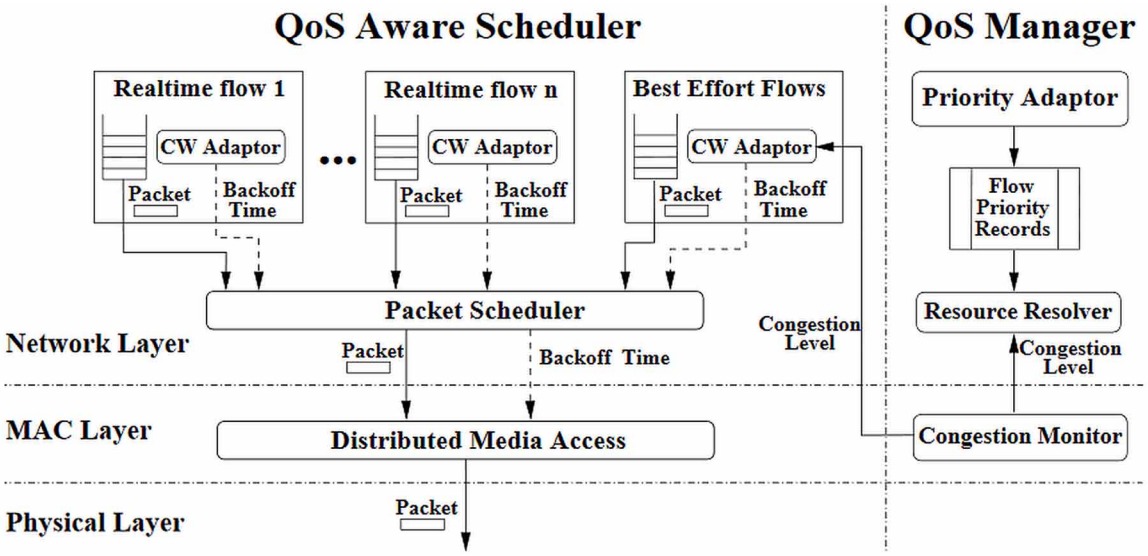
QPART

Yang and Kravets (2004) have presented a QoS Protocol for Ad hoc Real-time Traffic (QPART) that is a cross-layer solution used for providing QoS to real-time applications. In QPART, three different tasks are performed for ensuring desired QoS:

- Admission control that decides if a new flow can enter into the network;
- QoS-aware Scheduling that assigns resources to the admitted flows;
- Conflict resolution that selects and rejects the victim flow, which is causing problem to the other flows.

The QoS-Aware Scheduler and the QoS Manager are the main parts of the QPART architecture (Figure 6). The QoS-Aware Scheduler does the task of scheduling and operates on the principle of enhanced IEEE 802.11 MAC layer protocol [IEEE 802.11e (Mangold et al. (2002)]. The QoS Manager

Figure 6. QPART model (Yang and Kravets, 2004)

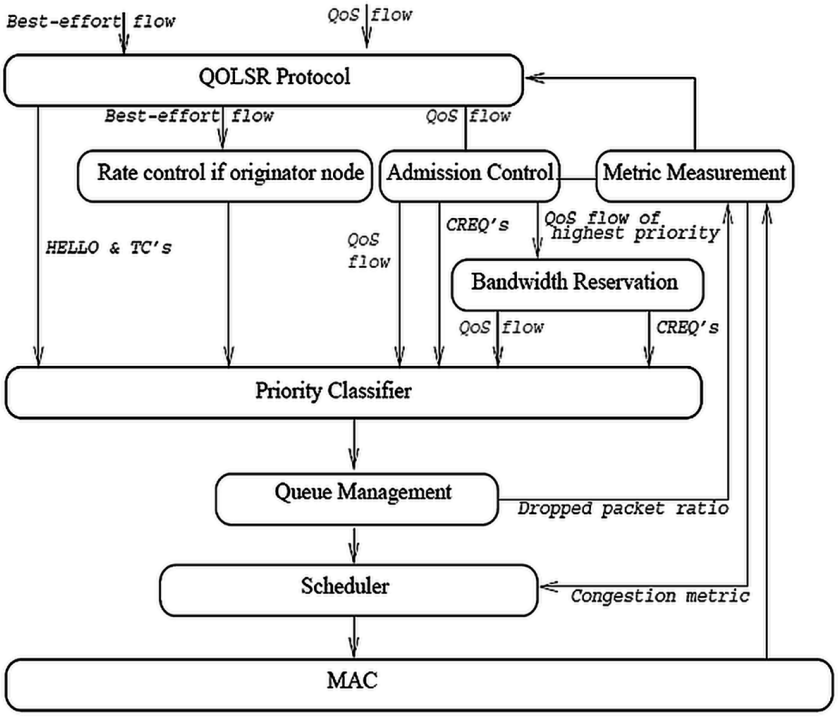


performs admission control and conflict resolution. OoS Manager does the flow prioritization in order to do the conflict resolution and admission control. However, the priorities are assigned dynamically by the Priority Adapter and a low priority flow becomes victim, if congestion occurs in the network. One remarkable advantage of QPART is that for resource allocation, no exchange of any control messages is necessary. In order to do so, it dynamically adapts the contention window size, based on local network congestion level. As it is a cross-layer solution, it also considers the received QoS while adapting the contention window.

CEQMM

Badis and Agha (2006) have introduced the Complete and Efficient QoS Model for MANETs (CEQMM). It is a hybrid model that combines the good features of IntServ and DiffServ. In CEQMM, QoS routing is implemented via the QOLSR protocol to decide the optimal paths available. QOLSR (Badis & Agha, 2005) is an extension of the Optimized Link State Routing (OLSR) protocol. OLSR makes use of MultiPoint Relay (MPR) nodes to forward broadcast messages during the flooding process (Clausen & Jacquet, 2003). The QoS metric is used to calculate the QoS-MPR's, which are then given to every node in the network. Firstly, it will decide whether or not the path is available to fulfill the required QoS provisioning. If no path is available to fulfill the QoS requirements, the traffic is simply rejected. Figure 7 shows the functional model of CEQMM. The Priority Classifier classifies the traffic according to its priority. Then, the Queue Management unit makes queues for this traffic. And the traffic Scheduler schedules each traffic class according to its priority and allows channel access (i.e. can be passed to MAC layer). CEQMM model also confronts the congestion control problem. For congestion control, each node that generates the best-effort traffic, limits the packet flow to available bandwidth. CEQMM also includes a Metric Measurement unit that predicts the QoS metric parameters like jitter, delay, bandwidth, loss probability etc. One limitation of implementing CEQMM for MANETs is that the average delay is

Figure 7. The CEQMM model



very long when node moves continuously. Thus, many packets are dropped, which makes it unfavorable for multimedia traffic (Muhammad et al., 2011). However, CEQMM model is better than FQMM as it confronts the congestion control problem.

Table 1 shows a comparison among all these QoS models and frameworks.

Table 1. A comparison of QoS models and frameworks

QoS Model	Features	Comments
IntServ	It provides a fine-grained and flow-based technique.	QoS is guaranteed on per-flow basis.
DiffServ	It provides a course-grained and class-based mechanism.	It uses a limited number of service classes.
FQMM	It combines IntServ and DiffServ models.	It is scalable.
INORA	It combines INSIGNIA signaling system and TORA routing protocol.	No resource reservation is done. It cannot be used for real-time application.
PRTMAC	It adopts a cross-layer approach.	It is useful for real-time communication.
SWAN	It is based on distributed routing and provides services differentiation.	Does not require QoS support from MAC layer.
Network Architecture	It adopts a cross-layer approach.	It provides better video quality and less average packet delay.
QPART	It adopts a cross-layer approach.	It supports real-time application. There is no need of any control messages for resource reservation.
CEQMM	It is a hybrid model and combines good features of IntServ and DiffServ.	It faces congestion control via an effective mechanism.

Routing in Wireless MANETs

The multi-hop nature in wireless MANET introduces many problems. As the number of hops increases, jitter gets badly affected. In addition, links come into existence and break down more frequently than static network. Because of users mobility, routing becomes more complex. It cannot just simply stop and wait for the link to regenerate every time it fails, it has to find alternate path and eventually this comes at a cost of increase in end-to-end delay. On the other hand, the hard real-time application needs the high bandwidth link to be available continuously, and the delay introduced by the link or node should be as minimum as possible. Also, the processing power of intermediate nodes should be enough to process the heavy amount of data. From all perspective, hard real-time applications demand for best services from all participating units.

To make routing more efficient, many routing protocols' categories have been proposed such as:

- Proactive routing protocols (e.g. Optimized Link State Routing - OLSR): In this category, all nodes periodically exchange routing information to maintain a consistent, updated, and complete network view. Each node uses the exchanged information to calculate the costs towards all possible destinations. In proactive routing schemes, there is no initial delay when a route is required;
- Reactive routing protocols. Examples are DSR, Ad hoc On Demand Routing protocol (AODV) (Perkins et al., 2003), and the dynamic on-demand routing protocol (DYMO) (Chakeres & Perkins, 2008). Reactive routing does not depend on periodic exchange of routing information or route calculation. When a route is required, the node must start a route discovery process.

Royer and Toh (1999) have compared many naive routing protocols. They have concluded that none of these protocols are uniquely sufficient to give best results for particular application. That implies that we must consider the application specific requirements (e.g. minimum power usage, minimum delay tolerance etc.) in order to use specific routing protocol. For example, in video downloading more throughput is desirable, while in live streaming more focus should be on delay and jitter. Thus, we must develop more specific (as per the application's requirements) efficient routing algorithms. Earliest, Chen and Nahrstedt (1999) have presented a ticket-based distributed QoS routing scheme, named as Ticket-Based Probing (TBP) for wireless MANETs. The simulation results prove that TBP has higher success ratio than most of the flooding algorithms. Pearlman et al. (2000) have presented the simulation results for the Alternate Path Routing (APR) protocol. They have concluded that it gives 40% improvement in end-to-end delay. The use of APR is beneficial, if the data being transmitted is more of delay sensitive. Feeney (1999) has explained and categorized the routing protocols as:

- **Topology-Based:** Examples are DSR and the Global State Routing (GSR) protocol (Chen & Gerla, 1998);
- **Destination-Based:** Examples are the Destination-Sequenced Distanced Vector (DSDV) (He, 2002) and AODV protocols;
- **Neighbor Selection-Based:** An example of this category is the Zone Routing Protocol (ZRP) (Hass & Pearlman, 2001);
- **Partitioning-Based:** An example is the Core-Extraction Distributed Ad hoc Routing (CEDAR) protocol (Sivakumar et al., 1999).

Rajaraman (2002) has also classified routing protocols as:

- Flat routing protocols (e.g. DSDV, OLSR, DSR, AODV, TORA);
- Hierarchical routing protocols, e.g. the Hierarchical State Routing (HSR)(Iwata et al., 1999);
- Geographical routing protocols, e.g. the Greedy Perimeter Stateless Routing (GPSR)(Karp & Kung, 2000).

Alotaibi and Mukherjee (2012) have also offered a comprehensive review of routing-algorithm categories, such as Geographical, Geo-casting, Hierarchical, Multi-path, Power-aware, and Hybrid routing algorithms. It is noteworthy that naive routing protocols can be used effectively only for text or images. For audio/video transmission, special routing protocols must be proposed, as special attention must be given towards the live streaming. Igartua and Frias (2010) have presented a self-configured framework for video streaming services over wireless MANET, entitled as Adaptive-Multi-path Multimedia Dynamic Source Routing (A-MMDSR). This framework can self-configure according to the dynamics of the environment. In particular, the routing algorithm in A-MMDSR periodically updates a set of paths, classifies them according to a set of metrics and arranges a multi-path forwarding scheme. Chow and Ishii (2007) have used multi-point-to-point transmission together with Multiple Description Coding (MDC) (Goyal, 2001) results in enhancement of the quality of video streaming. They have also suggested an extension to DSR protocol that eventually results in load balancing and finding of maximally disjoint routes. Munoz et al. (2010) have presented a more attractive extension: Reliable Dynamic Source Routing for Video (RDSR-V) streaming, which is a QoS-aware reputation-based routing protocol for video-streaming applications over wireless MANETs. Hu and Johnson (2002) have presented a more specific demonstration of DSR protocol for live audio and video transfer over wireless MANET. Their work significantly improves the transmission of real-time media over multi-hop wireless MANET.

In wireless MANET, multiple paths for the same source and destination may be present, and thus handling of an interactive application becomes somewhat an easier task. This happens because data from source node A to destination node B will take some path, while reply from node B to node A can take some different path, so the efficiency of the link and ultimate throughput can be increased. As a node selects the type of service (e.g. video-on-demand), it declares specific bandwidth requirements. And depending upon bandwidth requirements, appropriate paths may be set. Using multi-path for video/audio transmission over wireless MANET seems to be a good option as the failure probability of a single path is always more as compared to multipath. It allows packets to take multiple paths as if we are doing loose source routing (Johnson, 1993), and thus overall link utilization can be improved. In addition, probability of packet loss can be minimized. But to implement this scheme successfully, receiver has to struggle in handling jitter for each packet or in handling out of order packets and in some cases some packets in between might get misplaced. As a result, if we are dealing with real-time video/audio streaming, then multi-path might not give the desired output. Obviously, routing in case of multi-path becomes more interesting. Mueller et al. (2004) have demonstrated various issues and challenges related to multi-path routing algorithm in wireless MANETs. However, they have left out with handling out of order packets (introduced at receiver due to different packet arrival rate).

Resource Reservation

Every flow needs certain and prerequisite resources in order desired QoS to be provided. So, resources can be reserved in advance, so that when and as demanded by flow it should be there. Reserving the path in advance also tells us that whether the required resources are available or not to fulfill the desired QoS parameters. This might so happen that resources are currently occupied by some other flows, so the current flow can't be served. In this case, protocol may assign some waiting time to the current request to avail that resources or if the current request is of higher priority, then the protocol will snatch out the resources from current flow and will make it available to the requested flow. The resource can be reserved either in hard state or soft state QoS:

- The hard state QoS reservation forces the resources to keep reserved along the path from source to destination, until the whole communication process gets completed. Hard state QoS reservation releases the resource, if and when the path in between brakes. Obviously, this type of reservation is problematic in wireless MANET, because the link breaks happen most often;
- In case of wireless MANET, soft state QoS reservation is much better choice as the topology changes very frequently, and doing hard state reservation might result in wastage most often.

RSVP

In wired networks, the topology is fixed and the resources required by the nodes can be reserved efficiently by using the RSVP (Braden et al., 1997). However, RSVP cannot be directly applied to the wireless MANET because:

- Wireless MANET nodes are mobile in nature, so we cannot be sure whether or not reserved resource will be available when a need arises;
- The bandwidth of network devices is very much limited. Consequently, handling the heavy amount of control information generated by RSVP becomes an overhead.

Talukdar et al. (2001) have argued that there is no provision of passive reservation in RSVP. Therefore, RSVP cannot use advanced reservation viz. a node cannot reserve resources where it will be in future.

MRSVP

This resource reservation protocol is useful for infrastructure-based cellular networks. It requires some kind of prediction i.e. it is presumed that the mobile node is aware of all the locations to those it is going to visit during the lifetime of the flow. MRSVP can reserve resources using two different ways (Talukdar et al., 2001):

- **Active Path:** In this case, data packets are currently using the path reserved (i.e. path is active);
- **Passive Path:** If the path reserved is not active yet and will only be useful in future.

However, MRSVP is not suitable for wireless MANETs. The uncontrolled mobility of network devices makes it almost impossible to predict the future locations of the node; and this is the key requirement for MRSVP to work. Suppose somehow we obtained all the future locations and we reserved the resource along the path, then it may possible that node holding that resource will move out of the range, when the actual need will arise.

Dynamic RSVP

In DRSVP, the QoS can be guaranteed even in a network whose bandwidths are dynamic in nature (Mirhakkak et al., 2000). The DRSVP protocol automatically divides the available bandwidth among all other applications so that varying link bandwidth can be handled efficiently. DRSVP protocol decides whether to or not to accept the connection. If certain QoS parameters (e.g. maximum packet size, peak rate, token bucket depth, average rate and the minimum polished unit) can be supported by the network, then reservation can be accepted, otherwise it will be rejected (Mirhakkak et al., 2000). The DRSVP gives range of values, which allow it to entertain multiple flows. However, this becomes much more complex to handle than simple RSVP, and nodes having limited processing capability in wireless MANET makes it more difficult to implement.

QOS ROUTING

A routing protocol finds the path that can provide the required resources to the flow, while a resource reservation protocol reserves this path prior to data transmission. In wireless MANETs, the routing protocol must be very adaptive to the route changes that occur. For this purpose, novel QoS routing protocols have been proposed and operate by taking into account different (or maybe multiple) QoS parameters. Throughput is the most extensively considerable QoS parameter.

Hereafter, we present routing protocols that guarantee throughput. Chen et al. (1997) have proposed the Clustering-based Channel Capacity Routing (CBCCR) protocol. This protocol extends the concept of DSDV protocol, specially developed for supporting multimedia over wireless MANETs. Sivakumar et al. (1999) have proposed Core Extraction Distributed Ad hoc Routing (CEDAR) protocol which depends on the "core" which is constructed. The "core" provides efficient and low overhead infrastructure such as to provide routing and broadcasts in wireless MANETs. Chen and Nahrstedt (1999) have proposed Ticket-Based distributed Probing (TBP) protocol that selects multiple paths without using flooding those are capable of satisfying the QoS parameters. Stine and Veciana (2004) have proposed Node State Routing Protocol (NSRP) that is based on location awareness and signal strength. Chen and Heinzelman (2005) have proposed Contention-Aware Ad hoc On-demand Distance Vector (CAAODV) routing protocol that contains admission control with feedback scheme. By disseminating bandwidth information using "Hello" messages, the bandwidth estimation is performed. Yang and Kravets (2005) have proposed Contention-aware Admission Control Protocol (CACP) which also thinks about the effect of the admission of new flows on the neighboring nodes along with local information. Gupta et al. (2005) have proposed Interference aware QoS Routing Protocol (IQRP). IQRP makes use of probe packets to compare different paths that are available. Ivascu et al. (2009) have proposed Quality-of-Service Mobile Routing Backbone over AODV (QMRB-AODV) that struggles to distribute traffic all over the network, so that bandwidth can be utilized efficiently. In addition, it reduces the number of control messages.

Next, we discuss some protocols that guarantee bandwidth. Lin and Liu (1999) have proposed the Channel Capacity-Based Routing (CCBR) protocol. By performing the calculation of bandwidth and slot reservation, the CCBR protocol guarantees bandwidth. Zhu and Corson (2002) have proposed on-demand QoS routing protocol based on AODV for TDMA-based MANETs (QoSR-Z), which is cross layer approach that negotiates information between Network and MAC layers. Liao et al. (2002) have proposed a TDMA-based Bandwidth Reservation Protocol (TBRP) for QoS routing for a MANET. Furthermore, it considers hidden and exposed terminal problem, while taking decision about route discovery. Jia et al. (2005) have proposed Ad-hoc Shortest-Widest Path (ASWP) routing protocol that is based on Bellman-Ford architecture and k-shortest path approach. ASWP attains performance close to the optimal possible. Guimarães et al. (2009) have proposed Bandwidth Reservation on multi-rate Ad-hoc Wireless Network (BRAWN) protocol that performs bandwidth allocation on per flow basis. BRAWN is inclined to select highest possible transmission rate in order to perform data transmission.

Now we present QoS routine protocols that aim to guarantee delay. Zhang and Mouftah (2005) have proposed On-Demand QoS Delay-Constrained Routing (ODCR) protocol, which is on-demand unicast routing protocol. It works towards reducing communication overhead. Liu et al. (2006) have proposed Cross-Layer Scheduling Protocol (CLSP). CLSP considers multiple connections with different QoS requirements and uses a cross-layer approach. Abdrabou and Zhuang (2006) have proposed a position-based Quality-of-Service Greedy Perimeter Stateless Routing (QoS-GPSR) protocol that performs temporary bandwidth reservation. QoS-GPSR makes use of position information in routing and bandwidth reservation and adopts a cross-layer approach. Tang and Zhang (2007) have proposed Amplify-and-Forward (AF) and Decode-and-Forward (DF) QoS routing protocol (AF-DF) that considers throughput along with delay as its QoS parameter. It is a cross-layer approach that works towards maximizing the relay network throughput along with considering delay constraint. Nikaein et al. (2001) have proposed a Hybrid Ad hoc Routing Protocol (HARP) protocol. HARP is hybrid in nature and combines reactive and proactive schemes. It is noteworthy that HARP considers Buffer space as its QoS parameter.

Sheng et al. (2003) have proposed the Delay-Sensitive Adaptive Routing Protocol (DSARP) which considers Delay along with Buffer space as its QoS parameter. DSARP is based on constraint condition: 'The shortest route and the lowest delay'. Wang and Kuo (2005) have proposed Application Aware QoS Routing (AAQR) protocol which is a QoS-aware routing protocol. It also considers jitter along with delay and throughput as its QoS parameters. To estimate the node state, it makes use of Real Time Control Protocol (RTCP). Badis and Agha (2005) have proposed QoS Optimized Link State Routing protocol (QoLSR) which considers MAC delay along with throughput as its QoS parameter. It also proposes refined and a more efficient heuristic for selecting MPR set with minimum size. Fan (2004) has proposed a Cross-Layer Multi-Constraint QoS Routing (CLMCQR) protocol, which also considers Packet Loss Rate (PLR) as its QoS parameter along with throughput and MAC delay. It negotiates information between Network layer and MAC layer in order to select an optimal route. Barolli et al. (2003) have proposed Genetic Algorithm based routing for Mobile Ad-hoc Networks (GAMAN) which considers delay along with PLR as its QoS parameter. It is source initiated Genetic Algorithm (GA) based routing algorithm having good response time. Misra and Banerjee (2002) have proposed Maximum Residual Packet Capacity (MRPC) routing protocol, which considers energy along with PLR as its QoS parameters. It also considers the stuff that different links require different transmission powers instead of relying only on function of battery power for making routing decisions. Kim et al. (2004) have proposed Signal-to-Interference Ratio (SIR) and Channel Capacity-based Routing (SIRCCR) protocol, which considers SIR also along with throughput as its QoS parameters. It claims to reduce the probability of call denials.

Hereafter, we present some QoS routine protocols that consider Link stability as their QoS parameter. Shen et al. (2003) have proposed the Entropy-Based Routing (EBR) protocol, which is based on entropy (i.e. life of path). The QoS is guaranteed in wireless MANET by selecting path having longest-life i.e. calculated with the help of proposed entropy metric. Rubin and Liu (2003) have proposed a similar concept entitled as Link Stability-Based Routing (LSBR). Also, they have presented a number of models those can be used to predict the link stability. Sun et al. (2006) have presented a position-based routing protocol for wireless MANETs, called GvGrid. GvGrid takes into account Packet Arrival Ratio (PAR) as it's QoS parameter. It makes use of GPS in order to access the relative position of nodes, which might cause some delay.

Table 2 shows the comparison among these normal QoS routing protocols, while Table 3 shows the comparison among the discussed cross-layer based routing protocols.

RECENT ADVANCEMENTS IN QoS ROUTING

Many modifications have been made in the routing protocol to improve the performance of the network. Egilmez et al. (2012) have presented a Distributed QoS Routing (DQR) architecture for scalable video streaming. DQR architecture divides the video into different layers. As each layer will have different QoS requirements to be satisfied, DQR architecture forces different layers to take different paths. The DQR architecture works on Open-Flow network, but can be migrated easily to wireless MANET. Dai et al. (2012) have presented Correlation Aware QoS Routing (CAQR) algorithm for wireless sensor network. By using correlation-aware inter-node differential coding scheme, they achieved to reduce the traffic in the network. In particular, they proposed a load balancing scheme to distribute the traffic throughout the network. Finally, by integrating this correlation-aware technique to the routing framework, they accomplished low energy consumption system along with reduced traffic and load balanced system. The Light-Weight Trust-based QoS Routing (LW-TQR) algorithm has been proposed by Wang et al. (2014). This algorithm aims towards providing more secure, better packet delivery ratio and average end-to-end delay in the network. In this framework, malicious nodes are detected and isolated from the network. So, security does not get compromised enabling this mechanism best suited for the military-related application. In the case of stable links, the real-time application would perform better. Moussaoui et al. (2014) have proposed Link-State QoS Routing Protocol (LS-QRP) based on the link stability. LS-QRP protocol is best suited for the point-to-point voice call applications (e.g. Voice over MANET - VoMANET) or video streaming because it makes stable and sustainable links between each pair of nodes in the network. A stable link meets proper QoS requirements. Obaidat et al. (2013) have proposed QoS-aware Multipath Routing Protocol (QMRP). This protocol tries to reduce the delay such as to improve the reliability and QoS of the multimedia communication over wireless MANETs. QMRP passes the packets by using multiple links to the same destination in order to reduce delay. The same result in more reliable transmission as even though one link fails then it will not affect throughput badly. In order to achieve better quality, QMRP is a cross-layer approach that tries to make physical layer and network layer interact. The simulation study depicts that QMRP performs much better in most of the cases like end-to-end delay, packet delivery fraction and route discovery frequency, but fails in reducing the routing overhead in comparison to AODV. Alwan and Agarwal (2013) have proposed Multi-objective QoS Routing (MQoSR) protocol for wireless sensor networks. In order to provide the QoS, two differ-

Table 2. A comparison of QoS routing protocols

Protocol	QoS Parameter	Features	Explanation
CBCCR	Throughput	Can inform source of bandwidth and QoS to any destination	Provides more effective call acceptance control.
CEDARP	Throughput	Depends on "core": self-organizing routing infrastructure.	Core provides an efficient and low overhead infrastructure
NSRP	Throughput	Based on location awareness and signal strength.	NSR protocol provides capability to predict connectivity.
IQRP	Throughput	Uses probe packets to compare different packets.	Uses local knowledge and state information.
CACP	Throughput	Scalable	Considers effect of admission of new flow on neighboring nodes
QMRB-AODV	Throughput	Makes use of mobile routing backbone	Lesser control messages and better utilization of bandwidth by distributing traffic
MRPC	Throughput, Energy	Power-aware routing algorithm.	Routing decisions are based on a function of battery power
SIRCCR	Throughput, SIR	Selects multiple routes.	Reduces the probability of call denials.
QoLSR	Throughput, MAC delay	Considers packet collision probability, nodes MAC queuing and service times	Uses new heuristics for selection of MPR's
AAQR	Throughput, Delay, Jitter	Node state estimated using RTCP	No need of any additional probing messages.
CCBR	Bandwidth	Performs bandwidth calculation and slot reservation.	DSDV + "resource reservation" with/without bandwidth calculation.
ASWP	Bandwidth	Based on adopting Bellman Ford algorithm and k-shortest path protocol	Algorithm is able to achieve performance close to optimum possible.
BRAWN	Bandwidth	Allocates bandwidth on per flow basis.	Selects highest possible transmission rate for transmitting data.
TBP	Delay	Multipath and distributive.	Selects multiple paths without flooding.
ODCR	Delay	On-demand and unicast.	Reduces communication overhead
GAMAN	Delay, PLR	Source based and based on genetic algorithm.	Robustness is primary concern.
DSARP	Delay, Buffer Space	Based on constrained condition: the shortest route and the lowest average delay.	Ensures that minimum packets get lost in the network
HARP	Buffer space	Hybrid: combines reactive and proactive schemes.	Performs two level routing, intra zone and inter zone.
EBR	Link stability	Entropy based: lifetime of path.	Selects path having longest life.
LSBR	Link stability	Based on link survival time.	Proposed different models to estimate link stability.
GvGrid	PAR	On-demand and makes use of GPS	Selects nodes that are likely to move in similar direction with similar speed

ent kinds of metrics (i.e. Link-based-metric and Path-based-metric) are used. MQoSR uses heuristic neighbor selection mechanism with geographic routing algorithm in order to provide a routing solution.

It can be useful to a wide variety of applications as this is a multi-criteria QoS routing algorithm. Rehman et al. (2015) have introduced the Forward-Link-Quality-Estimation Routing (FLQER) protocol that is originally designed for VANET's. FLQER includes an efficient technique to predict the forward link quality. So, that whenever we will get that link won't be useful in future, we can immediately switch

Table 3. A comparison of cross-layer QoS routing protocols

Protocol	QoS Parameter	Features	Information Negotiation
QoSR-Z	Bandwidth	Distributed, based on AODV, can handle some degree of node mobility.	Between network and MAC layers.
TBRP	Bandwidth	TDMA based and solves hidden terminal and exposed terminal problems	Between network and MAC layers
CLSP	Delay	Allows multiple connections with different QoS requirements	Between physical and MAC layers
QoS-GPSR	Delay	Does temporary bandwidth reservation and provides per flow end-to-end guarantee.	Between network and MAC layers
AF-DF	Delay, Throughput	Aims at maximizing relay network throughput.	Between physical and data link layers.
CAAODV	Throughput	Combines admission control and feedback, estimates residual bandwidth available at each node.	Between network and application layers
CLMCQR	PLR, MAC delay, Throughput	Level of interference is calculated by observing MAC delay.	Between network and MAC layers

to some alternate paths. FLQER protocol can be useful in real-time applications, as the link quality estimation algorithm can be migrated to wireless MANET. Cadger et al. (2015) have presented Geographic Predictive Routing (GPR) which can be an efficient protocol for video-streaming applications, especially in the highly mobile network. GPR focuses on location and mobility criteria in order to get improved performance. The advance concept of Artificial-Neural-Network is being used to correctly depict the future locations of neighbor nodes so that link-switching decision can be made. Huang (2015) has presented a special QoS routing algorithm, which does the load-balancing for multi-path video transmission over wireless MANET. The QoS routing algorithm can be used efficiently for video streaming applications. Brak et al. (2014) have introduced a novel and effective modification to existing Optimized Link State Routing (OLSR) protocol entitled as OLSR-VA to make OLSR aware of VoIP applications. Brak et al. based their protocol in the principle that effective adaptation of routing parameters can enhance VoIP quality. OLSR-VA constantly monitors traffic and detects the VoIP activity. After that routing parameters are adapted in order to meet the QoS requirement of VoIP application. This protocol is self-adapting routing protocol, which adapts its parameters to the VoIP load in the network. Sanchez-Iborra et al. (2015) have proposed a new routing protocol entitled as Better Approach To Mobile Ad-Hoc Networking (BATMAN). This protocol exclusively claims to provide QoS in providing VoIP and video traffic. By using both emulator and simulator, the authors evaluated the performance of the BATMAN. They concluded that BATMAN performs much better than OLSR. They have also suggested that performance can be further improved with an appropriate tuning of configuration interval. In addition, BATMAN is capable of adjusting the bit-rate of the video traffic according to the number of streams in the network for managing video traffic.

Table 4 shows a comparison among all these recent advancements in routing protocols.

ACS-Based QoS Routing Protocols

Recent literature has focused on achieving QoS using ACS (ANT-Colony) algorithm. An Ant-based multi-QoS routing metric, named as AntSens-Net, has been introduced by Cobo et al. (2010). AntSens-Net

Table 4. Recent advancements in routing protocols

Protocol	Features	Comments
DQR	Supports video streaming over large-scale multi-domain Open-Flow networks.	Divides the video into different layers and force different layers to take diverse paths.
CAQR	Deliver visual information under QoS constraints.	Also proposed correlation-aware inter-node differential coding scheme and a correlation-aware load balancing mechanism
LW-TQR	Estimate the trust degree between nodes.	Best suited for the military-related application
LS-QRP	Minimizes the recalculation of MPR and routing table	Guarantees packet loss and response time.
QMRP	Introduces new parameter projected-load	Cross-layer approach(negotiates information among physical, MAC and network layers).
MQoSR	Uses heuristic neighbor selection mechanism.	Uses link and path-based metrics for QoS provisioning
FLQER	Improves the selection of next relay node.	Achieves higher reach-ability compared to existing relay selection protocols
GPR	Bottom-up routing process.	Predicts future locations of nodes using Artificial Neural Network
QRVS	Depicts multi constrained QoS routing mechanisms in AOMDV.	Can be used efficiently for video streaming
OLSR-VA	Extension of OLSR protocol	Can be used efficiently for VoIP applications
BATMAN	Capable of adjusting bit-rate of video according to the number of streams in the network.	Supports both VoIP and video traffic

is based on traditional ant-based mechanism and also consider QoS. It builds some type of hierarchical structure on the network and then selects the paths in order to fulfill the QoS requirements for different types of traffic. It uses multi-path video packet scheduling, which results in minimum video distortion transmission. Wang Y. et al. (2014) have presented an Improved Ant-colony based Multi-constrained QoS Energy-saving Routing (IAMQER) algorithm. This algorithm is also capable of energy saving and throughput optimization for wireless MANETs. IAMQER manages the relationship between the network throughput and energy consumption by analyzing the local node parameters, such as node queue length, node residual energy, number of forwarding data packets etc. Simulation studies of IAMQER have proven that it also improves the packet delivery ratio, thus resulting in better quality and better user satisfaction. Rodriguez-Perez et al. (2015) have proposed an Ant Colonization routing algorithm to Minimize network Power Consumption (ACS-MPC). The algorithm works on the principle that in low load network conditions, we can aggregate the whole traffic in a minimal set of links, so that all other nodes (that are not part of link aggregation) can sleep for a moment saving energy. This algorithm minimizes the global energy consumption by designing their routing tables in a decentralized manner. Eiza et al. (2015) have proposed Situation-Aware Multi-constraint QoS (SAMQ) routing algorithm that is based on the ACS routing algorithm. SAMQ focuses on vehicular ad hoc networks (VANETs) and is best suited for the highly wireless MANET where the speed of the mobile node is high. In particular, SAMQ computes the possible routes between the communicating vehicles depending on the multiple QoS constraints those are granted between them. It responds in a proactive manner in order to handle the route failure. In addition, it benefits from the situational awareness (SA) model that provides a framework for improving QoS routing reliability in VANETs.

Table 5 shows a comparison among all these ACS based routing protocols.

Table 5. Recent advancements in ACS based routing protocols

Protocol	Features	Comments
AntSens-Net	It builds hierarchical structure on network.	It uses efficient multi-path video scheduling.
IAMQER	It is based on the analysis of local-node information.	It proposes path evaluation function.
ACS-MPC	It works on power conservation.	It aggregates and/or divides traffic all over network.
SAMQ	It selects best route from multiple computed routes.	It responds locally and proactively to link/route disconnections

NOVEL APPROACHES FOR MULTIMEDIA OVER WIRELESS AD HOC NETWORKS

An interesting cross-layer approach for real-time streaming on wireless MANET has been demonstrated by Kuo et al. (2013). This approach is titled Cross-Layer Overlay for Multimedia Environment on P2P-MANET (COME-P2P). COME-P2P is useful for real-time point-to-point applications (like VoMANET or video communication) as it is specific for peer-to-peer communication. It is a cross-layer approach and thus the lower layers detect the mobility of nodes and convey this information to upper layers, so that the upper layer can maintain the routing table. The main contribution of COME-P2P approach is to maintain the stability of the routing paths for live streaming via IPv6 routing. The simulation results have depicted that it reduces the signaling overhead for live-streaming.

Bellavista et al. (2013) have proposed a light-weighted and self-organizing middleware, named localized relay-based mobile multimedia (LEM). LEM is useful for multimedia delivery in MANET (especially which is dense in nature). However, LEM approach is designed for providing multimedia services in some geographically bounded area of interest. Consequently, LEM middleware can be useful for applications like localized-video-conferencing or localized-rescue-operation.

Diaz et al. (2014a) have proposed the Multimedia Wireless Ad-Hoc Cluster Architecture (MWAHCA) to create and manage the cluster-based wireless MANET to provide multimedia streaming over it. It claims to provide proper QoS for a cluster-based wireless MANET. It evaluates the capacity for each individual node and uses this information to meet different QoS parameters. The main advantage of MWAHCA is that it divides the network into different clusters, where each cluster will be dedicated towards specific traffic types. It makes use of suitable Multimedia Init Profiles (MIPs) to adapt the different physical network configurations. However, MWAHCA does not take into account load balancing and fault tolerance mechanisms. Diaz et al. (2014b) have proposed the fault tolerance mechanism to be used with MWAHCA in order to increase its reliability. For fault tolerance, they have used a temporary fast switching path to improve the QoS recovery transition. They made provision to run algorithm independently for each multimedia flow in the network. They have reduced the convergence time to control the QoS parameters and to keep them as low as possible, which eventually resulting in minimum packet loss.

Ahmad et al. (2015) have demonstrated an efficient approach for delay optimization using the Knapsack algorithm, designed to deal with the multimedia data. First, they have demonstrated that delay is dependent on the packet size and buffer size to a great extent by presenting the mathematical relation of delay, buffer size, and packet size. Afterwards, they have used Knapsack algorithm to maximize the "in-order packets in the buffer", while on the other hand to minimize the "out-of-order packets in the buffer" simultaneously. For doing the same, they have also estimated the proper packet size and buffer size. They have made a buffer to act as a leaky-bucket for packets. With the help of simulation, they

have demonstrated that their approach can be useful for the multimedia transmission over MANET, especially when the size of the buffer is somewhat small, but the size of data is more. This is what will be the situation most of the time in wireless MANET.

Coll-Perales et al. (2015) have presented more interesting empirical models of the communications performance for the Multi-hop Cellular Network (MCN). MCN can be easily inherited to the wireless MANET, as it is dependent on the device-to-device (D2D) model. These models consider the impact of various parameters like: a number of hops, propagation conditions, distance etc. The authors have argued that this model can be very useful in case of design and demonstration, testing or optimization of novel communications and networking protocols designed to work with MCN. The models represent the MCN throughput experienced at the mobile destination node, as the function of multiple parameters like a number of hops, propagation condition, distance etc.

Ghazani (2015) have proposed a new Light Weight distributed QoS Algorithm (LWQA) for wide area ad hoc networks. It dynamically adjusts the Contention Window (CW) related to real-time flows using queue data structure and linear algebra. The algorithm distinguishes between the flows of the same type and can provide the different types of service for these similar flows. The main advantages of LWQA is that it doesn't need any type of resource reservation to ensure QoS. Unlike all other algorithms, flow in LWQA doesn't contend with other flows. Simulation studies have demonstrated that LWQA is capable of achieving the required quality.

Finally, Castellanos et al. (2016) have proposed a new QoS routing protocol based on AODV (AQA-AODV) that creates routes according to application QoS requirements. They have introduced link and path available bandwidth estimation mechanisms and an adaptive scheme that can provide feedback to the source node about the current network state, to allow the application to appropriately adjust the transmission rate. The authors proved that the combined use of AQA-AODV and the scalable video coding provides an efficient platform for supporting rate-adaptive video streaming.

The above mentioned approaches give much better results than earliest models in providing multimedia communication over MANETs. However, further improvements (e.g. support for end-to-end delay during the route discovery phase) must be proposed in order to enhance more their performance in MANETs. More experiments must be also performed using novel routing approaches with network-adaptive protocols for assessing the quality of experience (QoE) of the user.

CONCLUSION

MANET applications can be rapidly developed, if the technical issues concerning the provision of QoS will be resolved. Among these technical issues, the most important is QoS routing that includes the required routing mechanism and protocol as well as the required resource reservation protocol. Many intra-domain routing algorithms have been proposed which satisfy bandwidth, delay, and multiple constraints, while other multicast routing algorithms address the discovery of a tree covering source and multiple destination nodes subject to a set of constraints. Source, distributed and hierarchical routing algorithms have also been demonstrated in the literature.

This survey has provided an overview of some of the existing issues and challenges in providing multimedia communication over wireless MANETs. Especially, it has focused on the issues related with selecting proper QoS-based routing protocol, and it has enlisted some of the existing techniques resolv-

ing these issues. Also, it has discussed various QoS models, routing mechanisms and protocols used in order to provide efficient QoS routing over MANETs.

Most of the existing QoS models and frameworks are designed considering specific QoS routing protocols, which are working at their best to the some kind of applications and scenarios. Scalability and reliability of QoS for multimedia applications over wireless MANET will depend partially on QoS routing mechanisms operating on a full end-to-end basis. Obviously, other protocols and mechanisms, such as QoS PHY, QoS MAC, QoS signaling, and QoS admission control and scheduling will play their significant role to this issue, but studying them was not the goal of this survey.

Several combinations of QoS routing mechanisms are possible toward customized QoS routing solution for current multimedia application. In most cases, the nature of these QoS routing solutions will drive the combination of these mechanisms. We must design a generic QoS routing framework as it would be able to provide QoS routing to multimedia flows with divergent QoS requirements by having the scope for adaptation to various protocols/mechanisms, those can further help in achieving the desired QoS routing in MANETs. Such generic QoS routing framework should:

- Classify the traffic into real-time and non-real-time classes;
- Assign scalable priorities to the real-time traffic flows as they come with different bandwidth, throughput and delay requirements. Real-time flows must be treated differently according to their needs;
- Offer good bandwidth management based on an intelligent adaptation method that recognizes the priorities of the traffic.

Finally, the functionalities of this QoS framework (i.e. resource estimation, admission control, resource reservation and bandwidth adaptation) should be handled in a way that avoids the waste of resources and interference with other on-going flows.

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Chapter 43
Digital Storytelling and Digital Literacy:
Advanced Issues and Prospects

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ABSTRACT

This chapter reveals the overview of digital technologies; the overview of digital storytelling in education; and the overview of digital literacy in education. Digital storytelling and digital literacy are very important in modern education. Digital storytelling is used to improve student's learning through multimedia in the modern classrooms. Digital storytelling is the expressive medium that can explain even the most intricate topics in depth, integrating it with the rest of the curriculum. Digital literacy is the ability to use Information and Communication Technology (ICT) to find, evaluate, create, and communicate information, requiring both cognitive and technical skills. Digital literacy leads to the great increases in information that can be conveniently accessed. The chapter argues that developing digital storytelling and digital literacy skills has the potential to improve both teaching and learning performance in modern education.

INTRODUCTION

The impact of technology is one of the most critical issues in education (Sincar, 2013). Digital technologies become the essential parts of students' learning experiences in the classrooms (Kissel, 2014). The advent of digital technologies brings substantial shifts both at the material levels and at the global literacy levels in this digital world (Limbu, 2014). Storytelling on electronic platforms can become powerful if adopted and delivered with appeals known as digital storytelling (Hassan, 2016). With digital storytelling, technologies allow individuals to organize their educational messages through sophisticated multimedia and to participate in the cross-cultural communication (Kozdras, Joseph, & Kozdras, 2015). Digital storytelling brings the time-honored teaching and learning achievements of storytelling with the modern student's affinity for technology (Bhattacharyya, 2012).

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Digital storytelling represents an interesting method to establish a methodology that takes advantage of multimedia technologies to develop learning mechanisms (Carrozzino, Evangelista, Neri, & Bergamasco, 2012). The inherent interactivity of the Internet and the emotional engagement of digital story can lead to transformative learning experiences in the media-rich environments (Kalogeras, 2013). Educational leaders (e.g., school district managers and administrators who are implementing mobile learning devices) need deeper comprehension of the value of such technology initiatives and the types of technological support needed to bring about the meaningful learning projects toward effective digital programs (Ostashewski & Reid, 2013).

The growing digital experiences have radically transformed the traditional approach, and have traced the route for a new communication paradigm in education (Ganzerla, Colapinto, & Rocco, 2015). The 21st century literacy skills increasingly reflect the ability to use technology (Pilgrim & Bledsoe, 2013). Digital literacy for students and learners has developed into an important dimension of information and communication technology (ICT)-related educational policies worldwide (Karagiorgi & Gravani, 2012). The balanced literacy approach to teaching, reading, and writing derives from the philosophy that students learn best through opportunities for authentic reading and writing experiences (McGinnis, 2013). It becomes imperative for technology to be embedded in the digital literacy methods courses to prepare the future teachers of writing (Werderich & Manderino, 2014).

In the educational process, teaching with technology is as challenging as it is necessary as the 21st century has facilitated learners ever more vigorously into the digital age, offering multimedia for interpreting the world (Chen, 2016). Regarding digital literacy, the utilization of computers and video games, combined with more traditional storytelling, serves as the useful tools for motivating and engaging students as well as promoting learning in education (Jin, DaCosta, & Seok, 2016). Thus, teachers should consider how best to teach and apply their digital literacy skills in their classrooms so as to support the students' digital literacy development toward gaining better educational performance (Wake, 2013).

This chapter aims to bridge the gap in the literature on the thorough literature consolidation of digital storytelling and digital literacy. The extensive literature of digital storytelling and digital literacy provides a contribution to practitioners and researchers by revealing the advanced issues and prospects of digital storytelling and digital literacy in order to maximize the impact of digital storytelling and digital literacy in modern education.

BACKGROUND

Nowadays, many teachers are under pressure to provide the evidence of the impact that coursework has on student learning, and student-generated digital stories provide the valuable artifacts of learning (Matthews-DeNatale, 2013). In recent years, digital stories have been used for both teaching and learning purposes as a result of the advancements of technology and overspread use of technological devices by students and teachers (Soleymani, 2015). A constructive teaching approach is adopted to allow students to create their own digital stories based on an authentic experience and express their thoughts (Tay, Lim, & Lim, 2011). Unlike the traditional stories, digital stories have multimedia format and are made with different types of technological tools (Soleymani, 2015).

The advent of digital storytelling in educational environments is based on theories by which learning is a result of knowledge building (Psomos & Kordaki, 2012). Digital storytelling is a concept that

is growing in popularity and one which offers versatility as an instructional tool (Wright, 2008) and aims at generating the compelling stories based on the user's input (Smed, 2014). Digital storytelling approach provides students with several opportunities that enable them to utilize technology as the active participant designers in the process of putting forward their creativity and that allow them to create their own original and creative languages (Eristi, 2014). The integration of both traditional and new literacy practices is evident throughout the process of creating a digital story (Shelby-Caffey, Úbéda, & Jenkins, 2014).

Digital literacy is the set of skills, knowledge, and attitudes required to effectively access the digital information (Julien, 2015) and is one of the core competencies for the 21st century (Voogt, Erstad, Dede, & Mishra, 2013). In order to adequately characterize literacy, the definition of digital literacy has to capture the relationship between literacy and new technologies (Bodomo, 2010). Davis, Palmer, and Etienne (2016) defined digital literacy as the ability to access, analyze, evaluate, and produce messages and information across a range of ICT in a variety of social settings. Martinovic, Freiman, Lekule, and Yang (2015) viewed digital literacy as the ability to effectively use digital technologies for learning, working, and functioning in a modern society. Digital literacy needs, including general computing skills, computerized communications, distance education, and Web 2.0 tools can make navigating coursework an additional challenge (Hsu, Wang, & Hamilton, 2013).

Technologies used in teaching can be delivered through many mechanisms, such as slide projectors, overhead machines, filmstrip projectors, TV, interactive whiteboards, and computer projectors (Streeter, 2011). The changing nature of online engagement privileges interaction over information (Merchant, 2009a). Many online classes make use of discussion boards, on which students can interact with their peers, the content, and the instructor (Wegmann, 2010). With the rapid development of information technology (IT), the trend in education and learning has changed from traditional in-class teaching to teaching through digital media. In order for technology knowledge to be transferred to the classroom, teachers need to find both knowledge and digital literacy skills being taught relevant to their future classrooms (Ottenbreit-Leftwich, 2012).

The increase in the popularity of mobile and social media practices, from texting and sharing multimedia to social networking and online gaming, has aroused the discussion around the affordances of technologies for the creative learning (Ranieri & Bruni, 2016). While access to technology is rapidly growing, educators need to be aware that students' technological knowledge and skills are diverse (McAdams & Gentry, 2014). Regarding digital literacy enhancement in education, teachers and schools need to predict and prepare students for their future, the scope of which covers teaching students how to effectively apply digital technologies and information, how to think, and how to communicate (Tsai, Shen, & Lin, 2015). Technology education continues to rapidly develop as the basic channel for preparing students and learners concerning digital literacy (Thomas, 2016).

IMPORTANT PERSPECTIVES ON DIGITAL STORYTELLING AND DIGITAL LITERACY

This section emphasizes the overview of digital technologies; the overview of digital storytelling in education; and the overview of digital literacy in education.

Overview of Digital Technologies

The rapid development in digital technologies during the digital era confronts individuals with situations that require the utilization of an ever-growing assortment of technical, cognitive, and sociological skills that are necessary in order to perform and solve problems in the digital environments (Eshet, 2005). Modern digital technologies provide users with opportunities to create visual art and written works by reproducing and manipulating texts, visuals, and audio pieces (Eshet-Alkalai, 2009). Students need to be aware about the growing technologies and media so that they can effectively access, evaluate, and create the media messages of all kinds (Mahajan, Rather, Shafiq, & Qadri, 2016).

As digital technologies and social media have become the integral parts of individual's everyday life, there is a global trend for effectively integrating them in education (Marav & Espinoza, 2015). Technology utilization has been found to have the greatest effect on learning (Gibson, 2006). Universities and colleges are required to incorporate digital technologies into teaching and learning (Haneef, 2015). Using digital technologies to make both learning and teaching educationally productive must be cultivated over time (Arnseth & Hatlevik, 2010). An increasing reliance on digital technology necessitates the development of digital literacy skills to enable individual's continued participation in the digital age (Antonio & Tuffley, 2015).

Digital technologies refer to a subset of electronic technologies that include hardware and software utilized by both children and adolescents for educational, social, and recreational purposes (Ng, 2013a). The digital environment provides the abundance of multimedia and offers the new potential for using resources in the multiple modes of representation for teaching and learning (Matusiak, 2013). For example, learning with mobile devices is the need to develop the associated digital literacy in students (Ng, 2013b). Augmented by recent developments in user interfaces, the use of mobile devices is likely to broaden both user receptiveness and acceptance of video learning content in modern education (Abdous, Facer, & Yen, 2015).

Over the past three decades, new digital technologies have rapidly proliferated and transformed the character of both public and interpersonal communications (Underwood & Parker, 2011). Among the technological developments in educational environments are technology applications that allow individuals to express themselves better, to recognize their own potential, and to develop themselves (Eristi, 2014). The expectation for responsive change to the changing student learning needs significantly comes in the form of educators' attempts to transform K-12 classrooms with digital technology (Leneway, 2014). Digital curation appears to be an approach that helps frame an inquiry-based pedagogy geared toward student engagement and digital literacy comprehension (Mills, 2013).

Digital technologies are mainly used to communicate in social networks or to play music and movies (Cartelli & Di Nuzzo, 2013). Technology mediates the way in which students around the world communicate, consume content, and create meaning (Botha, Vosloo, Kuner, & van den Berg, 2009). The close relationship between modern technology and humanity affects the way of learning and teaching (Incikabi, 2015). Digital reading and writing are affecting not only how K-12 students think about literacy, but also how teachers teach and how educators and researchers define and investigate literacy (Foley, Guzzetti, Agnello, & Lesley, 2014). Beyond developing reading and writing skills, it is necessary to emerge in the digital culture and master the different codes of different languages (Fantin, 2012).

Community-based digital storytelling must take seriously the realities of the digital divide, and must consider the social, political, economic, and cultural contexts of communities and their specific relationship to digital technologies to ensure that educational communities have the effective access to

the digital medium (Tharp & Hills, 2004). Preservice English teachers reflect the positive perceptions toward the use of digital storytelling (Aşık, 2016). Their reflections are significant in terms of the tools to be used for digital storytelling, the viewpoints regarding young learners, and the improvement in their technological pedagogical content knowledge (TPACK) (Aşık, 2016). TPACK is one of the technology integration models that focuses on the effective technology integration regarding the teacher's technology integration competencies (Yurdakul, Odabasi, Sahin, & Coklar, 2013).

Overview of Digital Storytelling in Education

Digital storytelling refers to the use of digital media to produce and disseminate stories (Davis & Foley, 2016). Digital storytelling is an innovative tool and serves as a promising activity facilitating learning and development in the post modern society (Nilsson, 2008). Digital storytelling includes a special emphasis on the group process and the experience of individuals sharing stories with each other. Digital storytelling combines the functions of visualizing and verbalizing, which are essential for language comprehension and thinking from the perspective of cognitive neuroscience (Kimura, 2012). Digital storytelling provides the interactive approach for establishing learner communities, engaging learners in digital literacy, and creating educational opportunities for the global audience interaction (Alameen, 2011).

In recent years, digital storytelling models have helped teachers achieve the improved outcomes (Smeda, Dakich, & Sharda, 2014). Acquiring new literacies and learning how to integrate them into the classroom will take considerable time and resources. School must be prepared to invest both. Rather than focusing primarily on skills in technology and the development of high-quality media products, facilitators take care to build and further community connections through a process of reflecting on the stories in the classroom. Encouraging preservice teachers to reflect on their digital literacy stories provides them with the opportunity to connect their past experiences as literacy students with their present and future goal of becoming the digital literacy teachers (Hughes & Robertson, 2013). Preservice teachers can facilitate both mathematical problem-solving competences and pedagogical competences for applying digital storytelling in solving mathematical problems (Starčič, Cotic, Solomonides, & Volk, 2016).

Digital storytelling has the potential to contribute to the formation of new knowledge, expand dialog, and promote the exchange of ideas. Digital storytelling is the important approach for the transformative learning (Christopher, 2011) and is effective in both early child education and in all areas of higher education (Wang & Zhan, 2012). Digital storytelling projects can be beneficial in the development of student media production skill sets (Spicer & Miller, 2014). To optimize opportunities for this development, teachers are encouraged to consider the required media components with relevant production tasks and skill sets while designing a digital storytelling assignment toward digital programs (Spicer & Miller, 2014).

The process of digital storytelling requires that students explore the relationship between narrative, audio, and visual text, offering both storyteller and audience the multiple layers of meaning-making within each story. Research in online reading comprehension is informed by theoretical work in new literacies (Leu, Kinzer, Coiro, & Cammack, 2004). Additional reading comprehension skills are required to be a successful online reader (Coiro & Dobler, 2007). Little instruction in the new demands of online reading comprehension takes place in schools (Leu, 2006). Teachers will benefit from an understanding of new instructional models that take full advantage of the Internet, such as Internet Workshop (Leu, 2002), Internet Project (Leu, Leu, & Coiro, 2004), and inquiry models (Eagleton, Guinnee, & Langlais, 2003).

In game-based learning (GBL) and in teaching using virtual worlds, educational designers creating the learning products and teachers providing them to students are both faced with a dualism between instruction and construction (Martens & Maciuszek, 2013). Educational computer games can motivate students to develop the basic competencies and encourage challenging themselves to be better and learn the additional knowledge related to the important tasks (Kasemsap, 2017). Most of the literature supports the notion that the experience of creating digital stories can have a positive impact on the students' acquisition of literacy skills and their motivation to engage with the text (Tobin & Blanton, 2014). How-to manuals, project descriptions, and anecdotal comments are available on digital storytelling (Love, Cushing, Sullivan, & Brexa, 2011).

This section is dealing with the overview of digital storytelling in education and the next section is dealing with the overview of digital literacy in education. Digital storytelling is the process of using story and digital media for personal expression. This includes expressive outlets, such as blogs, podcasts, and social media. Performing digital stories encourages youth to move beyond the role of consumer and into the role of producer of media, and thus of culture. This process helps build cultural capital among young people. At its core, digital storytelling invites youth to combine technology, performance, and personal experience to contribute to the educational world.

Effective digital storytelling relies on creative, group facilitation skills, and an ability to structure a safe space for young people to share, listen to, and reflect on educational experiences toward improving digital literacy in education. Digital storytelling is utilized in the K-12 classroom to build community through personal exchange and reflection; support creativity, communication, and collaboration; foster connections between curriculum content (inside the classroom) and students' lived experiences (outside the classroom); engage youth in research, writing, and reflection; support peer-to-peer teaching and learning; and to promote language skills, as well as visual and media literacy.

Overview of Digital Literacy in Education

Literacy is a basic principle of any educational system (Heredero, 2012). Digital literacy refers to the ability to use digital technology to locate, evaluate, and create the information (Manzoor, 2016). Digital literacy represents the changes in the traditional views of literacy due to the impact of the Internet and technology tools (Pilgrim & Bledsoe, 2015). The 21st century literacy perspective can support the inclusive literacy practices that create the community of learners, utilize the digital tools to make the curriculum accessible, and link the academic goals with the real-world platforms (Price-Dennis, Holmes, & Smith, 2015). Blogs are recognized as the media-rich platforms in which learners operate with plural modes of literacy to construct educational meaning (O'Byrne & Murrell, 2014).

Digital literacy has gone from a virtually non-existent entity to an essential skill set (Weisberg, 2016). Introducing digital literacy into classroom settings is an important task and is encouraged by both policymakers and educators (Merchant, 2009b). The digital literacy practices of many educational communities provide the new ways of technological and digital culture (Tan, Abdullah, & Saw, 2012). Regarding cultural transition, global society moves from a literary society to digital one, adopting the widespread use of advanced technologies, such as the Internet and mobile devices (Rivoltella, 2008). Digital literacy education requires each learner to grasp unfamiliar terminology, learn skills for unfamiliar tools, and apply complex ideas to digital interactions (Donohue & Kelly, 2016).

With technology infused throughout the standards, teacher preparation programs are confronted with the challenge of priming preservice teachers to be the technologically literate educators ready to cultivate

the educational curriculum for 21st century learners (Robinson, 2014). As technology becomes more and more accessible outside of the classroom, educators are challenged to reconsider the digital literacy skills required to be successfully literate (Wells & Lyons, 2016). Becoming literate in the 21st century means that one must decode and comprehend multimodal digital texts and be able to purposefully engage with these texts with others (Mills, 2014). A digitally literate person must possess a wide range of abilities necessary to collaborate and present information through multimedia (Pilgrim & Bledsoe, 2013).

Digital literacy incorporates an ability to critically evaluate information, communicate concepts, and express ideas in a wide variety of media, all mediated by computers (Kennedy, 2008). Education institutions need to prepare their students and their own organizational processes to thrive in the age of digital knowledge practices (Littlejohn, Beetham, & McGill, 2012). The lack of knowledge of how to operate and utilize digital tools is a critical barrier to the enhancement of digital literacy (Lee, 2014). Teachers are confronted with not only developing curricula that focus on the important learning components, but also with incorporating curricula that highlight the technological skill sets students need to be the successful learners (Mallon & Gilstrap, 2014).

The development of digital learning skills in school curricula challenges the designers of educational software (Utsi & Lowyck, 2009). Regarding digital literacy, many students gain transformative benefits from knowing how to perform various tasks on the Internet and computers (Lee, 2015). ICT training can motivate students to develop digital literacy, numeracy, and language skills (Jimoyiannis & Gravani, 2012). By using digital literacy skills, students are able to utilize the forms of literacy for non-text based instructional material increasing the options available for them to learn (Brown, 2016). In addition to incidental learning taking place in virtual environments, learning style and digital literacy seem to predict the incidental learning in some instances (Thomas & Boechler, 2016).

The emergence of digital literacy skills to better fit the networked information economy presses higher education institutions (HEIs) to invest in the digitally rich environments that allow learning to be personalized, taking place in multiple locations and at time that suits both students and learners (Coutinho, 2016). In the higher education sector, technological resources have been devoted to the development of the virtual and game-based environments (Kennedy-Clark & Wheeler, 2014). Game technology can be successfully utilized to aid in the development of social skills among those with special needs (Kinsell, DaCosta, & Nasah, 2015).

The digital society is characterized by an extensive utilization of digital technologies (Rodríguez-de-Dios & Igartua, 2016). Facing digital society means to accept the need of a digital literacy (Vasilescu, Epure, & Florea, 2013). It is important to provide the cognitive and emotional support for the risk-taking cycles of experimentation and trial-and-error process that is essential for learning to utilize the digital tools (Hobbs & Coiro, 2016). Teachers and students use many digital tools including computers, iPads, and videos, and demonstrate practices that characterize the 21st century skills, such as collaborative learning, technology literacy, and information literacy (Lawrence, 2016).

Pedagogical decisions associated with the use of digital tools are an important part of the new literacies for 21st century learning. The utilization of digital tools requires educational leaders to consider what digital literacy means in the 21st century (Brown, 2014). Many digital tools offer the innovative approaches for writing instruction in K-12 settings (Brown, 2014). Handheld computers have the potential to have a tremendous impact on teaching and learning in the K-12 classroom (van 't Hooft, 2006). Laptops, personal digital assistants (PDAs), and cellular phones are the major components of digital literacy (Garland, 2006). The iPad-based curriculum can promote the critical digital literacy skills for students (Hilton & Canciello, 2013).

Modern technology continues to revolutionize the teaching and learning landscape establishing the new possibilities to utilize the new digital media to digitally enhance the multiple literacies (Levitt & Piro, 2016). Enhanced user engagement and collaboration are recognized in terms of rich media experience, semantic interaction services, intelligent content processing, and management automation over the interoperable multiplatform environments (Matsiola, Dimoulas, Kalliris, & Veglis, 2015). The pedagogical value of technological video projects creates the opportunities for learners to interact with authentic materials in the real world by searching for relevant information, thus developing their own interpretation and producing the multimedia video (Huang, 2015).

Preservice teachers indicate the transformative practices in two ways: firstly, through designing lessons that indicate that they will teach differently than the way that they were taught; and secondly, through utilizing digital literacy as a method of reflecting on their own social identities and working for the educational changes in both culture and society toward transforming the status quo (Hughes & Robertson, 2013). Concerning technology-rich teacher education programs, teacher educators engage preservice teachers in the world of diversity using technology (Thomas, 2016). Both the use of digital technology and the digital literacy pedagogy can help preservice teachers reflect on personal experiences to digitally develop both literacy teaching and learning practices that have the transformative elements (Robertson & Hughes, 2010).

FUTURE RESEARCH DIRECTIONS

The classification of the extensive literature in the domains of digital storytelling and digital literacy will provide the potential opportunities for future research. A virtual classroom is a teaching and learning environment where participants can interact, communicate, discuss presentations, and engage with the learning resources while working in groups, all in an online setting. A course management system (CMS) is a set of tools that enables the teachers to create the online course content and post it on the Web 2.0 without having to handle hypertext markup language (HTML) or other programming languages. An examination of linkages among digital storytelling, digital literacy, virtual classroom, and CMS in education would seem to be viable for future research efforts.

CONCLUSION

This chapter highlighted the overview of digital technologies; the overview of digital storytelling in education; and the overview of digital literacy in education. Digital storytelling and digital literacy are very important in modern education. With the advancement of digital tools, the practice of digital storytelling has become prevalent. Digital storytelling is used to improve student's learning through multimedia in the modern classrooms. Digital storytelling is the expressive medium that can explain even the most intricate topics in depth, integrating it with the rest of the curriculum. Digital storytelling can be shared on each student's device through the Internet and can make the classroom learning much more practical and easy in the modern learning environments.

Digital literacy is the ability to use ICT to find, evaluate, create, and communicate information, requiring both cognitive and technical skills. Digital literacy leads to the great increases in information that can be conveniently accessed. Teachers must be cognizant of promoting digital literacy, putting the

proper utilization of digital tools and technology right on par with reading and writing. Teachers and students must determine which tools are essential to their digital literacy tool kit. Embedding digital literacy lessons and social media across the curriculum can open up a wide variety of educational tools for teachers and students.

Commitment to providing digital tools must come with a commitment to providing fidelity in instructional practice toward effective digital storytelling and digital literacy for teachers and students. Allowing students to find their own learning resources creates a true personalized learning environment. The developed digital literacy skills through learning and development programs provided by universities and colleges can afford students the ability to seek out and utilize knowledge resources that help them create a personal learning connection in the digital age. Developing digital storytelling and digital literacy has the potential to improve both teaching and learning performance in modern education.

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KEY TERMS AND DEFINITIONS

Digital Literacy: The ability to find, evaluate, utilize, share, and create the content using information technology and the Internet.

Digital Storytelling: The practice of using computer-based tools to tell the stories.

Information Technology: The set of tools, processes, and associated equipment employed to collect, process, and present the information.

Knowledge: The state of knowing about or being familiar with something.

Learning: The activity of obtaining knowledge.

Literacy: The knowledge of the particular subject.

Storytelling: The art of telling stories.

Technology: The utilization of scientific knowledge to solve the practical problems, especially in industry and commerce.

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Chapter 44
Copyright Protection of Audio Using Biometrics

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ABSTRACT

In our global community, the Internet, the issue of copyright is increasing. The International Maritime Bureau (IMB) reported over thousands of incidents this year compared to three hundred only ten years ago. Although laws and other ways have been intended to protect the rights of content developers and describe restrictions that can be placed on copying materials, pirate users always find a way to breach the protection. Base on this fact, a new method has been implemented using biometrics as it is described in the following chapters. This paper was developed taking into consideration one of the most widely used biometrics which is the fingerprint. Precisely, the aim of the system includes embedding the fingerprint into an audio file which can only be read using the fingerprint of the registered user.

INTRODUCTION

In today's information technology era, a pirate user is offered a plethora of opportunities to make illegal copyrights with the use of digital techniques in the creation, editing and distribution of multimedia data. Furthermore, the widespread usage of Internet is providing additional channels for a pirate to quickly and easily distribute the copyrighted digital content without the fear of being tracked. As a result, the protection of multimedia content is now receiving a substantial amount of attention. In recent years solutions such as steganography and encryption were found, but due to some problems, pirate users have been able bypass the security provided by these techniques.

Biometrics is an alternative solution to eliminate copyright problem. The field of biometrics has been able to prove effective in various fields such as protection of sensitive data at the Federal Bureau of Investigation and the Central Intelligence Agency and also in biometric passports to authenticate the identity of travellers.

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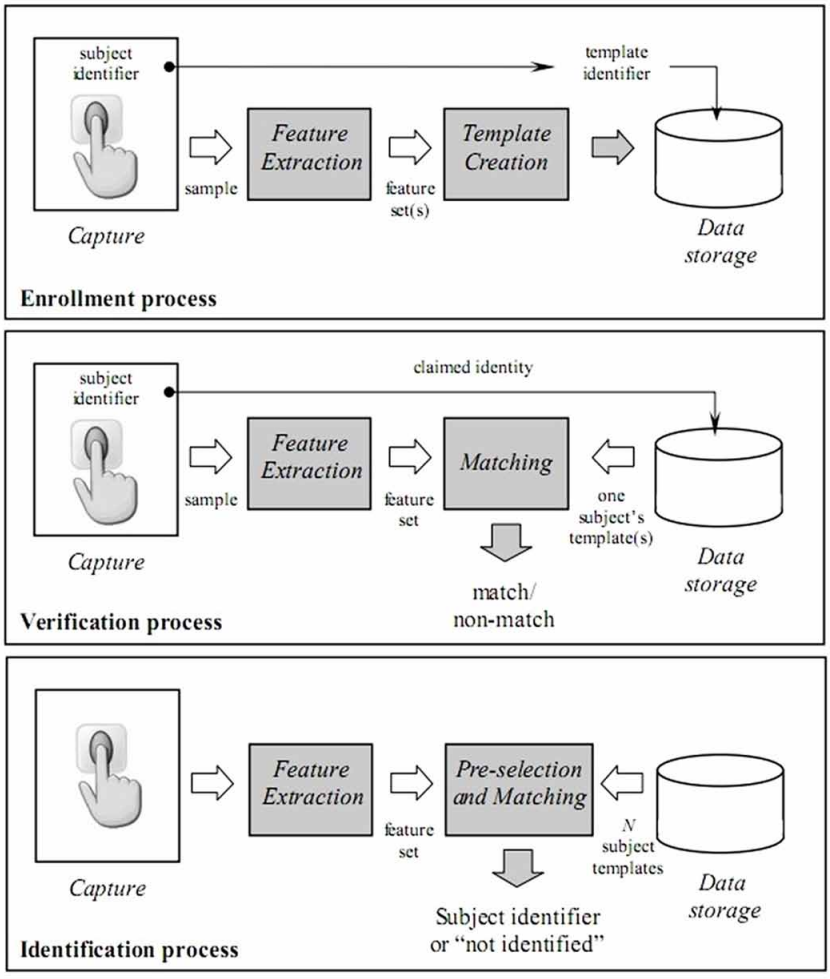
The ability to relate biometric to multimedia can enhance the trustworthiness of a system. In this paper, biometrics will be combined with existing protection technique such as steganography to alleviate the problem of copyright.

Biometrics Overview

The word biometrics is derived from the Greek words bios (meaning life) and metron (meaning measurement), so biometrics is in essence, the measure of life (Lim Dong, 2010). As the level of security breaches and fraud increases, the need for highly secure identification and personal verification technologies is becoming apparent

Figure 1. Biometrics Architecture (Jain et al, 2009)
Source: Jain et al. 2009



Biometrics System

For any biometric system the most important aspect for it to work properly is that the individual must first be enrolled. Furthermore in designing a practical biometric system is to determine how an individual is going to be recognised. Depending on the application, a biometric system may be called either a verification system or an identification system:

- **Enrolment:** User enrolment is a process that is responsible for registering individuals in the biometric system storage. During the enrolment process, the biometric characteristic of a subject is first captured by a biometric scanner to produce a sample. A quality check is often performed to ensure that the acquired sample can be reliably processed by successive stages. A feature extraction module is then used to produce a feature set. The feature set is then used to produce an enrolment template. The enrolment template is stored in the system storage together with the demographic information about the user.
- **Verification:** The verification process is responsible for confirming the claim of identity of the subject. During the recognition phase, an identifier of the subject is provided to claim an identity. The biometric scanner captures the characteristic of the subject and converts it to a sample, which is further processed by the feature extraction module to produce a feature set. The resulting feature set is fed to the matcher, where it is compared against the enrolment template of that subject. A match/non-match decision is produced by the verification process.
- **Identification:** In the identification process, the subject does not explicitly claim an identity. The system is set to compare the feature set against the templates of all the subjects in the system storage. The output is a candidate list that may be empty or contain one identifier of matching enrolment templates.

Traits

Any human anatomical or behavioural trait can be used as a biometric identifier to recognise a person as long as the following requirements are satisfied: (Jain et al, 2009)

- **Universality:** Each person should have the characteristic.
- **Uniqueness:** How well the biometric separates individuals from another.
- **Permanence:** Measures how well a biometric resists aging
- **Collectability:** Ease of acquisition for measurement.
- **Performance**: Accuracy, speed, and robustness of technology used.
- **Acceptability:** Degree of approval of a technology.
- **Circumvention:** Ease of use of a substitute.

Examples of biometrics (Table 1).

Table 1. Biometrics traits

Bertillonage	Measuring body lengths
Fingerprint	Analysing fingertip patterns
Facial Recognition	Measuring facial characteristics
Hand Geometry	Measuring the shape of the hand
Iris	Analysing features of coloured ring of eye
Retinal	Analysing blood vessels in eye
Vascular Pattern	Analysing vein pattern
DNA	Analysing genetic makeup

Recent Application

Forensics

Biometric recognition techniques have been used in forensic applications for over 100 years. They have helped criminal investigations, identified disaster victims, and helped to locate missing children. Biometric systems can spare investigators the time-consuming process of sorting through thousands of files by hand.

Government

Forged or stolen identification cards are a common security problem all over the world. According to the United Kingdom's Identity and Passport Service, over 290,000 U.K. passports are lost or stolen each year. Some international airports are adopting iris, fingerprint, or face recognition systems to prevent individuals from entering a country using false credentials.

Commercial

The need to protect personal information has led to the deployment of numerous commercial biometric recognition systems. In the U.S. alone, identity theft and credit card fraud strike millions of consumers every year, with an annual cost of around $50 billion dollars. More and more personal and private data is stored in electronic form: medical history, credit card information, vital statistics, and more. Biometric recognition techniques add an extra layer of security to traditional password-based systems or replace them altogether.

Scope of the Work

The multimedia protection system requires that a biometric sample is verified against a biometric sample stored in a multimedia file. Three components are used for both enrolment and verification stages:

1. A mechanism is used to scan and capture digital images of individuals' biometric characteristic.
2. An agent and database are used to process and store the image as binary files for verification process.

3. An application system is used to interact with individuals for confirming their true identity.

BACKGROUND

Background Study is set to exploit one of the most popular biometrics, the fingerprint. A fingerprint is an impression of the friction ridges of all or any part of the finger. Using the template created concepts for copyright protection can be derived to be used in today's modern era.

Fingerprint Formation

Fingerprints are fully formed at about seven months of fetus development. Finger ridge configurations do not change throughout the life of an individual except due to accidents and cuts on the fingertips (Babler, 1991). This property makes fingerprints a very attractive biometric identifier.

Fingerprint History

A timeline from prehistoric until 1999 of how fingerprint became part of everyday life and an important tool in maintaining security is placed in the Appendix.

Fingerprint Sensing

Historically the acquisition of fingerprint images was performed by using the so-called "ink- technique". While this technique is still in use, new technologies such as sensors are being used to acquire better quality images.

Offline Technique

In the ink-technique the finger skin is first spread with black ink and then pressed against a paper card. The card is then converted into digital form by means of a paper scanner or by using a high-quality camera.

Live Scan

The most important part of a fingerprint scanner is the sensor, which is the component where the fingerprint image is formed. The two most common families of fingerprint scanner that exist are:

- Optical
- Solid-state

- **Optical Sensors:** The finger touches the top side of a glass prism, but while the ridges enter in contact with the prism surface, the valleys remain at a certain distance. The left side of the prism is illuminated through a diffused light. The light entering the prism is reflected at the valleys, and absorbed at the ridges.

Figure 2. Images acquired off-line with the ink technique
Source: Maltoni, 2003

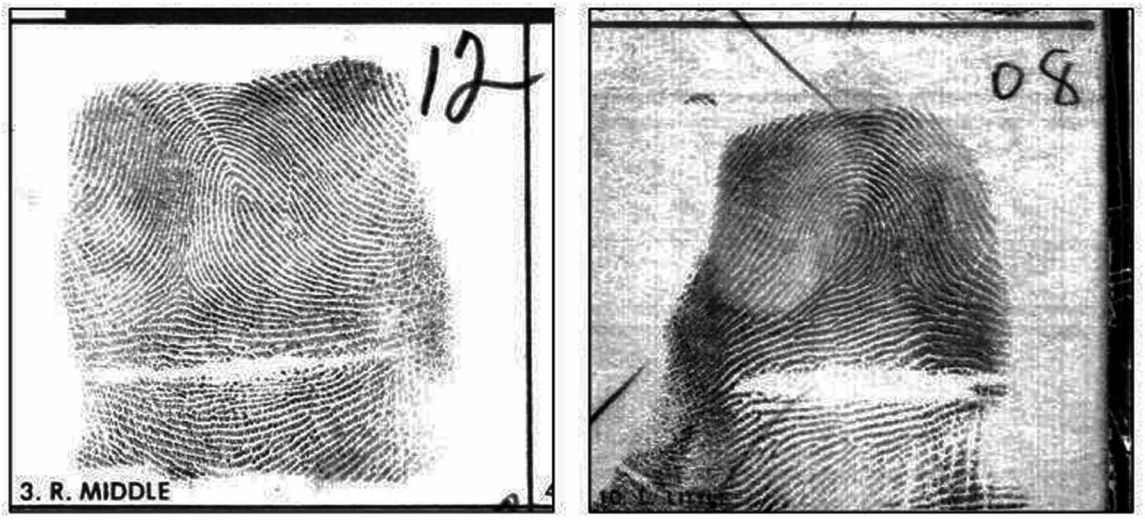
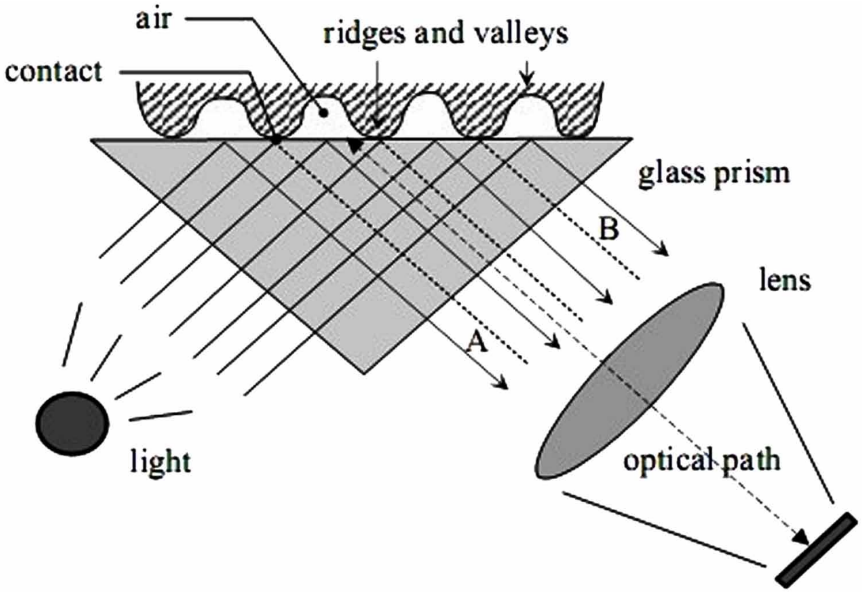
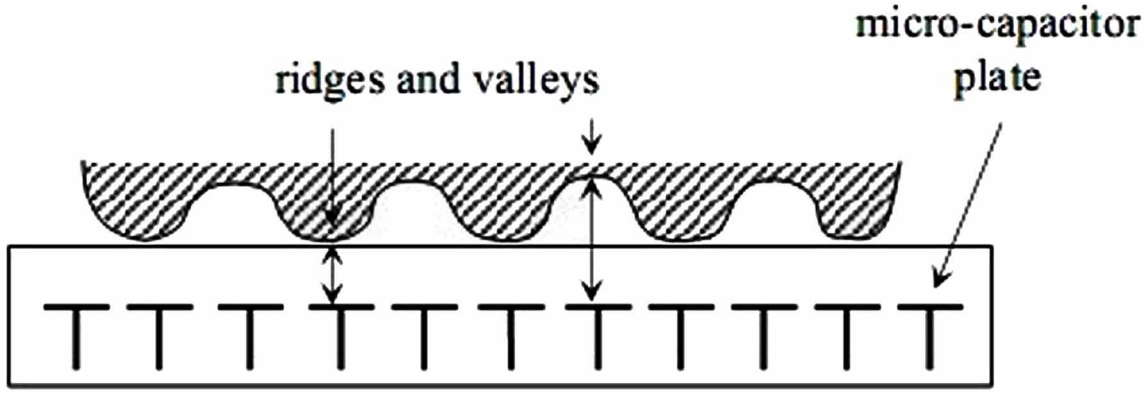


Figure 3. Optical sensor
Source: Maltoni, 2003



- **Solid-State:** All solid state-based sensors consist of an array of pixels, each pixel being a tiny sensor itself. The user directly touches the surface of the silicon. A capacitive sensor is a two-dimensional array of micro-capacitor plates embedded in a chip. The other plate of each micro capacitor is the finger skin itself. Small electrical charges are created between the surface of the finger and each of the silicon plates when a finger is placed on the chip. The magnitude of these electrical charges depends on the distance between the fingerprint surface and the capacitance plates.

Figure 4. Solid-state sensor
Source: Maltoni, 2003



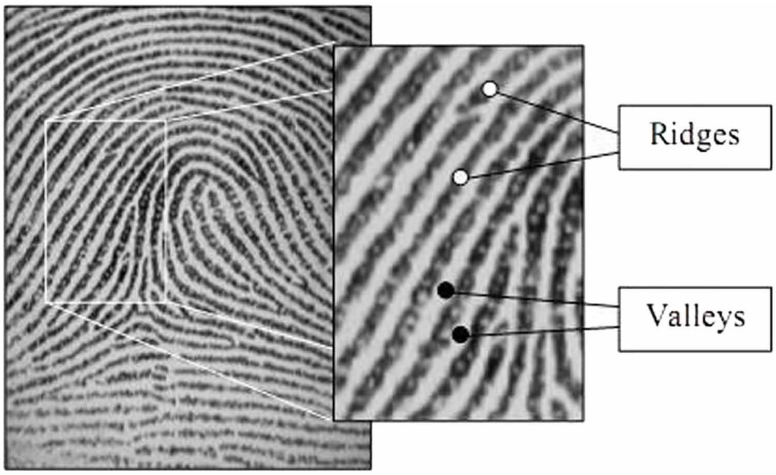
Storage

Storing raw fingerprint images may be problematic for large-scale identification systems. In 1995, the size of the FBI fingerprint card archive contained over 200 million items, and archive size was increasing at the rate of 30,000 to 50,000 new cards per day. Although the digitization of fingerprint cards seemed to be the most obvious choice, the resulting digital archive could become extremely large. In fact, each fingerprint card, when digitized at 500 dpi requires about 10 megabytes of storage. (Jain, 2007)

Representation and Feature Extraction

A fingerprint is the reproduction of a fingertip epidermis, produced when a finger is pressed against a smooth surface. The most evident structural characteristic of a fingerprint is a pattern of interleaved

Figure 5. Ridges and valleys in a fingerprint image (Jain & Prabhakar, 2009)
Source: Jain & Prabhakar, 2009



ridges and valleys. Ridges and valleys often run in parallel; sometimes they bifurcate and sometimes they terminate. Generally, the period of a ridge/valley cycle is about 500 μm. (Jain et al, 2003)

Level 1

When analyzed at the global level, the fingerprint pattern exhibits one or more regions where the ridge lines assume distinctive shapes. These regions may be classified into three typologies: loop, delta, and whorl. Singular regions belonging to loop, delta, and whorl types are typically characterized by ∩, Δ, and O shape, respectively. (Maio et al, 2003)

Singular regions are commonly used for fingerprint classifications, that is, assigning a fingerprint to a class among a set of distinct classes, with the aim of simplifying search and retrieval.

Level 2

At the local level, other important features, called minutiae can be found in the fingerprint patterns. Minutia refers to various ways that the ridges can be discontinuous. Although several types of minutiae can be considered, usually only a coarse classification is adopted to deal with the practical difficulty in automatically discerning the different types with high accuracy.

Extraction

There has been proposed many methods for the minutia extraction, the traditional method consist of the following steps: (Griaule, 2008)

Figure 6. Singular regions (white boxes) and core points (small circles) in fingerprint image (Maio et al, 2003)
Source: Maio et al, 2003

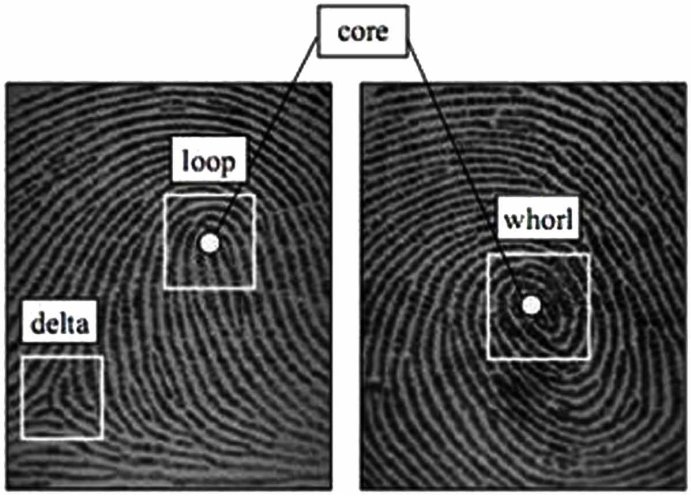
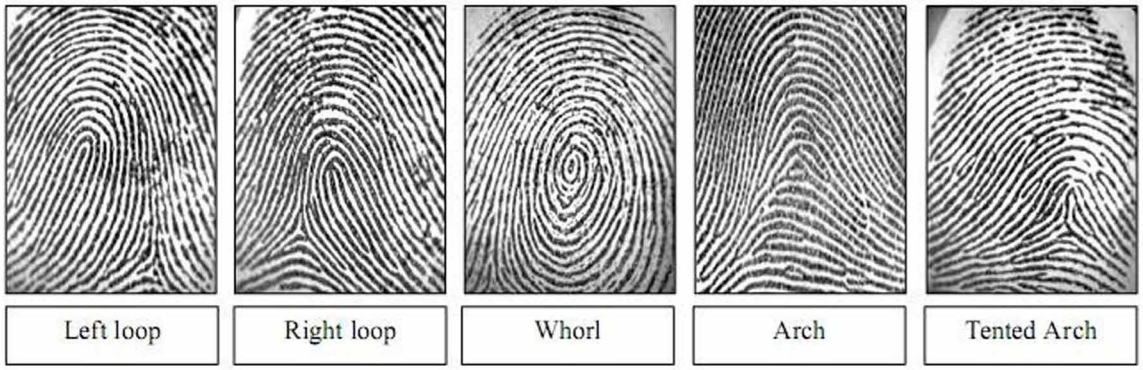


Figure 7. Classification of Fingerprint (Maio et al, 2003)
Source: Maio et al, 2003



- Binarization,
- Thinning
- Minutiae detection.

- **Binarization:** The global threshold value is used in converting the gray scale image in binary image. The intensity of the image has only two values: black, representing the ridges, and white, representing the valleys and the background.
- **Thinning:** The objective of thinning is to find the ridges of one pixel width. The process consists in performing successive erosions until a set of connected lines of unit-width is reached. This line is also called skeleton.
- **Minutiae Detection:** From the binary thinned image, the minutiae are detected by using 3x3 pattern masks. Although the process seems to be simple, it is necessary to consider the elimination of false detected minutiae.

The results of each step for minutiae extraction are shown in Figure 9.

Figure 8. Seven most common minutiae types (Jain & Ross, 2007)
Source: Jain & Ross, 2007

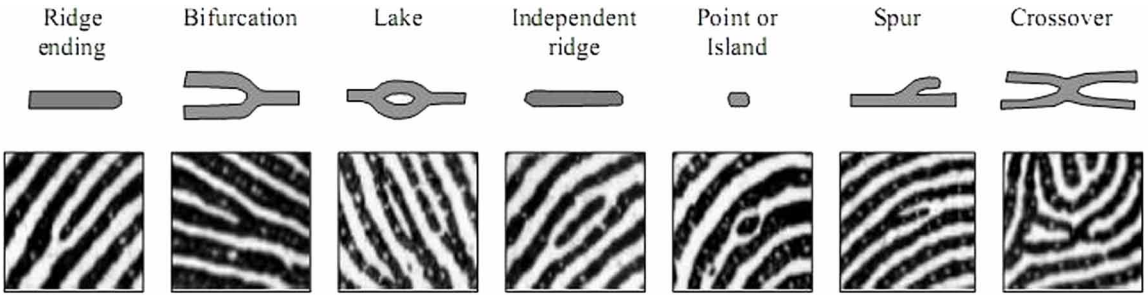
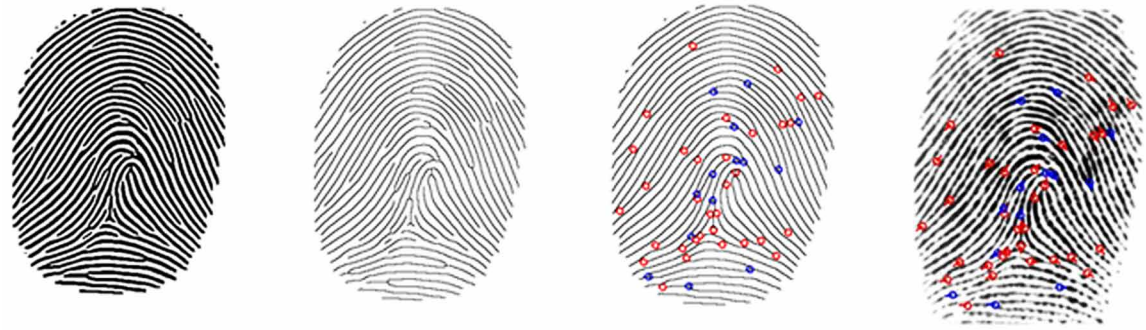


Figure 9. Minutia Extraction (Griaule, 2008)
Source: Griaule, 2008

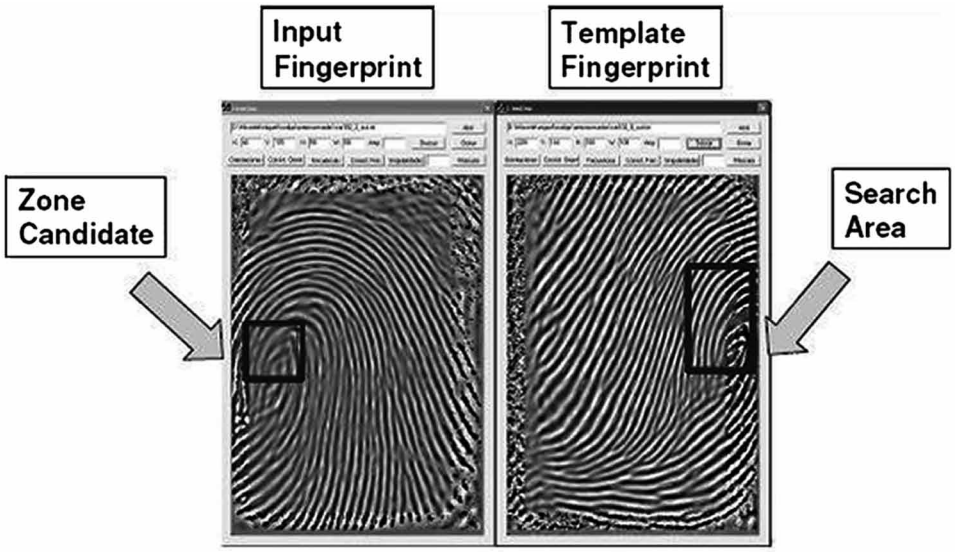


Matching

Correlation-Based Matching

In order to match two fingerprint using correlation based technique, the fingerprint are aligned and computed the correlation for each corresponding pixel, however as the displacement and rotation are unknown it is necessary to apply the correlation for all possible alignments. The singularity information may be useful in order to find an approximated alignment.

Figure 10. Correlation based Matching (Systems Lab, 2010)
Source: Systems Lab, 2010



Minutiae-Based Matching

This method tries to align the minutiae of the input image and stored templates and finds the number of matched minutiae. After alignment, two minutiae are considered in matching if the spacial distance and direction difference between them are smaller than a given tolerance. The query template (q) and reference template (r) are compared using their segments. Two segments (r,q) are considered in matching if their length (l) and angles (α,β) difference are below some threshold.

Where *tl* is the tolerance of the segments length difference and *ta* is the tolerance of the angles difference.

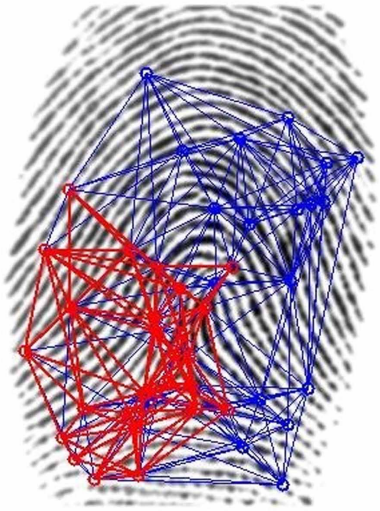
DIGITAL RIGHTS AND PROTECTION TECHNIQUES

The growth of the Internet has allowed images, audio, video and so on to become available in digital form. Though Internet is used as an additional way to distribute material to consumers it has also made it far easier for copies of copyrighted material to be made and distributed. In the past, pirating music

Figure 11. Matching Equation (Griaule, 2008)
Source: Griaule, 2008

$$\left|l_r - l_q\right| < tl$$
$$\left|\alpha_r - \alpha_q\right| < ta$$
$$\left|\beta_r - \beta_q\right| < ta$$

Figure 12. Matching Minutia (Griaule, 2008)
Source: Griaule, 2008



used to require some form of physical exchange. Using the Internet a copy stored on a computer can be shared easily with anybody regardless of distance often via a peer- to-peer network. Therefore it is harder for the copyright owner to locate and prosecute offending parties.

Today multimedia security can be achieved by a method or a set of methods used to protect the multimedia content against unauthorized access or against unauthorized distribution.

The methods are:

1. Encryption
2. Steganography and Digital Watermarking

Encryption

Encryption is the process of transforming plaintext using cipher to make it unreadable to anyone except those possessing the key. Encryption has long been used by militaries and governments to facilitate secret communication. Encryption is now used in protecting information within many kinds of civilian systems such as copyright protection. Multimedia encryption technology is used to provide end-to-end security when distributing digital content over a variety of distributions systems. (NewEncyclopedia, 2010)

Application in Multimedia Security

Digital images and textual digital media can be accomplished by means of standard symmetric key cryptography. Such media can be treated as binary sequence and the whole data can be encrypted using a cryptosystem such as Data Encryption Standard (DES). Encrypting the entire multimedia stream using standard encryption methods is often referred to as the naive approach. It involves careful analysis to determine and identify the optimal encryption method when dealing with audio and video data. It is also oriented towards exploiting the format specific properties of many standard video and audio formats in order to achieve the desired speed and enable real -time streaming. (Sharma et al, 2010)

Limitations

Even though encryption is the accepted standard, it is not foolproof. For this reason, it has not completely solved copyright infringement. Here are some of the main problems:

1. Encryption is susceptible to impersonation attacks.
2. Difficult to implement correctly and prone to weaknesses based on usage
3. Cryptanalytic attacks such as ciphertext-only attack and brute force attack can be used to eliminate the protection

Steganography

Steganography is derived from the Greek for covered writing and essentially means “to hide in plain sight”. As defined by Cachin (Cachin, 1998) steganography is the art and science of communicating in such a way that the presence of a message cannot be detected. Simple steganographic techniques have

been in use for hundreds of years, but with the increasing use of files in an electronic format new techniques for information hiding have become possible.

Types of Steganography

Steganography can be split into two types; these are Fragile and Robust (Cummins et al, 2004). The following section describes the definition of these two different types of steganography.

- **Fragile:** Fragile steganography involves embedding information into a file which is destroyed if the file is modified. This method is unsuitable for recording the copyright holder of the file since it can be so easily removed, but is useful in situations where it is important to prove that the file has not been tampered with. Fragile steganography techniques tend to be easier to implement than robust methods.
- **Robust:** Robust marking aims to embed information into a file which cannot easily be destroyed. Although no mark is truly indestructible, a system can be considered robust if the amount of changes required to remove the mark would render the file useless. Therefore the mark should be hidden in a part of the file where its removal would be easily perceived.

One of the most popular types of robust marking is Digital Watermarking.

Digital Watermarking

Digital watermarking is the process of embedding information into a digital signal in a way that is difficult to remove (Cummins et al, 2004). The signal may be audio, pictures or video. If the signal is copied, then the information is also carried in the copy. A signal may carry several different watermarks at the same time.

Limitations

Information hiding techniques still suffer from several limitations leaving them open to attack and robustness criteria vary between different techniques. Attacks can be broadly categorized although some attacks will fit into multiple categories (Cummins et al, 2004).

1. **Robustness**: Attempt to diminish or remove the presence of a unique identity
2. **Presentation**: Modify the content of the file in order to prevent the detection of the unique identity
3. **Implementation**: If the mark detection software is vulnerable it may be possible for attackers to deceive it.

MAIN FOCUS OF THE CHAPTER

In this section we shall look at recent research on Encryption, Steganography and Watermarking that could have help in mitigating the risk of copyright.

Encryption

Securing information is obviously a challenge for research worker as they are building creative and new approach to get it more safe. Over several decades, several encryption schemes are executed, each with different characteristics, pros and cons. There is a need to perform security evaluation of the schemes to analyse the research gap.

All methods may be generally classified into two types: symmetric- key cryptography and asymmetric - cryptography. The primary difference between both of these techniques is in relation to the kind of crucial decryption and encryption procedure used by them. In symmetric- cryptography, just one key is used for both decryption and encryption approach. This one crucial component is called the secret key or private key. When just one key is be used to do decryption and encryption procedure, the odds are quite high that the message may be decrypted by an unauthorised user. But this demerit will not necessitate the prevention of its usage due to the concealed efficacy inside.

In asymmetric - cryptography, two keys- private-key and still another public-key can be used for decryption and encryption procedure. This offers more safety and feasibility over symmetric - cryptography. In cases like this, public key can be used for encryption of data and private-key can be used for decryption of data. Asymmetric- cryptography is founded on sophisticated mathematical theories, where it is infeasible to locate the right private key of the receiver to decrypt the right information, even though, public-key may be available to everyone. These attacks are cost-effective when it comes to revealing the cipher text, although there are several kinds of attacks still potential with this cryptography.

RSA cryptosystem is among the asymmetric- cryptography, which centered its approach on some theories. It is strong in terms making data infeasible, inflexible, and cheap. The XOR method that is according to symmetric-key cryptographic supplies flexibility to pick distinct sequence of keys for every single round of encryption that allow to create option that is more robustness. But this does not in any way reduce its usability and profitability although, some attacks are possible with this cryptosystem.

A paper by Kulkalni (2015) proposes an efficient image encryption scheme according to a Peter De Jong disorderly map as well as an RC4 stream cipher. A Peter De Jong map is used to find out the original stream keys as well as during permutation phase. The stream generator is used to create the random figures for the diffusion procedures and the value spinning. Each encryption round is made up of three phases; permutation, pixel value rotation and diffusion. The permutation is based on scrambling the rows and columns, in addition, circular rotations of the rows and columns in alternate. By using M * N pseudo random numbers every single value circularly rotates. By scanning the picture in two manners, the final phase is carried out. In a different work proposed by Li (2015) a new picture encryption scheme is proposed base on two even-symmetric chaotic maps as well as a skew tent disorderly map. In the permutation procedure, a P-box is generated by sorting a straight-symmetric disorderly sequence is used to shuffle the locations of image pixels. In the diffusion method, equally symmetric map and skew map are employed to create the key stream. The pixels in the picture that is permuted discover which of two symmetric maps is iterated for byte in the key stream each time, therefore the key stream is carefully associated with the basic picture. Kwon, Lama, Pyun and Park (2015) suggest a sophisticated encryption of MP3 and MPEG4 coder using an excellent degradation-centered safety design. For the MP3 sound, the magnitude and phase details of changed discrete cosine transform (MDCT) coefficients is encrypted. DCT coefficients and motion vectors (MVs) are useful for the scrambling of the MPEG4 movie. This encryption scheme procures in understanding, has a degree of security, keeps format conformity, and gets better time performance by decreasing the volumes of multimedia contents. These qualities allow it

to be practical to integrate encryption and decryption procedure into de-compression and compression procedure, and therefore ideal for risk-free sharing or A/V transmission.

Kwon, Wang, Lian and Hwang (2011) suggest an enhanced partial encryption of watermarking and scrambling utilizing the magnitude advice of Modifed Discrete Cosine Transform (MDCT). In MPEG1/ Audio Layer III (MP3), the magnitude and phase details of changed discrete cosine transform (MDCT) coefficients is encrypted. The approach is aimed at safeguarding the contents after descrambled against eavesdropping and also against prohibited mass distribution, and uses both scrambling and watermarking.

Guesmi, Farah, Kaouchiri and Samet (2015) suggest a colour picture encryption scheme utilizing onetime keys according to crossover operator, chaos as well as the Secure Hash Algorithm(SHA2). The (SHA2) is used to create a 256-bit hash value from the clear-picture as well as the solution hash keys to help make the vital stream shift in every encryption procedure. The SHA2 worth is used to create three first values of the program that is chaotic. The permutation-diffusion method is dependent on cross over operator and XOR operator . Mosavi, Norouzi, Seyedzadeh and Mirzakuchaki (2015) suggest a new algorithm for image encryption on the basis of the hyper-chaotic system. To be able to create the first states of the -chaotic method, 256- bit outside secret key can be used. The algorithm contains three major sections. In the initial section, as an alternative to encrypting each pixel, columns and the rows of the picture are encrypted utilizing a row-column algorithm. To be able to achieve higher sensitivity, higher sophistication and higher-security, the next segment applies masking procedure that will be applied to every quarter of the picture which is to be encrypted, utilizing that sub-picture information itself and among the other sub-pictures as well as the typical information of other quarters of picture.

In the research dated 2015 by Verma, Singh and Kumar, a fresh encryption algorithm for protected video transmission is proposed utilizing permutation and doping perform, thus protection of the initial cipher was improved by inclusion of impurities to misguide the cryptanalyst. The synthetic neural networks are suitable for this particular goal in decryption algorithm, considering that the encryption procedure is one way perform. The ANNs have several features including learning, generalization information condition, precision, easy execution, and computer software and components availability, which can make it quite appealing for a lot of programs. Additionally demand of exchange before information exchange was removed.

A new method was proposed by Singh and Singh (2015) where the traditional means of mapping the figures to affine factors in the elliptic curve was removed. The ASCII values of the plaintext are matched up. The matched values function are used as input for the curve cryptography. This method prevents expensive operation of mapping as well as the need to talk about the typical look-up table involving the receiver and also the transmitter. The algorithm was created in this fashion that it may be used to encrypt or decrypt almost any script with defined ASCII values

Steganography and Digital Watermarking

Digital watermarking technologies is among the primary methods to recognize the protection and authentication of electronic functions in the info age, and lots of outstanding watermarking algorithms are proposed to reach distinct operations in various use. But, attackers can also use the plan fault of the algorithms to recognize their prohibited intent, including embedding authority, access without authority or removing without authority, and the security issue of watermarking system has become increasingly more serious.

Thus in the paper by Wang et al. (2015), an electronic watermarking centered copyright protection system is proposed with regard to information security in wireless sensor networks. In accordance with the special features of gathering data, the capability may be enlarged applying this approach to controlling both MSRB and LSB components of as the electronic watermarking to the info to be forwarded. The authors make use of the speed of information parsing to increase when the base station receives the information. So that one can reach and check the copyright defense on WSNs, both theoretical analysis and experimental results have shown the technique can efficiently find the data dependability.

Gopal and Powal (2015) newspaper comprises of various techniques of embedding and extracting watermarks, used in time-domain/spatial-domain and transform domain of transmission signal. Genetic Algorithm strategies can be used as the principal issue so as to ameliorate robustness of multimedia information and each the fidelity. Hallur (2015) paper describes the strong digital watermarking for grayscale picture according to algorithms discrete wavelet transform (DWT), discrete cosine transform (DCT) and singular value decomposition (SVD). The purpose of the paper will be to improve imperceptibility and robustness of the picture for approaches like cropping, rotation and compression.

Gosh, Chatterjee, Maity and Rahaman (2015) paper provides a brand new algorithm on wavelet established robust and imperceptible digital picture watermarking for multimedia protection. The algorithm was designed, executed and checked using MATLAB R2014a simulation for extraction and embedding of the watermark and the outcomes of which reveals major progress in efficiency metrics like PSNR Suggest Correlation, MSE than another algorithms in the literature that was current. The protect picture contemplated within our algorithm is of the size (256*256) as well as the binary watermark picture size is taken as (16*16).

Li, Zhang, Zhao and Wu (2015) present a strong algorithm of digital image watermarking based on discrete wavelet transform. Binary picture watermark is added by it in to grey picture as well as the host picture is needed for detecting. The algorithm have two features:

1. It is adapted to different grey pictures owing to utilizing the mean value of chosen coefficients.
2. Arnold change pre-treatment removes spatial correlation coefficient and disperses the malfunction bits among all picture elements to create watermarking more powerfully strong against cropping procedure.

Results demonstrate the algorithm that is proposed is strong and undetectable against typical image-processing and cropping procedure.

Nilchi and Taheri (2008) provides a new powerful digital image watermarking approach depending on discrete cosine transform (DCT) and neural net. The neural net is complete full counter propagation neural-network (FCNN). FCNN continues to be utilized to model the visible and perceptual features of the first picture. The characteristics of the first picture have already been utilized to find out the very best changeable threshold values of DCT coefficients. The maximum changeable threshold values are utilized to embed the watermark in DCT coefficients of the first picture. The watermark is a binary picture. The values of the picture are added as zero and one values. The execution results show this algorithm comes with an okay robustness versus different types of assaults.

Xie and Qin (2010) proposed an algorithm-based on wavelet transform of electronic image watermark. By embedding and extraction, the algorithm is developed and executed using an intuitive importance

of the image and extraction of the concealed watermark. The filtering, sound, geometry as well as other assaults on experiments is also taken into account by the algorithm. To validate the robustness of the algorithm, the writers used Normalized Cross- Correlation Coefficient to check the watermark with all the watermark likeness and utilizing Peak Signal-to-Sound Ratio to measure the variation between the watermarked picture as well as the first image. The results demonstrate the algorithm research-paper is possible, straightforward, an easy task to execute.

Massachusetts, Zang a Li (2010) present a fresh wavelet domain watermarking system, the carrier wave picture using wavelet decomposition. Following the Walsh transform low-frequency wavelet coefficients, computed by block adaptive embedding power, change the wavelet coefficients of every block, and then do singular value decomposition (SVD), duplicate on embedded watermark in the singular worth. Fractional portion of the anti-changed picture is saved, correction of the image may be correctly extracted watermark. The results show the algorithm can efficiently resist cutting, scaling, transformation and also other geometric assaults, assaults generally are also strong.

Chaudhari and Venkatachalam (2014) paper depicts a scheme to safeguard copyright of raster images using wavelet change. Third degree wavelet coefficients (LL and HH) are employed to embed and extract the watermark in the raster image. Results demonstrate the algorithm that is proposed hasn't only great foil, strongness, substantial information hiding right and ability extraction of watermark, but has powerful robustness against JPEG compression and sound. The categorization of first and watermarked information is performed and it's found the proposed watermarking scheme results in less categorization. The planned scheme satisfies each of the conditions for copyright protection of raster pictures essentially.

Zie, Hong, Zhu and Tao (2015) paper studies anti-counterfeiting techniques for printed QR barcode. The primary performance parameter, decoding rate of QR barcode as well as detection rate of digital watermark, is defined and discussed. A multi-channel robust watermarking scheme based on discrete wavelet transform (DWT) is proposed. In the watermarking scheme, the DWT domain is divided into non-overlapping rectangular areas as called watermarking channels. Channel watermark as well as anti-counterfeiting watermark is embedded into each watermarking channel. At the stage of anti-counterfeiting watermark extracting, the distortion rates of the watermarking channels are estimated by channel watermark. Based on the distortion rates, anti-counterfeiting watermark is computed by a well-designed linear estimation algorithm, whose validity is theoretically proved by analyzing anti-counterfeiting watermark bit error.

A no reference strategy according to digital watermarking is proposed by Som, Mahapatra and Senator (2015) for the authentication goal of pictures getting some malicious or non-malicious assaults. It's no reference in the meaning that it needs a reference picture nor an outside watermark. This characteristic makes the scheme desirable for scenarios where authentication of a picture should be achieved without having an entry to first picture or the reference watermark. The watermark built in the picture and is embedded as a strong signature The Discrete Wavelet Transform (DWT) can be used to split the approximation and detail areas of the picture. The watermark is built in the low frequency area and embedded to the spatial domain by changing the Least Significant Bits (LSBs) of each pixel. Upon comparing, centered on metrices like Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM), authentication is ensured. Simulations on the pictures from a well known picture database happen to be performed to present the efficiency of the planned strategy that is planned}.

Rajab, Al Khatib and Al Haj (2015) paper provides a blind digital-video watermarking approach according to a mix scheme involving the Discrete Wavelet transform in (DWT) as well as the actual Schur Decomposition. The scheme begins with using 2-degree DWT to the movie scene accompanied by by Schur decomposition where the watermark bits are embedded in the block upper triangular matrix The method reveals high efficiency as a result of usage of Schur decomposition which needs fewer computations in comparison with other transforms. The imperceptibility of the scheme can also be quite high as a result of utilization of DWT change; so, no visible distortion is seen in the movie after embedding, so, no visible distortion is seen in the movie. Moreover, the technique turns out to be sturdy against established of common strikes like: salt, Gaussian and pepper and turning and a few video assaults including: body averaging, cropping and dropping. Both ability and blindness characteristics will also be considered in this this system.

Naik, Prasad and Pal (2015) proposed to compressed picture as a protect media for embedding the key message along with the altered compressed picture elements will maintain the visual message when it is going to be re-built. Singular worth decomposition was used in cover picture for compression. Where the coefficients are not chosen in sequence arrangement so that you can improve the protection, the key concept was embedded in to compressed picture elements. So in the planned work, a clear-cut message extraction procedure won't be appropriate.

A new image steganography algorithm proposed by Li, Pan, Yan and Yang (2015) combine compressive sensing with subsampling, which can hide secret message into an innovative embedding domain. Considering that natural image tends to be compressible in a transform domain, the characteristics of compressive sensing (CS), dimensional reduction and random projection, are utilized to insert secret message into the compressive sensing transform domain of the sparse image and the measurement matrix which is generated by using a secret key is shared between sender and receiver. Then, stego-image is reconstructed approximately via Total Variation (TV) minimization algorithm. Through adopting different transform coefficients in sub-images gained by subsampling, high perceived quality of the stego-image can be guaranteed. Bit Correction Rate (BCR) between original secret message and extracted message are used to calculate the accuracy of this method.

SOLUTIONS AND RECOMMENDATIONS

Copyrighted works of authors have been receiving considerable attention in recent years. Unfortunately, techniques such as digital watermarking and encryption have not been able to provide an efficient and reliable protection against pirate users. As an alternative solution, biometrics was suggested to be used with multimedia. After going through the background study, among all the biometrics that is available, fingerprint will be used as the key to protect multimedia.

Multimedia Selection

Multimedia is a combination of different types of media. With the current tools available for implementation only one type can be considered for protection for now. In this section the three most common types are analysed: (NSBHS,2010)

1. Image
2. Audio
3. Video

- **Image:** Images are pictures, such as drawings, paintings or photographs. Images are used to provide interest and provide information. It is stored as bit maps or vector objects which may be compressed. Common formats include JPEG, GIF, PNG and BMP.
- **Audio:** Audio is sound that has been digitised. It is used to explain concepts, reinforce selections and provide special effects. It is represented by the sampling size and rate, and common file types include .wav, .mp3, MIDI and .wma.
- **Video:** Video combines pictures and sounds displayed over time. It is stored as a series of images combined with audio and often compressed. Formats include MPEG, Quicktime, avi and .wmv.

The easiest way to proceed with the implementation would have been to use images. However, a more challenging approach would be to choose audio or video. It was noted during some experiments that the video type will take an eternal long time to process. In conclusion only the audio type of file will be used in the implementation.

Designing the Solution

The design phase is set to illustrate what is going to be carried out in the implementation phase. All the functionalities identified in previous chapters are represented graphically. All the requirements are transformed into a workable solution through the use of Unified Modelling Language (UML).

Architecture

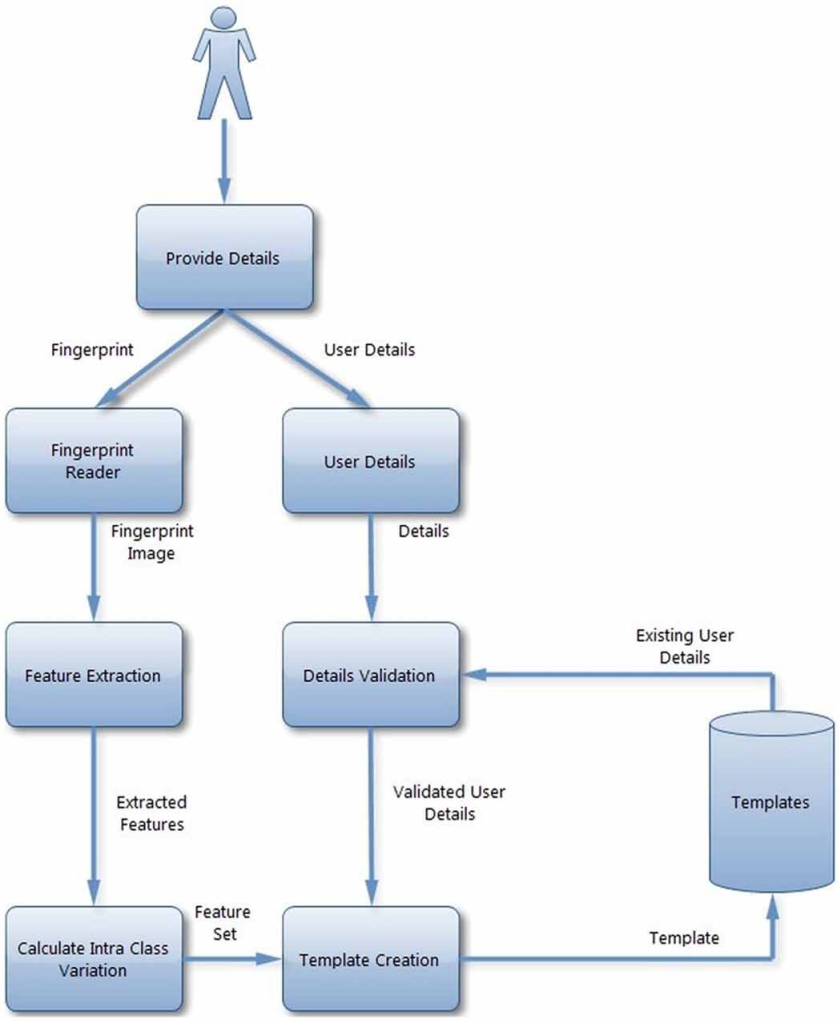
The system consists of two main sections; the enrolment section and the access section. During the enrolment process, the user is prompted to enter his username and password and the fingerprint is captured by a scanner to produce a sample. After extraction of features a template is created. To alleviate the problem of intra variation, the user is asked to re-enter the fingerprint. After validation and computation of a standard template, the template is stored in the system storage together with the demographic information about the user.

During the recognition phase, the characteristic of the subject is captured by a fingerprint reader and is converted into a sample. It is then compared against the enrolment template of that subject a match/non-match decision is produced by the verification process. Using the matching values on the fingerprint, a steganography algorithm is applied on the audio file requested by the user. The audio file is sent towards the media player.

The Workflow

The system workflow is shown in Figure 15.

Figure 13. System architecture



Implementation

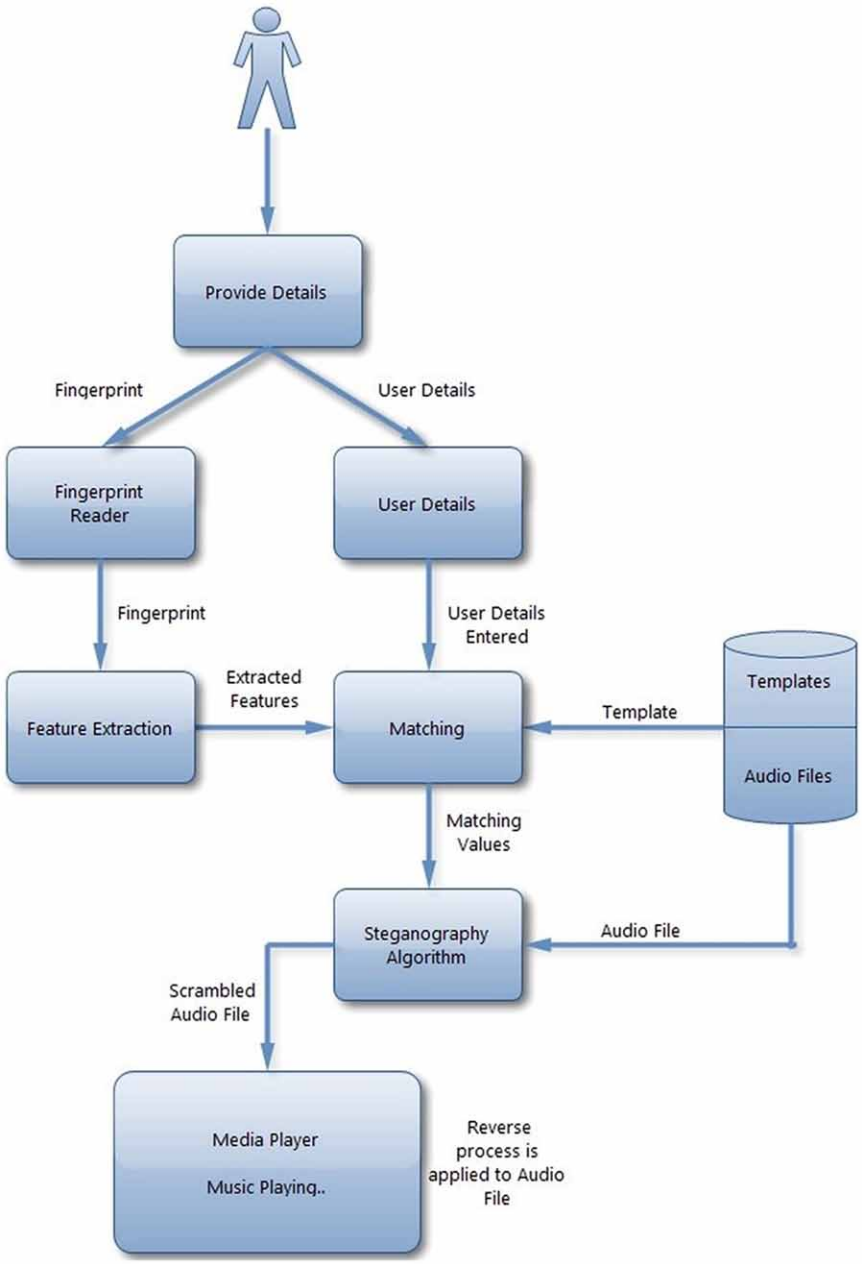
Requirement Specification

A requirement specification is a comprehensive description of the intended purpose and environment for software under development. It fully describes what the software will do and how it will be expected to perform.

It will consist of:

1. System Requirements
2. Functional Requirements
3. Non Functional Requirements
4. Domain Requirements

Figure 14. Recognition phase

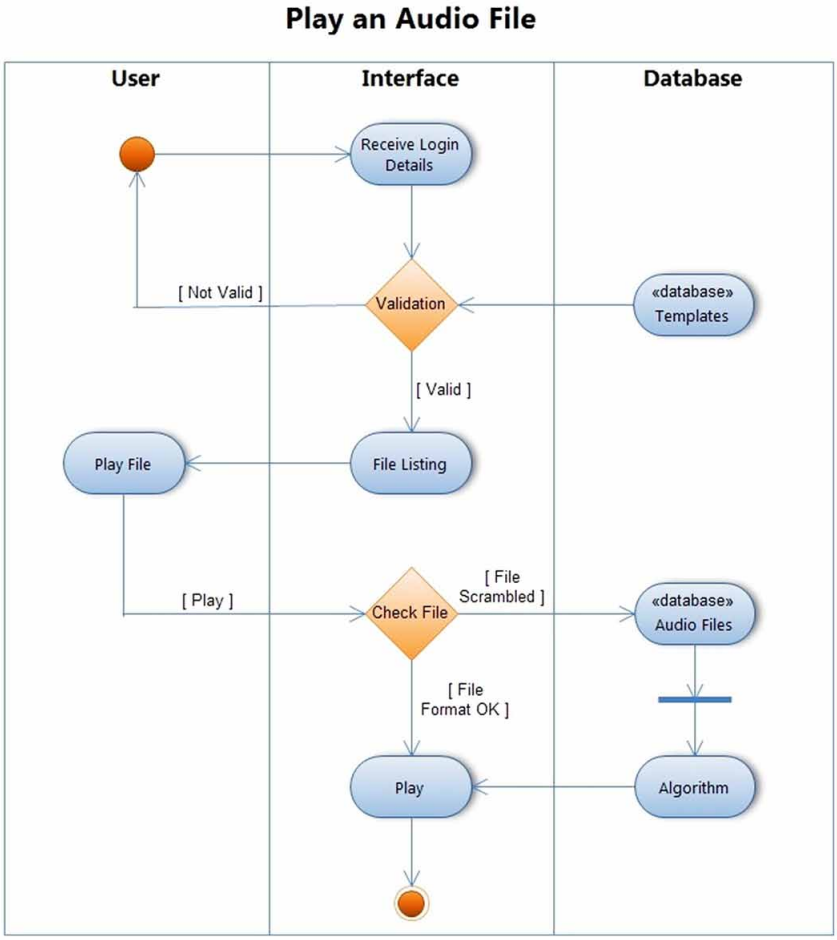


The following section each of the requirements above in details.

System Requirements

To use software efficiently, certain hardware components or other software resources need to be present on a computer. These pre-requisites are known as system requirements and are often used as a guideline as opposed to an absolute rule.

Figure 15. System workflow



Recommended Software Requirements

- Windows 7 Professional
- SUN Java with JavaFx
- MySQL
- GrFinger SDK
- Driver for Fingerprint Reader

Recommended Hardware Requirements

- 2 Gigahertz 32-bit processor
- 2 Gigabytes RAM
- 32 GB available hard disk space
- DirectX 9 graphics device
- Fingerprint Reader

Functional Requirements

A function is described as a set of inputs, the behaviour, and outputs of a system. Functional requirements define what a system is supposed to accomplish.

The Functional Requirements are:

1. The system should allow for fingerprint enrolment of new users
2. The system should be able to store the fingerprint templates of each user
3. The system should perform verification and identification of a registered user
4. The system should be able to store all the details about each user
5. The system should perform the steganography algorithm on the audio files
6. The system should store audio files for each user

Non-Functional Requirements

A non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system.

The Non-Functional Requirements are:

- The system should have a graphical user interface
- A fingerprint reader should be available to the system
- The system should provide database management facilities
- The system should provide appropriate response on different actions

Domain Requirements

Domain Requirements are derived from the application domain of the system rather than from the specific needs of the system needs.

The Domain Requirements are:

- The system shall use fingerprint biometric traits when enrolling a user
- The system shall use fingerprint biometric traits when identifying a user
- The template shall be optimised for a proper recognition process
- The audio file shall be scrambled before any transmission

The types of the requirement mentioned above are an official statement of what is required of the system developers. Therefore, it should be taken into consideration when implementing the system, otherwise the developer might go astray.

The implementation consists of many functions, but some which are regarded as most important will be used in the following sections to show how it was done.

The functions are:

1. Database Connection
2. Fingerprint Enrolment

3. Fingerprint Verification
4. Intra Class Variability
5. Fingerprint Steganography

Database Connection

The database connection allows the client software to communicate with the database. A data access object (DAO) is an object that provides an abstract interface to some type of database, providing some specific operations without exposing details of the database.

Using a data access object, the communication was established with the database. Each form on the system was assigned a data access object. Finally the following codes were used to enable permanent connection.

private static String dbURL= jdbc: mysql://localhost:3306/FingerStego"; private static Connection dbConnection; Class.forName("com.mysql.jdbc.Driver").newInstance();
dbConnection = DriverManager.getConnection(dbURL,"root","root");

Fingerprint Enrollment

This function will allow a user to enrol his/her fingerprint upon signing up in the system (media player). The fingerprint enrolment works as follows:

1. Image Acquisition
   a. Stores the captured Fingerprint Image
   b. Call for Fingerprint Extraction
   c. Display Fingerprint Image
      onImageAcquired(String idSensor, FingerprintImage fingerprint)
      this.fingerprint=fingerprint;
      showImage(fingerprint)
2. Extract Minutia
   a. Extracts a template from the current fingerprint image.
   b. Identify Quality
   c. Display Fingerprint Image with Minutia
      template = fingerprintSDK.extract(fingerprint);
      switch (template.getQuality()){
      case Template.HIGH_QUALITY: break;
      case Template.MEDIUM_QUALITY: break;
      case Template.LOW_QUALITY: break; }
      showImage(GrFingerJava.getBiometricImage(template,fingerprint));
3. Template Identification
   a. Starts identification process by supplying query template.
   b. Gets enrolled templates from database.
   c. Iterate over all templates in database
   d. Reads the current template data on a buffer

e. Creates a new Template
f. Compares current template.
fingerprintSDK.prepareForIdentification(this.template); ResultSet rs = identifyStmt.execute-Query();
byte[] templateBuffer = rs.getBytes("template");
Template referenceTemplate = new Template(templateBuffer);
boolean matched = fingerprintSDK.identify(referenceTemplate);

4. Template Enrolment
   a. Get array of data from template
   b. Convert data to bytes if input stream
   c. Insert into database
   enrollStmt.setBinaryStream(1,new ByteArrayInputStream(template.getData()), template.getData().length);
   enrollStmt.executeUpdate();

Fingerprint Verification

This function will allow a user to verify his/her fingerprint upon signing in the system (media player). The fingerprint enrolment works as follows:

The Image Acquisition and Extract Minutiae process is the same procedure as shown in the Fingerprint Enrolment section. As these two processes, the template verification is triggered up.

Template Verification

- Gets the template with entered id from database.
- Reads the template data from the database
- Creates a new Template
- Compares the templates.
- Show Image if Matched

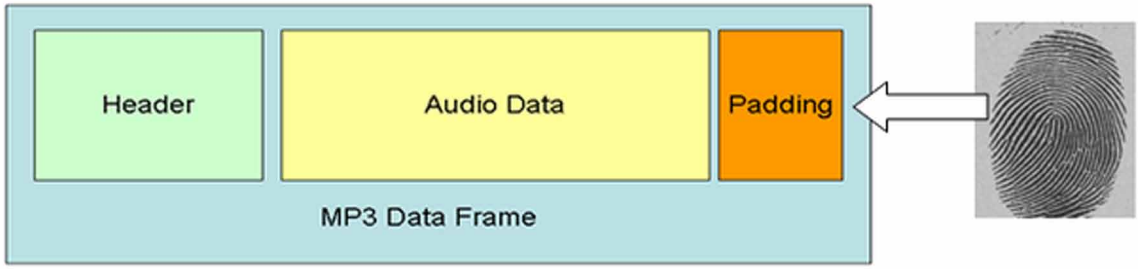
```
ResultSet rs = verifyStmt.executeQuery();
byte templateBuffer[] = rs.getBytes("template");
Template referenceTemplate = new Template(templateBuffer);
boolean matched = fingerprintSDK.verify(template,referenceTemplate);
showImage(GrFingerJava.getBiometricImage(template, fingerprint, fingerprintSDK));
```

Fingerprint Steganography

Some mp3 audio frames are padded with an "empty" byte to even out the frame rate. On average mp3 files tend to have hundreds of frames which need to be padded. Since the padding bytes do not carry any audio information they are a good target for data stuffing.

Padding byte stuffing is an attractive method because it is relatively straightforward to implement and has good average storage capacity. It is possible to encode information at 1 byte per frame as long as padding bytes are available. There be should enough padding bytes to contain a template.

Figure 16. Padding byte stuffing

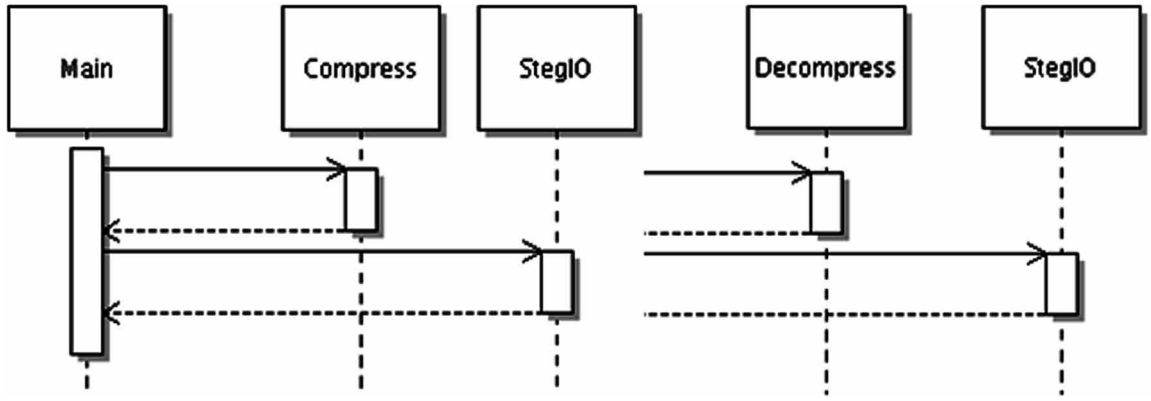


StegIO has a dual role of reading and writing data into the file. The Main class calls either the Compress or Decompress to do the lzw compression, and then calls the StegIO class to do actual embedding. This is a very simple, and yet powerful design.

The StegIO class uses a fairly straightforward algorithm to find padding bytes. The procedure used to accomplish this can be expressed in the pseudo code below:

```
calculate the length of the message in bytes prepend the length to the message
put the message on a byte queue while(there are still bytes to be written) {
Header = read 4 bytes from the file
if(Header is_valid && contains padding byte) {
seek to the end of frame
pop the byte from the queue
write the popped byte into file } }
To read back the data, and reverse the process see the pseudo code below:
length = integer > 4 counter = 0
while (counter < length)
{ Header = read 4 bytes from the file
if(Header is_valid && contains padding byte)
```

Figure 17. StegIO process flow



```
{ if(counter == 4)
{ length = to_integer (pop 4 bytes from queue) }
seek to the end of frame read a byte from the file
push the read byte onto queue }
}
}
```

Results

When a user will first run the media player, he/she will have to register in order to make full use of the player. At first the user will be prompted to enter his/her details and will then proceed to the fingerprint enrolment.

The clear option will erase all content of the fields and the cancel will close and abort the signing up process. Any error message will be displayed in red on the top just below the title.

The error controls are the same as discussed in the previous sections.

Once the user filled in the required fields and click on Submit, he/she will be prompted to enter her fingerprint twice.

Steganography

When the user will add an audio file to his/her playlist, the current file will be scrambled and placed in the music folder of the user. The only way to play the file is to login into the media player and select the file to play.

Figure 18. Signup form

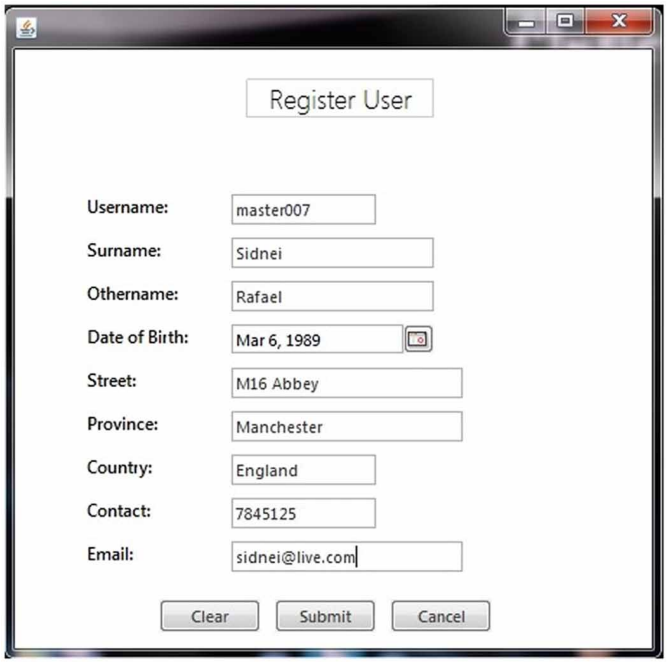


Figure 19. Fingerprint registration

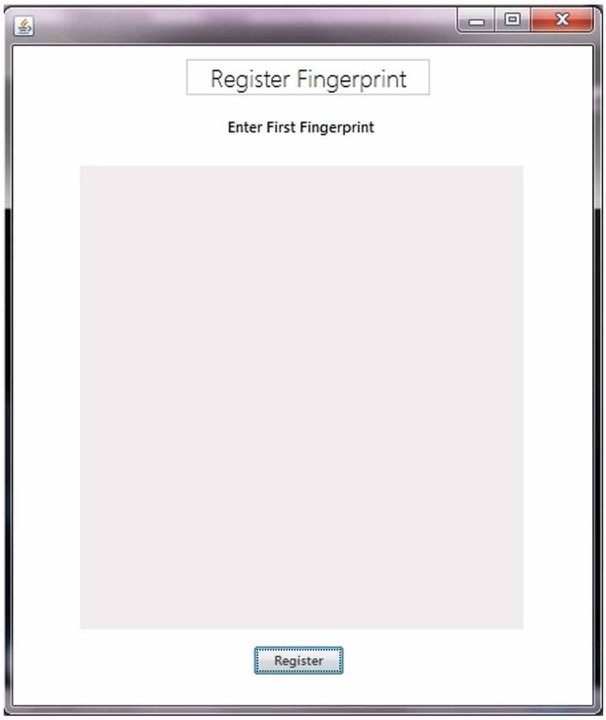
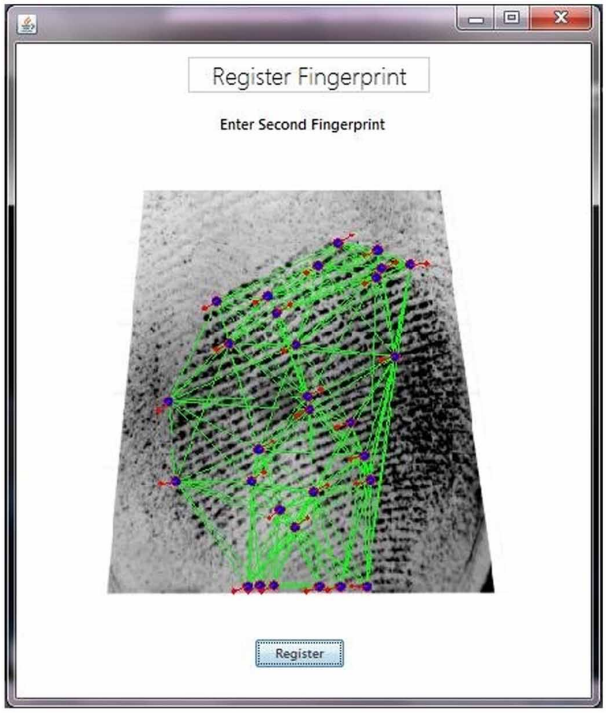


Figure 20. Fingerprint enrollment



If a user tries to open the file with other players around, an error message will pop out indicating a file error.

FUTURE RESEARCH DIRECTIONS

In this section some suggestions are made of how the system would have been developed without current time and resource constraints.

- The steganography algorithm can be extended to work for any type of audio files
- The steganography can be used to apply to any type of media.
- Visualization and graphic equalizer can be used to enhance the media player.
- The media player can be built with features like reshuffling, repeat and multiple playlist creation.
- Using a very powerful server, the system can be deployed online. No change in coding will be needed since JavaFx can be compiled to run on web.
- Together with online system, the issue of distributed system and networking can be catered
- Security measures for protecting the templates on the server can be addressed.

CONCLUSION

Digital watermarking is among the crucial technologies that may be found in Electronic Rights management techniques for avoiding prohibited replication, tracking use, ensuring approved entry, creating possession rights, and easing content authentication. There are two kinds

Of electronic watermarking methods they can be invisible and visible watermarking identified Steganogtaphy techniques that are identified. It gives authentication for possessors. By using this methods that were watermaking the information might be protected and saved users that were unauthorized.

Figure 21. Error reading file directly

In this paper we supply essence of utilizing finger print and Steganography for security. Identification according to biometric fingerprint scan removes the requirement to recall a password or carry a token which additionally eliminates theft of fobs or cards and so continuous replacements. As people are easily taken out of the machine at no additional price biometric choices can also be more affordable. The organisation must issue a card that is new to all beginners whereas in card-based methods.

Everybody has a special, finger-print that is unchanging. A finger print consists of some ridges and furrows on the area of the finger and all these are utilized to look for the singularity of the finger print. After enrolled on the finger-print scanner, the picture of the designs is converted by way of a sequence called an algorithm which efficiently becomes a kind of you right into a code. That is saved on a data base for comparing which allows accessibility and authentication during the guaranteed door.

Using fingerprints for recognition and identification is the earliest usage of biometrics. Now, notebook computers and USB pen-drives are available with finger-print visitors. However, you will find lots of reasons why the employment of finger prints is the most frequent type of biometric protection. Primarily, fingerprinting will stay an honest kind of protection whilst you get older. facial-recognition in certain can-not beat attribute changes, whereas through employing a biometric finger-print scanner, the finger print will endure the test of time facial-recognition in certain can-not and Iris beat attribute changes. Additionally, you will not have to alter anything in regards to the looks of your finger prints. In case you have hair obstructing specific points of the encounter for instance you'll need to get rid of the eyeglasses or wear eyeglasses or pull-back your hair whenever you present that person for scan.

In large government organizations and corporations, biometrics plays a huge role in employee identification and security. Additionally some data centers have jumped on the bandwagon and have implemented biometric scanners to enhances remote access and management by adding another layer of network security for system administrators. Unfortunately the cost of implementing fingerprint and other biometric security scanning in data centers is still quite expensive, and many centers still rely on ID badges while waiting until biometric technology becomes a little more pocket-book friendly.

Today companies have realized that fingerprint scanning is an effective means of security. While the cost of implementing biometric scanners in larger organizations and data centers is still quite costly, we did find several fingerprint scanning devices which would fit into the budget of many small offices and home users. These home and small office products are designed to protect your hard drive, notebook or even to remove the need for users to remember multiple passwords.

Table 2. Security analysis

	Replay-attack	Input Tampering	Session Error	Sensitive Data Exposure
Password	1%	0%	0%	0%
Cryptosystems Based System	89%	93%	71%	99%
Multi-factor authentication	92%	91%	88%	99%
Secure Biometric Fuzzy Vault Using Personal Image Identification	90%	89%	85%	99%
Blind Authentication	82%	89%	78%	99%
Sparse Watermarking Techniques for Multibiometric System	91%	92%	88%	97%
Biometrics and Steganography	92%	91%	92%	99%

We tested the implementation with certain scripts and open source software for the implementation vulnerability. The result below shows at which rate the threats are secured. The figures have been obtained by a global average of the number of attacks at application and network level.

Accordingly we found that the proposed arrangement fulfills the security and copyright issue of multimedia. However no matter how good the new system can be, it does suffers in terms of usability.

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APPENDIX

Table 3. History of fingerprint

Year	Description
~1000-2000 B.C.	Fingerprints were used on clay tablets for business transactions in ancient Babylon.
3rd Century B.C.	Thumbprints begin to be used on clay seals in China to "sign" documents.
610-907 A.D.	During the T'ang Dynast, fingerprints are reportedly used on official documents.
1st Century A.D.	A petroglyph located on a cliff face in Nova Scotia depicts a hand with exaggerated ridges and finger whorls, presumably left by the Mi'kmaq people.
14th Century A.D.	Many official government documents in Persia have fingerprint impressions. One government physician makes the observation that no two fingerprints were an exact match.
1686	Marcello Malpighi notes the common characteristics of spirals, loops and ridges in fingerprints
1858	The Chief Magistrate of the Hooghly district in Jungipoor, India, Sir William Herschel, first used fingerprints to "sign" contracts with native Indians.
1880	Dr. Henry Faulds was credited with the first fingerprint identification
1888	Sir Francis Galton became the first to provide scientific evidence that no two fingerprints are exactly the same, and that prints remain the same throughout a person's lifetime

Chapter 45
Video Authentication: An Intelligent Approach

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ABSTRACT

With the growing innovations and emerging developments in sophisticated video editing technology, it is becoming highly desirable to assure the credibility and integrity of video information. Today digital videos are also increasingly transmitted over non-secure channels such as the Internet. Therefore, in surveillance, medical, and various other fields, video contents must be protected against attempts to manipulate them. Video authentication has gained much attention in recent years. However, many existing authentication techniques have their own advantages and obvious drawbacks. The authors propose a novel authentication technique that uses an intelligent approach for video authentication. This chapter presents an intelligent video authentication algorithm for raw videos using a support vector machine, which is a non-linear classifier, and its applications. It covers both kinds of tampering attacks, spatial and temporal. It uses a database of more than 2000 tampered and non-tampered videos and gives excellent results with 98.38% classification accuracy. The authors also discuss a vast diversity of tampering attacks, which can be possible for video sequences. Their algorithm gives good results for almost all kinds of tampering attacks.

INTRODUCTION

With the rapid development and innovation in digital information technologies, video applications are infiltrating into our daily lives at breakneck speed, from traditional television broadcasting to Internet/Intranet, wireless communication and consumer products such as VCD/DVDs and smart phones. Though this immense development in digital information technology has brought us in the new era of powerful

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information, we are having some severe challenging issues related with the information. One of them is credibility of the information. Today, editing or modifying the content of a digital video can be done efficiently and seamlessly, and the credibility of the digital data decreases significantly (Friedman, 1993). To ensure the trustworthiness, authentication techniques (Lin & Chang, 2001; Naor & Pinkas, 1997; Perrig, Canetti, Tygar, & Song, 2000) are needed for verifying the originality of video content and preventing the forgery. Building a mechanism that enables media authenticity verification, is basically needed in court of law where digital media might be used as evidence against potential criminals. A possible scenario that justifies the need of such a mechanism is a case where a defendant claims that an incriminated media was fabricated.

So the video authentication is a process which ascertains that the content in a given video is authentic and exactly same as when captured. For verifying the originality of received video content, and to detect malicious tampering and preventing various types of forgeries, performed on video data, video authentication techniques are used.

These techniques also detect the types and locations of malicious tampering. In fact a wide range of powerful digital video processing tools are available in the market that allow extensive access, manipulations and reuse of visual materials (Hauzia & Noumeir, 2007). Since different video recording devices and close circuit television camera system become more convenient and affordable option in the private and public sectors, there is a corresponding increase in the frequency in which they are encountered in criminal investigations[1]. The video evidences have significant role in criminal investigations due to their ability to obtain detailed information from their own. And they have tremendous potential to assist in investigations. Therefore, it would be necessary to take utmost care to make sure that the given video evidence, presented in the court, is authentic.

MOTIVATION BEHIND VIDEO AUTHENTICATION

In some applications the authenticity of the video data is of paramount interest such as in video surveillance, forensic investigations, law enforcement and content ownership (Upadhyay, Singh, Vatsa, & Singh, 2007). For example, in court of law, it is important to establish the trustworthiness of any video that is used as evidence. As in another scenario, for example, suppose a stationary video recorder for surveillance purpose, is positioned on the pillar of a railway platform to survey every activity on that platform along a side. It would be fairly simple to remove a certain activity, people or even an event by simply removing a handful of frames from this type of video sequences. On the other hand it would also be feasible to insert, into this video, certain objects and people, taken from different cameras and in different time. A video clip can be doctored in a specific way to defame an individual. In the recent years, several cases have been reported where the eminent personalities of the society were caught in illegal activities in the video recordings made by so called journalists. However in the absence of foolproof techniques to authenticate the video it is difficult to trust on such reports. On the other hand criminals get free from being punished because the video (used as evidence), showing their crime cannot be proved conclusively in the court of law. In the case of surveillance systems, it is difficult to assure that the digital video produced as evidence, is the same as it was actually shot by camera. In another scenario, a news maker cannot prove that the video played by a news channel is trustworthy; while a video viewer who receives the video through a communication channel cannot ensure that video being viewed is really

the one that was transmitted (Pradeep, et. al., n.d.). In the scenario of sensitive cases where a video is produced as a witness in the court of law, even a small modification may not be acceptable. However there are some scenarios where editing also may be allowed while keeping intact the authenticity of the video. For example after shooting the video, a journalist may need to perform some editing before broadcasting it on a news channel. In such a case a video authentication system should be able to allow editing on the video up to a certain level ensuring the authenticity of the video (Pradeep, Atrey, El Saddik, & Kankanhalli, 2009). Now a day an ordinary person can easily make unauthorized copies of digital video data and manipulate them in such a way that may lead to severe financial and social losses. These are the instances where malicious modifications cannot be tolerated. Therefore, there is a compelling need for video authentication. Although traditional data authentication technology for message integrity was mature, video authentication is still in its early development stage and many fundamental questions remain open (Han & Chu, 2010). For example, for a number of different authentication algorithm developed over the past few years, it is difficult to affirm which approach seems most suitable for ensuring the integrity adapted to videos (Han & Chu, 2010). For verifying the credibility of received video content, and to detect malicious tampering attacks and preventing various types of forgeries, performed on video data, video authentication techniques are used.

CHALLENGING SCENARIOS FOR VIDEO AUTHENTICATION

In some of the surveillance systems storage and transmission costs are the important issues. In order to reduce the storage and transmission cost only those video clips, containing objects of interest, are required to be sent and stored. Moreover in most of the surveillance applications background object changes very slowly in comparison to foreground objects. A possible efficient solution in these scenarios is that only the objects of interest (mostly foreground objects) are sent out frame by frame in real time while the background object is sent once in a long time interval. In such surveillance applications, it becomes very important to protect the authenticity of the video: the authenticity against malicious alterations and the authenticity for the identity of the transmission source (i.e. identify the video source).

In event based surveillance systems, the video sequences are captured when there is any kind of change in the scene (existence of an event) which would be captured by the camera. If there is uniformity in the scene in such a way that there is not any change in the scene then the surveillance camera does not capture any video sequence. This kind of surveillance system is used in military system for border security purpose. Authenticity for this kind of video sequences is a challenging issue because there is no proper time sequence in video sequences which are captured by surveillance camera.

In another scenario where a surveillance camera is recording the postmortem activity of a human body in postmortem house, any kind of disturbance in recording (due to electricity problem or some other hardware problem) would be resulted in frame dropping. This would be a severe issue since some important activities may have happened during frame dropping and these activities may be missed to be recorded by surveillance camera. Authentication of this kind of video sequence is also a very challenging task because we are not in the condition of detecting all the positions where and how many frames have been dropped.

In addition of these scenarios, there are some challenging conditions for video authentication. To assure the authenticity of the videos, captured in the following situations, would be fairly difficult.

- The videos recorded in the foggy and rainy weather condition
- The videos recorded in the hazardous condition.
- The videos recorded in a condition where the camera or the objects (recorded by the camera) or both are moving very rapidly.
- The videos recorded in the night vision mode.

These all are the different scenarios which poses considerable challenges for the authentication purpose.

VIDEO TAMPERING

A continuous video data $V_c(x, y, t)$ is a scalar real valued function of two spatial dimensions x and y and time t, usually observed in a rectangular spatial window W over some time interval T. If $M(x, y, t)$ is modification vector then the tampered video $B_c(x, y, t)$ would also be a scalar real valued function of spatial dimensions x and y and time t as follows:

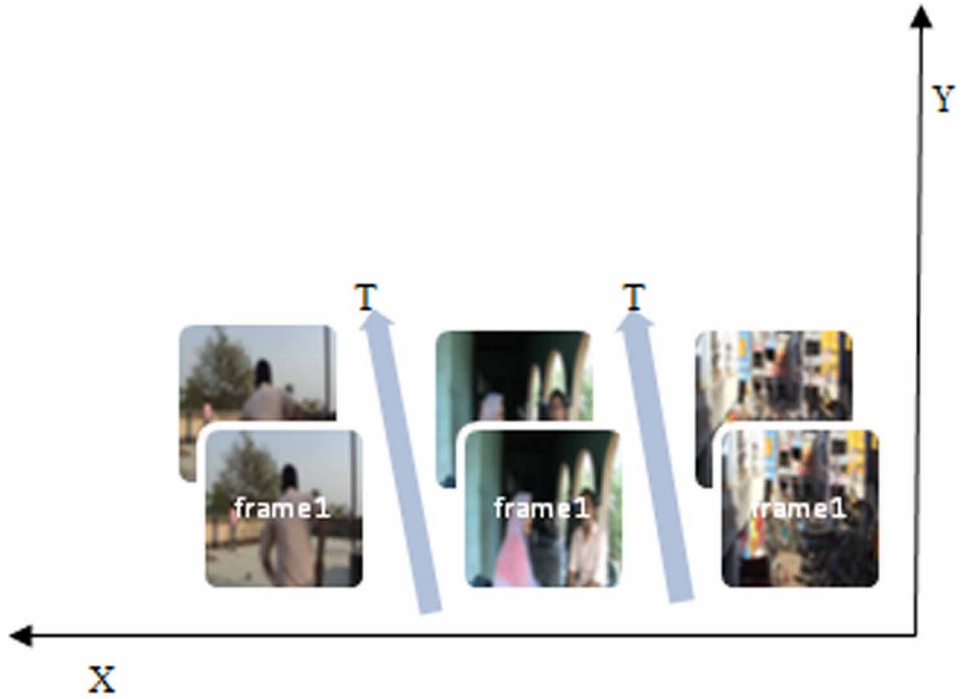
$$B_c(x, y, t) = M(x, y, t) + V_c(x, y, t)$$

When the content of information, being produced by a given video data is maliciously altered, then it is called tampering of video data. It can be done for several purposes, for instance to manipulate the integrity of an individual or to deceive any one by producing fake information through tampered video. Since a wide range of sophisticated and low cost video editing software are available in the market that makes it easy and less expensive to manipulate the video content information maliciously, it poses serious challenges to researchers to be solved.

VIDEO TAMPERING ATTACKS

There are several possible attacks that can be applied to modify the contents of a video data. Formally a wide range of authentication techniques have been proposed in the literature but most of them have been primarily focused on still images. However the basic task of video authentication system is to prove whether the given video is tampered or not but in several applications, due to large availability of information in video data, it may be more significant if the authentication system can tell where the modifications happened (It indicates the locality property of authentication) and how the video is tampered (Yin et al., n.d.). On considering these where and how, the video tampering attacks can have different classifications. A lot of works have been done that briefly address the classification based on where (Upadhyay, Singh, Vatsa, & Singh, 2007; Yin et al., n.d.). And some papers address the classification based on how (Dittman et al., 2000). In general finding where the video data is altered is more efficient than to find out how the how data is tampered. When a video is being recorded by a video recording device, it captures the scene which is in front of the camera lens, frame by frame, with respect to time. Number of frames being captured by video recording device in a second, depends on the hardware specification of the device. Thus a video can be viewed as a collection of consecutive frames with temporal dependency, in a three-dimensional plane, as shown in Figure 1.

Figure 1. Three-dimensional view of video information



It refers to the regional property of the video sequences. When a malicious modification is performed on a video, it either attacks on the contents of the video (i.e. visual information presented by the frames of the video), or attacks on the temporal dependency between the frames of the video. Therefore based on the regional property of the video sequences, we can broadly classify the video tampering attacks into three categories: spatial tampering attacks, temporal tampering attacks and the combination of these two, spatio-temporal tampering attacks (Yin et al., n.d.). They can be further classified into their subcategories.

Spatial Tampering

In spatial tampering malicious alterations are performed on the content of the frames (X-Y axis). The operations which are performed as a tampering attack in spatial tampering are cropping and replacement, morphing, content (object) adding and removing, in the frames of the video, etc. (Yin et al., n.d.). These attacks can be efficiently performed with the help of any professional video editing software for example Photoshop, etc.

Temporal Tampering

In temporal tampering malicious manipulation is performed on the sequence of the video frames. The focus is on the temporal dependency of the video. Temporal tampering attacks are mainly affecting the time sequence of visual information, captured by video recording devices. The common attacks in temporal tampering are frame addition, frame removal and frame reordering or shuffling in the video.

Spatio-Temporal Tampering

Spatio-temporal tampering attacks are the combination of the both kinds of tampering attacks: spatial and temporal tampering attacks. Frame sequences are altered and also visual contents of the frames are modified in the same video. The authentication system should be able to identify both kinds of tampering attacks.

All these tampering are further classified into their subcategories. Spatial tampering can be in effect either at block level or at pixel level. In both the cases the objects of the frames of the video are altered.

Further the objects of the frames are classified into two categories: Foreground objects and Background objects. The foreground objects are those which are captured as individual elements, excluding the background, in a frame. And the background object is the background part of the frame excluding all of the foreground objects. The different pieces of visual information shown in the frames of the video are altered in spatial tampering. Basically the contents of the video frames are treated as objects. Based on these objects and their classification the spatial tampering can be further classified as shown in Figure 2.

OBJECT REMOVAL ATTACK

In object removal attack of the spatial tampering, the objects of the frames of the video are eliminated. This kind of tampering attack is commonly performed where a particular person wants to hide his/her presence in a certain sequence of frames. With this kind of attack he /she may disappear in a specific time domain, recorded in the video, and with the help of this, he/she can easily prove his/her absence in any event which has been recorded by video recording device, as shown in Figure 3.

OBJECT ADDITION ATTACK

An object or set of object is inserted in a frame or in a set of frames of the video in object addition attack of spatial tampering. In any video, which can be treated as evidence, an additional object can be

Figure 2. An explicit classification of spatial tampering attacks in reference of objects of the frames

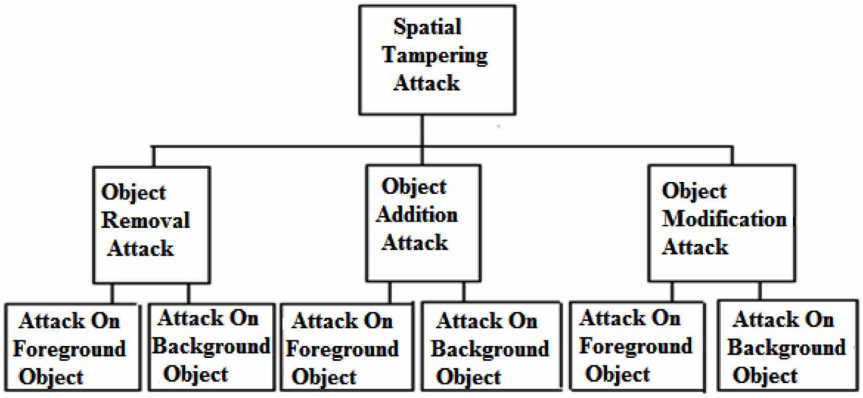


Figure 3. Example of object removal attack: (a) shows object removal attack with foreground object, where a small device is removed from the original frame in tampered frame, whereas (b) shows the object removal attack with background object

Original Frame

Tampered Frame

Figure 3 (a)

Original Frame

Tampered Frame

Figure 3 (b)

pasted in a frame or set of frames, with the help of sophisticated video editing software to mislead the investigation agencies as well as court of law. With the help of this kind of attack, one can prove his/her presence in any event of the pre-recorded video, as shown in Figure 4.

OBJECT MODIFICATION ATTACK

In Object modification attack of the spatial tampering, an existing object of the frame(s) can be modified in such a way that the original identity of that object is lost, and a new object may be in appearance which is completely different from the original object. The object modification attacks can be existed in many prospects of the given video. For instance, the size and shape of any existing object may be changed, the color of the object may be changed or it may be discolored, and with the help of additional effect the nature of the object and it's relation with other objects also may be changed. It depends upon the intention. In fact it is very hard to detect and locate this kind of attack of spatial tampering for authentication systems, since these attacks are performed at pixel level. The authentication systems should also be robust enough to differentiate this kind of attack with the normal video processing operations. Figure 5 shows a typical example of object modification attack where the face of a person has been changed in such a way that the person's face, which is introduced in the altered frame, is completely different from the face of the person in original frame.

Besides spatial tampering, temporal tampering attacks have also sub classifications. Temporal tampering attacks are specific to video applications and can be performed at scene level, shot level and frame level, but the primary focus is on attacking the temporal dependency of the frames of the video. This kind of tampering attack basically affects the sequencing of video frames. We call it 'Third dimensional

Figure 4. Example of object addition attack: in original frame (a) two persons are there as major foreground objects, while in tampered frame (a) an additional person as a foreground object is added. In tampered frame (b), not only a foreground object is added but also an additional wall as a background object in the middle of the frame is added

Original Frame

Tampered Frame

Figure 4 (a)

Original Frame

Tampered Frame

Figure 4(b)

Figure 5. Example of object modification attack: the face of the person in original frame is modified in tampered frame in such a way that the new face of the person cannot be identified as the same as in original frame

Original Frame

Tampered Frame

(dimension with respect to time) attack' on the video sequences. Therefore based on this third dimensional attack we can classify the temporal tampering attacks into following subcategories.

FRAME ADDITION ATTACK

In frame addition attack of temporal tampering, additional frames from another video, which has the same statistical (height and width of frames) and dimensional (number of frames per second) properties, are

intentionally inserted at some random locations in a given video. This attack is intended to camouflage the actual content and provide incorrect information (Upadhyay, Singh, Vatsa, & Singh, 2007). A typical example of the frame addition attack is shown in Figure 6.

FRAME REMOVAL ATTACK

In frame removal attack of temporal tampering, the frames of the given video are intentionally eliminated. In this kind of tampering attack frames or set of frames can be removed from a specific location to a fixed location or can be removed from different locations. It depends upon the intention. Commonly this kind of tampering attack is performed on surveillance video where an intruder wants to remove his/her presence at all. Figure 7 shows a typical example of frame removal attack.

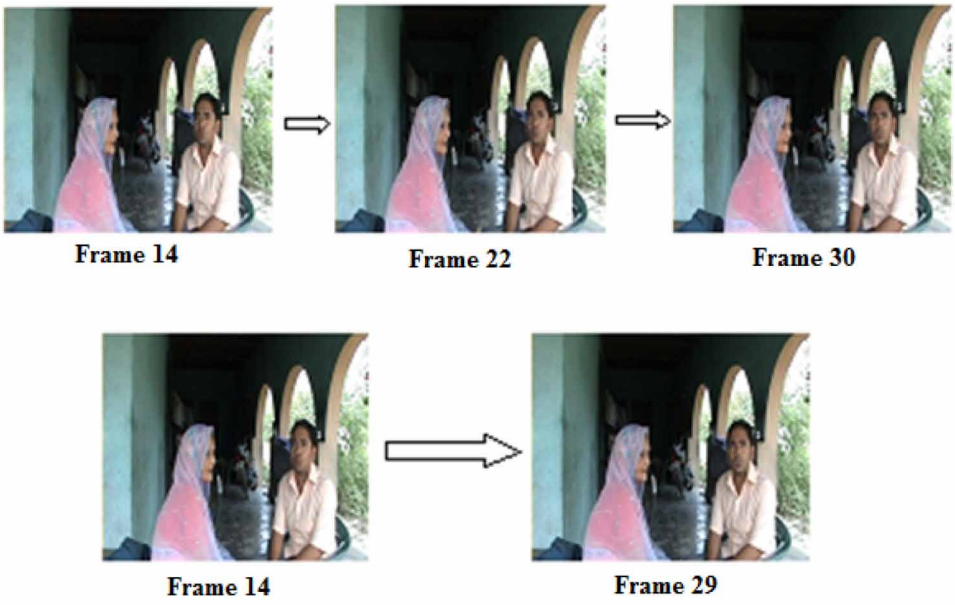
FRAME SHUFFLING ATTACK

In frame shuffling attack of temporal tampering, frames of a given video are shuffled or reordered in such a way that the correct frame sequence is intermingled and wrong information is produced by the video as compared to original recorded video. Figure 8 shows a typical example of frame shuffling attack where two frames are shuffled.

In addition to these types of tampering attacks, tampering can be done at different levels in video sequences.

Figure 6. Example of frame addition attack: in first row the original frame sequence from frame 6 to frame 16 has been shown. After attack, the second row of the frames shows the altered frame sequence in which a new frame is inserted between frame 6 and frame 16.

Figure 7. Example of frame removal attack: the first row of this figure shows the original frame sequence with frame 14, frame 22, and frame 30. In second row of the frame sequence, which shows the tampered frame sequence with frame removal attack, frame 22 is eliminated from the video and hence frame 30 becomes frame 29.



Scene Level

When the tampering attacks are performed at scene level then a whole scene of the video sequence is manipulated in such a way that, not even the scene itself is modified but also in reference to the given video the scene of that video is modified. It means spatial and temporal both kinds of tampering can be done at scene level.

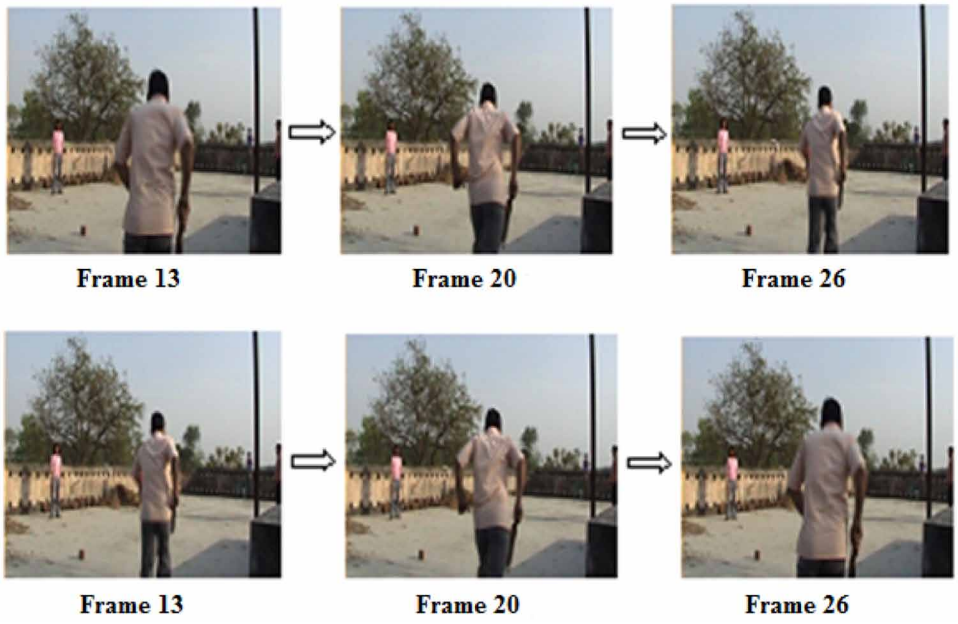
Shot Level

In shot level tampering a particular shot of the given video is modified in reference to the given video. In shot level tampering a shot can be added or removed from the video. It can also be performed with all kinds of tampering attacks.

Frame Level

When frames of the given video are maliciously modified, then it is called tampering at frame level. Frame removal, frame inserting and frame shuffling are the common tampering attacks that can be performed at frame level. In other words, temporal tampering attacks are commonly performed at frame level.

Figure 8. Example of frame shuffling attack: the first row of this figure shows the original frame sequence with frame 13, frame 20, and frame 26. After the frame shuffling attack, the original frame sequence is tampered as shown in second row of the figure where the positions of frame 13 and frame 26 have been changed.



Block Level

In block level tampering, tampering attacks are performed on the blocks of the video frames. The content of the video frames are treated as blocks on which the tampering attacks are applied. Blocks (a specified area on the frame of the video) can be cropped and replaced, morphed or modified in any way in block level tampering. Spatial tampering attacks are commonly performed at block level.

Pixel Level

In pixel level tampering contents of the video frames are modified at pixel level. This is the smallest level in video sequences at which tampering attacks can be performed. The video authentication system should be robust enough to differentiate the normal video processing operation and pixel level tampering, since many normal video processing operations are performed at pixel level. Spatial tampering attacks are commonly performed at pixel level.

All these levels of tampering show the different aspects of tampering.

AUTHENTICATION TECHNIQUES

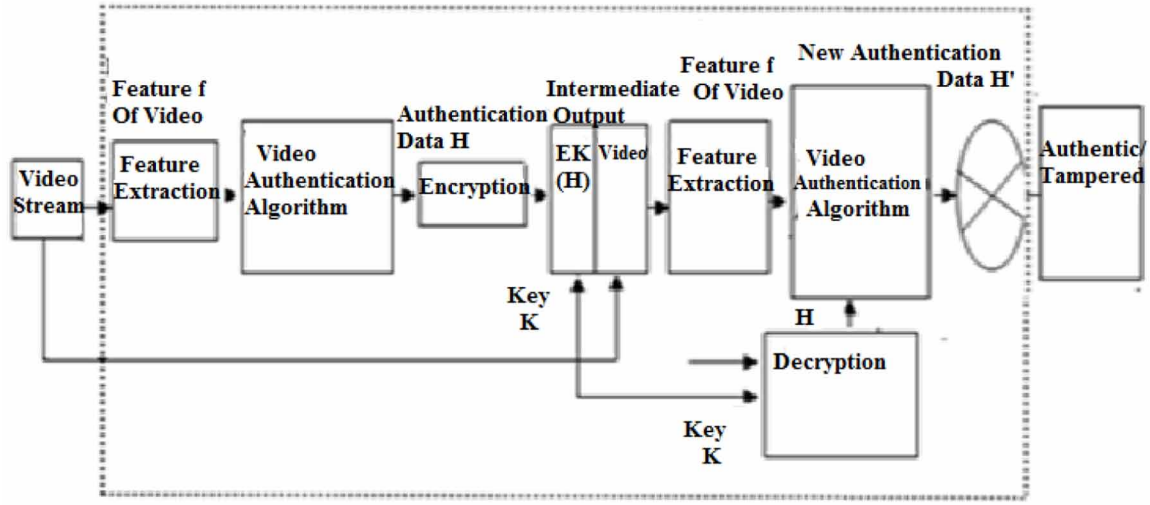
By definition, authenticity means sometimes "as being in accordance with fact, as being true in substance," or "as being what it professes in origin or authorship, as being genuine" (Authenticity, 1989).

Another definition of authentication is to prove that something is "actually coming from the alleged source or origin" (Authenticity, n.d.). A video authentication system ensures the integrity of digital video and verifies that whether the given video has been tampered or not. But in most of the cases, especially in the court of law, it may be more beneficial if the authentication system can tell where the tampering happens and how the video is tampered. A typical video authentication system is shown in Figure 9. For a given video, authentication process starts with feature extraction. After that, with a specific video authentication algorithm, the authentication data H is generated using the features f of the video. This authentication data H is encrypted and packaged with the video as a signature or alternatively it can be embedded into the video content as a watermark. The video integrity is verified by computing new authentication data H` for the given video. The new authentication data H` is compared with decrypted original authentication data H. If both are matched, the video is treated as authentic else it is considered as tampered video.

An ideal video authentication system, to be effective, must support to the properties such as sensitivity to malicious alteration, localization and self-recovery of altered regions, robustness to normal video processing operations, tolerance against some loss of information, compactness of signature, sensitivity against false intimation and computational feasibility. In fact in addition to having robustness against benign operations, an ideal video authentication system must make a given video resistant against all possible attacks and must verify whether a given video is tampered or not. Benign operations are those video processing operations that do not modify its content semantically such as geometric transformations, image enhancements and compression. Once the verification is done for the given video, it would be useful to find where and how the tampering has been done.

However, based on the objectives of authentication, an authentication system can be categorized as complete verification and content verification. Techniques that are proposed for complete verification consider that the multimedia data, which have to be authenticated, have to be exactly the same as the original one. Content verification is a characteristic of multimedia data authentication.

Figure 9. A typical video authentication system



CLASSIFICATION OF AUTHENTICATION TECHNIQUES

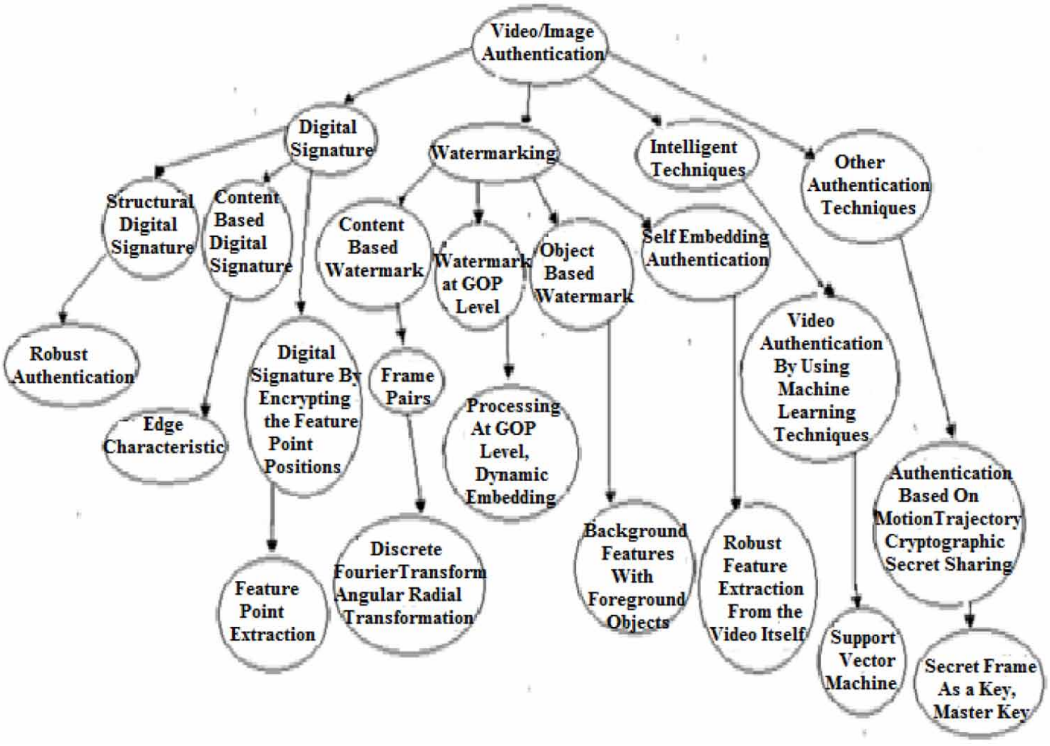
In past few years, watermarking and digital signatures have been widely used for the purpose of video authentication. Different techniques have their own advantages and shortcomings. In fact fragile watermarking and digital signatures are the two commonly used schemes for authentication.

Fragile watermarking embeds the authentication data into the primary multimedia sources, while digital signature stores the authentication data separately, either in user defined field, as like, in the header of MPEG sequence, or in a separate file (Yin et al., n.d.). Moreover there has also been worked on intelligent techniques for video authentication (Upadhyay, Singh, Vatsa, & Singh, 2007; Singh, Vatsa, Singh, & Upadhyay, 2008). Intelligent authentication techniques use learning based techniques for authentication purpose. Apart from these digital signature, fragile watermarking and intelligent techniques, some other authentication techniques are also introduced by researchers, which are specifically designed for various cases of malicious attacks. Basically video authentication techniques are broadly classified into four categories: Digital signature based techniques, watermark based techniques, intelligent techniques, and other authentication techniques. Figure 10 represents a tree structure of authentication techniques which have been commonly proposed for the purpose of video/image authentication.

Digital Signature

Integrity of multimedia data can be greatly verified by digital signature. For the authentication of multimedia data, it was first introduced by Diffie and Hellman in 1976 (Diffie & Hellman, 1976). For

Figure 10. Tree structure of authentication techniques



the purpose of authentication, digital signatures can be saved in two different ways. Either they can be saved in the header of the compressed source data, or it can be saved as an independent file. Further they can be produced for verification. In the prospective of robustness, since the digital signature remains unchanged when the pixel values of the images/videos are changed, they provide better results. In the digital signature authentication, the digital signature of the signer to the data depends on the content of data on some secret information which is only known to signer (Wohlmacher, 1998). Hence, the digital signature cannot be forged, and the end user can verify a received multimedia data by examining whether the contents of data match the information conveyed in the digital signature. In fact digital signature can be used to verify the integrity of multimedia data which is endorsed by the signer.

In Lin and Chang (1999), two types of robust digital signatures are used for video authentication in different kinds of situations. The first type of authentication signature is used in situation where the GOP (Group of Pictures) structure of the video is not modified, after transcoding or editing processes. The situation, where the GOP structure is modified and only the pixel values of picture will be preserved, a second type of digital signature is used.

In another work, video authentication is done by generating digital signatures for image blocks and using them as watermarks (Celik et al., 2002). In this approach localization packet, watermark insertion is done via LSB modification of pixel values. As compared to (Mobasseri & Evans, 2001) where video tampering is identified through an analysis of watermark sequencing, here (explicit) block ID's are used for this purpose.

The Johns Hopkins University Applied Physics Laboratory (APL) has developed a system for authentication of digital video (Johns Hopkins). The authentication system computes secure computer generated digital signatures for information recorded by a standard digital video camcorder. While recording, compressed digital video is simultaneously written to digital tape in the camcorder and broadcast from the camera into the Digital video authenticator. In this authentication system, video is separated into individual frames and three unique digital signatures are generated per frame—one each for video, audio, and (camcorder) control data—at the camcorder frame rate.

Here the key cryptography is used. One key, called a "private" key is used to generate the signatures and is destroyed when the recording is complete. The second a "public" key is used for verification. The signatures that are generated make it easy to recognize tampering. If a frame has been added it would not have a signature and will be instantly detected and if an original frame is tampered the signature would not match the new data and it will be detected in verification process.

In digital signature based video authentication schemes, different features are used for different applications. Dittman (Ditmann, Steinmetz, & Steinmetz, 1999) and Queluz (Queluz, 1998) used the edge /corner of the image as the feature to generate the digital signature. They claimed this feature is robust against high quality compression and scaling but the problem is that the signature generated based on the edge is too long, and the consistency of the edge itself is also a problem. Formally digital signature based authentication techniques are able to detect regions that have been tampered, but often they are too fragile to resist incidental manipulations. For this type of incidental manipulations structural digital signature (Lu & Liao, 2003) can be used for image authentication. This approach makes use of an image's content to construct a Structural Digital Signature (SDS) for image authentication. The characteristic of the SDS is that it can tolerate content preserving modifications while detecting content changing modifications. In this approach (Lu & Liao, 2003), many incidental manipulations which can be detected as malicious modifications in other digital signature verifications or fragile watermarking schemes, can be ignored.

In the scenario of a station streaming video over network, it is significant for the audiences to have guarantees that the video stream they are watching is indeed from the station. Schemes that are used for this purpose can prevent the malicious parties from injecting commercials or offensive materials into the video streams. Actually, this problem has been covered in information security called streaming signing (Gennaro & Rohatgi, 1997; Park, Chong, & Siegel, 2002), which is an extension from message signing by digital signature schemes which are able to both protect the integrity of the message and prevent the signer's repudiation.

In another technique, a separate authentication code is written in (Su, Chen, & Chang, 2009) from the blocks of the video frames. Here the authors Po-Chyi Su, Chun Chieh Chen and Hong Min Chang use the approach of scalar/vector quantization on the reliable features. Once the authentication code is written, it is transmitted along with the video. Thus, the authenticity of the given video content can be checked by matching the extracted feature with the transmitted authentication code. The authentication code chosen by authors is sensitive to malicious modifications of video data. The proposed work also considers two classical false detection tests. These are false alarms and misses. In the situation of former false detection test the authentication scheme wrongly signals a happening of tampering while the normal video processing operations are there. In the later situation, false detections are related to misses of detection after an actual tampering on video content has been performed. This work is resilient to lossy compression procedures, while the tampered regions on the video frames can be located if malicious attacks were applied (Su, Chen, & Chang, 2009).

Navjit Saikia and Prabin K. Bora present a scheme for video authentication in (Saikia & Bora, 2007) that generates the Message Authentication Code (MAC) for a Group Of Frames (GOF) using coefficients from the last but one high pass band at full level of temporal wavelet decomposition. This digital signature based scheme uses temporal wavelet transform for the generation of message authentication code. After the extraction of GOFs from the video, these GOFs are recursively decomposed into high pass band up to a certain level using temporal wavelet transform (Chuk, Jayant, & Farrardin, 1995). At this level the high pass band consists of two frames. In the signature generation process, these frames are divided into some blocks of fixed sizes. These blocks are randomly mapped on to a set of groups, using a mapping key in such a way that each group contains equal number of blocks. With the transform coefficients and these groups of blocks, a set of linear combination values is evaluated for each frame in the high pass band. And with these sets of linear combination values, message authentication code (MAC) is obtained for the GOF. In the signature verification process, the distances d ($MAC_{i,1}$, $MAC`_{i,1}$) and d($MAC_{i,2}$, $MAC`_{I,2}$) are calculated where d is any distance measure and { $MAC_{i,1}$, $MAC_{i,2}$ } is the MAC of i^{th} GOF of the original video and {$MAC`_{i,1}$, $MAC`_{i,2}$} is the MAC of corresponding GOF calculated at receiver site. Here the GOF of the video would be authentic if these two distances are below some predefined threshold values, otherwise tampered. When all GOFs in it are found authentic then the given video is declared as authentic video. This authentication scheme would be advantageous for spatio-temporal manipulations, since it is effective for spatial tampering as well as for temporal tampering.

Watermarking

Watermarking always remains a significant issue for solving authentication problems regarding digital multimedia data, in past few years. A wide variety of watermark based authentication techniques have

been proposed by various researchers in literature. However watermarking techniques can be used for authenticating various multimedia data, but most of the work has been done for image and video authentication. Based on the application areas, watermarking can be classified in different categories (Dittman et al., 2000). Beside to ensure the integrity of the digital data and recognizing the malicious manipulations, watermarking can be used for the authentication of the author or producer of the content. Watermarks can be embedded with the multimedia data, without changing the meaning of the content of the data. The advantageous feature with the watermarks is that, they can be embedded without degrading the quality of multimedia data too much. Since the watermarks are embedded in the content of video data, once the data is manipulated, these watermarks will also be modified such that the authentication system can examine them to verify the integrity of data. In (Guerrini, Leonardi, & Migliorati, 2004), authors describe the use of video authentication template, which uses a bubble random sampling approach applied for synchronization and content verification in the context of video watermarking. The authentication template is introduced in order to ensure temporal synchronization and to prevent content tampering in video sequences (Guerrini, Leonardi, & Migliorati, 2004).

Basically in past few years, an increasing use of digital information in our society and availability of very sophisticated and low cost video editing software creates problems associated with copyright protection and authentication. One of the main advantage of digital world is that here perfect copying is performed easily. That causes severe security related issues. The owners or producers of information resources are being worried of releasing proprietary information to an environment that appears to be lacking in security (Queluz, 2001). On the other hand with the help of powerful video editing software one can challenge the trustworthiness of digital information.

In (Queluz, 2001), M. P. Queluz presents the generic models with labeling and watermarking approaches for content authentication, in which existing techniques for content authentication are described and compared. In labeling based approach authentication data are written in separate file (Queluz, 2001), while in watermarking based approach the authentication information is embedded in the frames. In this labeling-based authentication system, features C and C` are extracted from the original and modified pictures respectively as according:

$$C = f_c\left(\ I \ \right),$$

$$C' = f_c(\ \hat{\mathrm{I}})$$

In order to assure the authenticity of the label content, it is signed in a trustworthy way, that is, the label is encrypted with a private key (K_{pr}). The label content is produced as:

$$L = EKpr(C,\ C_I)$$

where C_I is optional information, say Complementary Information, about the frame and its author, assigned by an author society. Besides image-dependent features, the label can also convey this information. In the authentication system the corresponding public key Kpu is used to decrypt the label, producing:

$$C,\ C_I = EKpu(L)$$

Moreover in (Queluz, 2001), M. P. Queluz presents two classical image features for image/video content authentication. The first image feature is concerned with second order image moments. It has a less computational requirement with small memory which makes it more advantageous computational feature. The second feature relies on image edges and it takes the problem of image/video authentication from a semantic, higher level point of view (Queluz, 2001). In image moments feature, for a two dimensional continuous function f(x, y), the moments of order $(p+q)$ is defined as

$$m_{pq} = \int_{-\infty-\infty}^{+\infty+\infty} x^p y^q \; f\left(x,y\right) dxdyfor \;\; p, \;\; q = 0,1,2,\ldots\ldots\ldots\ldots$$

For a digital image the above equation would be as follows:

$$m_{pq} = \sum_i \sum_j i^p j^q \;\; f(i, \;\; j)$$

where $f(i, \;\; j)$ represents image color values at pixel site (i, j). Moments are usually normalized dividing it by the image total mass, defined as $\sum_i \sum_j f(i,j)$. He also presents a brief comparison of labeling approach with watermarking for tamper detection, which is independent of applications where they can specifically be implemented. The video authentication techniques using the watermarking approach have wide dimension in the literature.

In (Liang, Li, & Niu, 2007), Chang-yin Liang, Ang Li and Xia-mu Nin proposed a video authentication system which is robust enough to separate the malicious attack from natural video processing operations with the cloud watermark. The authentication system in (Liang, Li, & Niu, 2007) first of all splits the video sequence into shots and extracts the feature vector from each shot. Then the extracted feature is used to generate watermark cloud drops with a cloud generator (Liang, Li, & Niu, 2007). Here, for robustness, a con tent based and semi fragile watermark is used for authentication. In this authentication technique DCT coefficients are evaluated firstly by partially decoding the given video. After watermarking the video is encoded again (Liang, Li, & Niu, 2007). Invariable features of the video are selected for content based watermarking. The watermarks are then embedded back into DCT coefficients of the video. The extracted watermarks are compared with the features derived from the received video, to check the authenticity of the given video.

However attacks on watermarks may not necessarily remove the watermark (Johnson, n.d.), but can disable its readability. Image/video processing operations and transforms are commonly employed to create and apply watermarks on the multimedia data. These techniques can also be used to disable or overwrite watermarks. Multiple watermarks can be placed in an image and one cannot determine which one is valid (Craver, Memon, Yeo, & Yeung, 1998).

In (Mobasseri & Evans, 2001), the proposed algorithm explains the frame-pair concept where one video frame would watermark another frame downstream based on a specific sequencing and a key. Basically in this approach three points are there: First the watermark is derived from the video itself, therefore cannot be pirated. Second if video frames are taken out, it is possible to identify their locations by simply monitoring the breaks in authentication key sequence. And third, video frames that are removed could

actually be recovered because frame pairs contain copies of other frames disguised as watermarks. In this approach unless both frames are removed, frame restoration is possible. Watermarking can also be used for the authentication of compressed video (Cross & Mobasseri, 2002). Here the watermarking of compressed video (Cross & Mobasseri, 2002) is done by identifying label carrying VLCs in MPEG-2 bit stream. In this approach every bit in the watermark payload is compared with the LSB of the current label carrying VLC. If they are the same, the VLC remains unchanged, if they are not, the LSB is replaced by the watermark bit. The embedded watermark may be used for the authentication of video and protection against tampering.

For the authentication of MPEG video, authentication data can be embedded at the Group Of Pictures (GOP) level (Yin et al., n.d.). Since it is almost infeasible to embed information in all pictures of a video clip or embed all the information for each picture in a video clip, Dynamic Embedding for each picture in a digital video can be adopted (Yin et al., n.d.). In this approach current GOP's authentication data (bits) are embedded into next GOP. Basically this approach has three advantageous features. First, by making each watermarked GOP dependent upon other GOP, the problem of watermark counterfeiting becomes computationally impossible and thus reduces the chances of success for the attackers. Second, for MPEG video, if watermark is added in I picture in a GOP, it results in drift errors for the following P or B pictures in the same GOP. If the video quality requirement is in demand, the drift errors should be corrected, the correction could cause the changes of the authentication bits and thus need to re-add the watermark in I picture. This will cause dead loop. Therefore it would be advantageous to embed the authentication data at the GOP level. Third this operation is causal and saves much memory to store a GOP's data.

For the investigation of the authenticity of uncompressed video signal, the quality of digitization process is considered significantly (Geradts & Bijhold, n.d.). The way the A/D conversion is done is important for the result. For this purpose the histogram of gray values can be checked. Previously Lin et al (Lin & Chang, 1999) and Peng et al (Peng, 2002) have worked on compressed domain schemes that are robust against transcoding and editing operations. For computing the signature Lin (Lin & Chang, 1999) used the difference in DCT coefficients of frame pairs. Since the value of DCT coefficients can be modified keeping their relationship preserved, it is vulnerable to counterfeiting attacks. Peng (Peng, 2002) used DC-DCT coefficients as features to build watermark.

An object based watermarking scheme for video authentication is proposed by Dajun et al (He, Sun, & Tian, 2003). They use background features to embed the watermark into foreground objects to establish a relation between background and the foreground of a video. Here the raw video is segmented into foreground objects and background video the watermark is generated by using the features extracted from both the foreground and background. The watermark is then embedded into foreground objects, so that a secure link between foreground objects and the back ground is created. At the receiving end integrity between the foreground objects and the background can be verified by comparing two sets of codes: one is the watermark extracted from the objects and the other is regenerated from both the received object and the background. If these two sets of codes are the same, then the video is claimed as authentic.

A more robust authentication scheme for scalable video streaming by employing Error Correction Coding (ECC) in different ways (Sun, He, Zhang, & Tian, 2003) has also been produced. This scheme achieves an end - to-end authentication independent of specific streaming infrastructure. Actually this scheme is an extension from (Sun, Chang, & Maeno, 2002) where a semi fragile authentication framework, for images in terms of ECC and public key infrastructure, is used.

In another work, a semi fragile object based authentication solution is produced for MPEG 4 video (He, Sun, & Tian, 2003). To protect the integrity of the video objects /sequences, a content based watermark is embedded into each frame in the Discrete Fourier Transform domain before the MPEG 4 encoding. A set of Angular Radial Transformation (ART) coefficients are selected as the robust features of the video objects. Error Correction Coding (ECC) is used for watermark generation and embedding. The main difference between the frame based video application and the object based video application lies in the utilization of the shape information.

In a self-embedding authentication system (Martinian, Wornell, & Chen, n.d.), a robust and important feature of the video is extracted and embedded in to the video at the sending site; the detector retrieves this original feature from the watermark and compares it with the feature extracted from the received video to determine the authenticity of the video. If the difference exceeds a threshold, the received video will be claimed as un-authentic video.

INTELLIGENT TECHNIQUES

Intelligent techniques for video authentication use database of video sequences. The database comprises authentic video clips as well as tampered video clips. As in (Upadhyay, Singh, Vatsa, & Singh, 2007), the authors proposed an intelligent technique for video authentication which uses inherent video information for authentication, thus making it useful for real world applications. The proposed algorithm in (Upadhyay, Singh, Vatsa, & Singh, 2007) is validated using a database of 795 tampered and non-tampered videos and the results of algorithm show a classification accuracy of 99.92%. The main advantage of intelligent techniques is that they do not require the computation and storage of secret key or embedding of watermark. The algorithm in (Upadhyay, Singh, Vatsa, & Singh, 2007) computes the local relative correlation information and classifies the video as tampered or non-tampered. Performance of this algorithm is not affected by acceptable video processing operations such as compression and scaling. Here the algorithm uses Support Vector Machine (SVM) for the classification of the tampered and authentic videos. SVM (Vapnik, 1995) is a powerful methodology for solving problems in nonlinear classification, function estimation and density estimation (Singh, Vatsa, & Noore, 2006). In fact SVM is a nonlinear classifier that performs classification tasks by constructing hyper planes in a multi-dimensional space and separates the data points in different classes. This algorithm (Upadhyay, Singh, Vatsa, & Singh, 2007) is performed in two stages: (1) SVM training and (2) Tamper detection and classification, using SVM. In SVM training, the algorithm trains the SVM by using a manually labeled training video database, if the video in the training data is tampered, then it is assigned the label -1 otherwise the label is +1 (for the authentic video). From the training videos, relative correlation information between two adjacent frames of the video is computed, with the help of corner detection algorithm (Kovesi, 1999). Then relative correlation information RC is computed for all adjacent frames of the video with the help of

$$RC = \frac{1}{m}\sum_{i=1}^{m} L_i$$

where Li is local correlation between two frames for i=1,2,…m. and m is the number of corresponding corner points in the two frames. The local correlation information RC is computed for each video and

the RC with the label information of all the training video data are provided as input to the SVM. With this information of all the video in video database the SVM (Vapnik, 1995) is trained to classify the tampered and non-tampered video data. Output of SVM training is a trained hyper plane with classified tampered and non-tampered video data. In (Singh, Vatsa, Singh, & Upadhyay, 2008), authors integrate the learning based support vector machine classification (for tampered and non-tampered video) with singular value decomposition watermarking. This algorithm is independent of the choice of watermark and does not require any key to store. This intelligent authentication technique embeds the inherent video information in frames using SVD watermarking and uses it for classification by projecting them into a nonlinear SVM hyper plane. This technique can detect multiple tampering attacks.

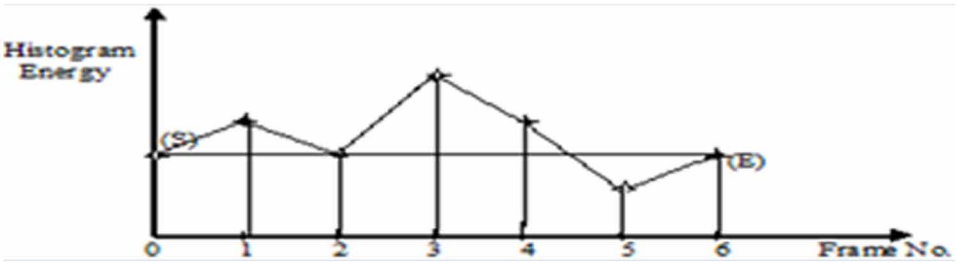
OTHER AUTHENTICATION TECHNIQUES

Apart from digital signature, watermarking and intelligent techniques, various other techniques are there for authentication purpose of digital video in the literature. In (Yan & Kankanhalli, 2003), an authentication scheme for digital video is introduced which is based on motion trajectory and cryptographic secret sharing (Yan & Kankanhalli, 2003). In this scheme, the given video is firstly segmented into shots then all the frames of the video shots are mapped to a trajectory in the feature space by which the key frames of the video shot are computed. Once the key frames are evaluated, a secret frame is computed from the key frames information of the video shot. These secret frames are used to construct a hierarchical structure and after that final master key is obtained. This master key is used to identify the authenticity of the video. Any modification in a shot or in the important content of a shot will be reflected as changes in the computed master key. Here trajectory is constructed, using the histogram energy of the frames of the video shot. For a particular video shot, in Figure 11, vertical axis indicates the histogram energy of each frame of the shot and the horizontal axis marks the frame number in the shot. A polyline belonging to the video shot is drawn which is a motion trajectory. This figure also shows the process of key frames extraction from the video shot. The starting frame S and the last frame E of the trajectory are connected to each other. Then a distance d between each frame point and this line is computed by using:

$$d = \frac{\left|Ax + By + C\right|}{\sqrt{A^2 + B^2}}$$

where d is the distance from a point $(x,\ y)$ to the straight line $Ax + By + C = 0$.

Figure 11. Frames with their histogram energy for a video shot



After that the point at the maximum distance from the line is chosen and the corresponding frame is declared as one of the key frames in this shot. Once the key frames are computed these are utilized to compute the secret frame by extrapolation. Now an interpolating polynomial $f(x)$ is computed by using key frames as follows.

$$f(x) = \sum_{j=1}^{n+1} \prod_{i=1}^{n+1} \frac{x - x_i}{x_j - x_i} I_j$$

This is Lagrange interpolation formulation where the x_i position refers to each key frame and I_i is the pixel value of the key frames. By using this equation and extrapolation a frame at $x = 0$ is computed, which is regarded as the secret key. Considering the set of secret keys as another set of shares, the master key frame is computed for that particular video. With this scheme any video can be authenticated by comparing its computed master key with the original master key. This comparison can be performed by using the general cosine correlation measure given by:

$$sim = \frac{I_O \cdot I_N}{\left| I_O \cdot I_N \right|}$$

where I_O and I_N are the original master key and the new master key considered as vectors. The similarity value would be in the range [0, 1] and if sim = 1, the two master keys would be the same, however if sim = 0, the two master keys would be different. Here the authors also claim that if the similarity value is high then the video has undergone benign transformations. But if the similarity value is low, then the video must have undergone some significant tampering. In (Latechi, Wildt, & Hu, n.d.), the key frames are selected by deleting the most predictable frame. In the approach of reference (Zhao, Qi, Li, Yang, & Zhang, 2000), the key frames are extracted from a video shot based on the nearest feature line. The work in (Quisquater, 1997) authenticates a video by guaranteeing the edited video to be the subsequence of the original video using a special hash function. The MPEG video standard is one of the most popular video standards in today's digital era. In (Wang & Farid, 2007) Weihong Wang and Hany Farid have been worked on MPEG video standard (MPEG-1 and MPEG-2) in this paper they specifically show how a doubly compressed MPEG video sequence introduces specific static and temporal statistical perturbations whose presence can be used as evidence of tampering. In a MPEG video sequence, there are three types of frames: I-frame, P-frame and B-frame. Each with different level of compression occurs in a periodic sequence in the MPEG video. Amidst all the frames I-frames are the highest quality frames of the video sequence, which are usually encoded by standard JPEG compression scheme. In the I-frame, compression is achieved at spatial level by reducing spatial redundancies within a single frame (Wang & Farid, 2007). Temporal redundancies are concerned with P-frames arcos the frames of video sequence. For achieving double MPEG compression, I-frames of the MPEG video sequence are compressed twice. For this purpose when the frames are double quantized with different step size, there is a significant difference in their histogram. When the step size decreases in image quantization, some bins in the histogram are empty while in greater step size some bins of the histogram contain more samples than their neighboring bins (Wang & Farid, 2007). In both cases of double quantization, periodicity of the artifacts is introduced in to histograms. This artifact would be used as evidence of double compression

and hence tampering. In temporal analysis, addition or deletion of frames from a video sequence and re-encoding the resulting sequence, results in a large motion error between consecutive P-frames of the video, since they originated from different GOPs. Moreover this increased motion error would be periodic, occurring throughout each of the group of pictures following the frame deletion or addition. Periodic spikes in the motion error indicate tampering (Wang & Farid, 2007).

In (Farid, 2006), Hany Farid describes three techniques to expose digital forgeries in which the approach is to first understand how a specific form of tampering disturbs certain statistical properties of an image and then to develop a mathematical algorithm to detect this perturbation. These are Cloning, Lighting and Retouching. In Cloning, a digital image is first partitioned into small blocks of the regions. The blocks are then reordered so that they are placed a distance to each other that is proportional to the differences in their pixel colors (Farid, 2006). Since it is statistically unlikely to find identical and spatially coherent regions in an image, therefore their presence can be used as evidence of tampering. In lighting approach the direction of an illuminating light source for each object or person in an image is automatically evaluated by some mathematical techniques. The retouching technique exploits the technology by which a digital camera sensor records an image, for detecting a specific form of tampering.

A robust video authentication system should tolerate the incidental distortion, which may be introduced by normal video processing such as compression, resolution conversion and geometric transformation, while being capable of detecting the intentional distortion, which may be introduced by malicious attack. There has also been some work for scene change detection of video sequences in the literature.

LIMITATIONS OF EXISTING VIDEO AUTHENTICATION TECHNIQUES

There are different challenges with the existing watermark and digital signature based video authentication approaches. However there is no issue related with the size of authentication code in digital signature based video authentication techniques, but if the location where digital signature is stored is compromised then it is easy to deceive the authentication system. On the other hand fragile watermarking algorithms perform better than algorithm based on conventional cryptography (Hauzia & Noumeir, 2007). Fragile and semi fragile algorithms show good results for detecting and locating any malicious manipulations but often they are too fragile to resist incidental manipulations. Moreover embedding the watermark may change the content of video which is not permissible in court of law (Upadhyay, Singh, Vatsa, & Singh, 2007).In other techniques, most of the authentication techniques are established for specific attacks. Moreover existing algorithms are also affected by compression and scaling operations.

PROPOSED METHODOLOGY

Keeping in mind all those limitations, we are going to propose an intelligent video authentication technique, which does not require computation and storage of any key or embedding of any secret information in the video data. We have designed our algorithm especially for raw videos (videos captured and given in any situation or condition), which suited best for surveillance videos. Our proposed video authentication algorithm computes the statistical local features information in digital video frames and establishes

a relationship among the frames. A Support Vector Machine (SVM) (Vapnik, 1995) based learning algorithm is then used to classify the video as tampered or non-tampered. The proposed algorithm uses inherent video information for authentication, thus making it useful for real world applications.

SUPPORT VECTOR MACHINE

Support Vector Machine, pioneered by Vapnik (Vapnik, 1995), is a powerful methodology for solving problems in nonlinear classification, function estimation and density estimation (Singh, Vatsa, & Noore, 2006). The main idea of a support vector machine is to construct a hyper plane as the decision surface in such a way that the margin of separation between two classes of examples is maximized. It performs the classification task by constructing hyper planes in a multidimensional space and separates the data points into different classes. SVM uses an iterative training algorithm to maximize the margin between two classes (Upadhyay, Singh, Vatsa, & Singh, 2007; Singh, Vatsa, & Noore, 2006). The mathematical formulation of SVM is as follows:

Let $\left\{(x_i, d_i)\right\}_{i=1}^{N}$ be the training sample of N data vectors, where x_i is the input pattern for the i^{th} example and d_i is the corresponding desired response. It is assumed that the pattern (class) represented by the subset $d_i = +1$ and the pattern represented by the subset $d_i = -1,$ are linearly separable. The equation of generalized decision function can be written as:

$$f\left(x\right) = \sum_{i=1}^{N} w_i \varphi_i\left(x\right) + b = \quad W\overline{\varphi}\left(x\right) + b$$

where $\varphi_i\left(x\right)$ is a nonlinear function representing hidden nodes and $\overline{\varphi}\left(x\right) = \left[\varphi_1\left(x\right), \quad \varphi_2\left(x\right), \ldots . \varphi_N(x)\right]^T$, and b is a bias. To obtain a non linear decision boundary which enhances the discrimination power, the above equation can be rewritten as:

$$f\left(x\right) = \sum_{i=1}^{N} d_i \propto_i K\left(x, x_i\right) + b$$

Here $K\left(x, x_i\right)$ is the nonlinear kernel that enhances the discrimination power and $\propto_i$ is the Lagrangian multiplier (Upadhyay, Singh, Vatsa, & Singh, 2007). Basically a nonlinear SVM uses a kernel function $K\left(x, x_i\right)$ to map the input space to the feature space so that the mapped data becomes linearly separable. One example of such kernel is the RBF kernel

$$K\left(x, x_i\right) = exp\left(-\gamma x - x_i^{\,2}\right), \quad \gamma > 0$$

where x and x_i represent the input vectors and γ is the RBF parameter (Upadhyay, Singh, Vatsa, & Singh, 2007). Additional details of SVM can be found in (Vapnik, 1995).

PROPOSED VIDEO AUTHENTICATION ALGORITHM

As mentioned above the common tampering attacks on a video data are spatial and temporal tampering attacks which include object addition, object removal, object modification, frame removal, frame addition, and frame shuffling. Our proposed algorithm gives excellent results for temporal and spatial, both types of tampering attacks. In this chapter, we have focused on the three kinds of tampering attacks, frame addition attacks, frame removal attacks and spatial tampering attacks. However the proposed algorithm can handle all kinds of malicious attacks. Since we are using SVM based learning and classification technique, it can also differentiate between attack and acceptable operations.

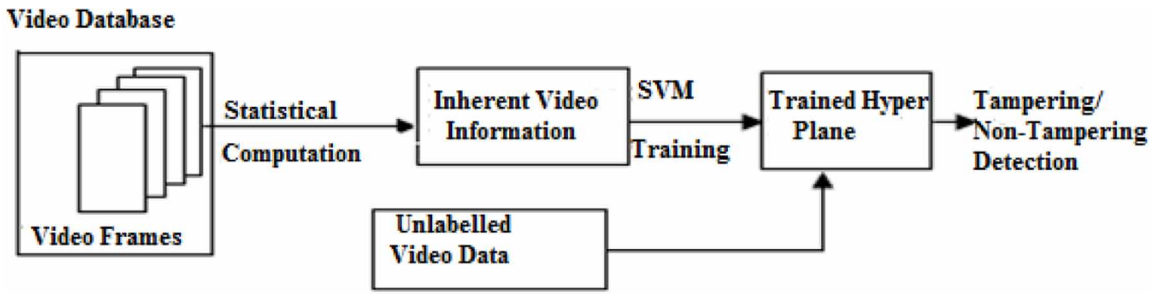
The concept of the proposed algorithm is shown in Figure 12. The proposed video authentication algorithm computes the statistical local features information between two consecutive video frames.

Here we take the absolute difference of every two consecutive video frames. The average object area and entropy of difference frames are used as statistical local features information. They are worked here as the basis for SVM learning. This information is computed locally using statistical tools and then classification is performed using support vector machine (Vapnik, 1995). Based on the functionality, the proposed algorithm is divided into two stages: (1) SVM Learning and (2) tamper detection and classification using SVM.

SVM LEARNING

SVM learning is the first step of the proposed algorithm. For this purpose a database of 50 tampered and non-tampered video clips is used, and the hyper planes are trained for frame addition, frame removal and spatial tampering attacks, separately. Training is performed using manually labeled training videos of the video database. For each of the video of the video database, if the video in the training data is tampered then it is assigned the label 0 otherwise (if it is not tampered) the label is 1. From the training videos, statistical local information (average object area and entropy) are extracted. This labeled information, together with the statistical local information (SL), is then used as input to the SVM which performs learning and generates a non-linear hyper plane that can classify the video as tampered and non-tampered. All these steps involved in the training of the kernel are performed for the video database and are explained in the learning algorithm.

Figure 12. Block diagram of the proposed video authentication algorithm



Learning Algorithm

- **Input:** Labeled training video frames.
- **Output:** Trained SVM with a non-linear hyper plane to classify tampered and non-tampered video data.
- **Algorithm:**
  - Individual frames are obtained from the different tampered and non tampered video data.
  - The difference frames of all the video data are obtained by taking absolute difference between every two consecutive frames. In absolute difference, we subtract each pixel value in second frame from the corresponding pixel value in the first frame.
  - All these difference frames are converted into binary frames.
  - The total number of objects in first binary difference frame and their area are calculated. Then the average object area and the entropy of the first binary difference frame are computed statistically.

If the area of an object in a binary frame is a_i then the average object area of the binary frame A would be

$$A = \frac{1}{N}\sum_{i=1}^{N} a_i$$

where N is the total number of objects.

If the average object area and entropy of a binary frame are A_i and E_i then the statistical local information of a video of the video database would be defined as

$$SL = \sum_{i=1}^{m}\left[A_i, E_i\right]$$

This statistical local information is a column vector of size $\left[\left(m-1\right)\times 2\right]$ where m is the total number of binary difference frames extracted from all the tampered and non tampered video of the video database.

Steps 1-6 are performed on all the labelled training videos and the statistical local information SL is computed for each video of the video database.

- Statistical local information and labels of all the training videos are given as input to the Support Vector Machine.
- In the learning process the SVM kernel (Vapnik, 1995) is trained to classify the tampered and non tampered video data. Output of this training is a trained hyper plain with classified tampered and non tampered video data.

TAMPER DETECTION AND CLASSIFICATION

We now explain the proposed tamper detection and classification algorithm. Input to this classification algorithm is a video data of which authenticity needs to be established. As performed in SVM learning algorithm, statistical local information of all the binary frames of the given video is computed and the trained SVM is used to classify the video. The proposed algorithm uses the dynamically adoptive threshold value to decide whether the given video frame is tampered or not. It automatically selects a threshold value with the help of learning database, for declaring any binary difference frame as a tampered frame. If the SVM classifies the input video as tampered then the location of tampering is computed. The tamper detection and classification algorithm is described below.

Tamper Detection and Classification

- **Input:** Unlabelled video frames.
- **Output:** Classification result as tampered and non-tampered video data.
- **Algorithm:**

Using steps 1-7 of the SVM learning algorithm, the statistical local information SL for the input video is computed.

1. This statistical local information of the input video data is projected into the SVM hyper plane to classify the video as tampered or non-tampered. If the output of SVM is one for all of the difference frames of the input video then the given video is authentic otherwise it is tampered.
2. If any of the frame of given video is classified as tampered then we determine the particular frames of the video that have been tampered.

Plot the statistical local information SL (average object area and entropy) of difference frames of all the adjacent frames of the video.

3. Local values showing the maximum deviation in the plot are the values corresponding to the tampered frames.
4. Plot the trained SVM classifier which shows the support vectors for the training video data

EXPERIMENTAL RESULTS AND DISCUSSION

The proposed algorithm shows very good results for all the three kinds of attacks, frame addition attacks, frame removal attacks and spatial tampering attacks. We have shown the results for all kinds of tampering attacks of temporal tampering and also for spatial tampering.

RESULTS FOR FRAME REMOVAL ATTACK

Figure 13 shows the plot of average object area values as statistical local information (SL) for 120 tampered videos, 120 non-tampered videos and 100 videos for validation process in the database, subjected to frame removal attack. Here 120 tampered and 120 non-tampered videos of the database are used for the learning process of SVM. The average object area (SL) values of all the non-tampered videos are below than almost all the SL values of tampered videos. However some of the SL values of tampered videos are below than some of the SL values of non-tampered videos. This is because; some of the videos in database have normally greater difference in consecutive frames than the difference due to malicious modifications, in consecutive frames.

Here we are using 100 testing videos for the validation of our algorithm. The testing video, which has the SL value lower than the highest SL value of non-tampered videos and also lower than or equal to lowest SL value of tampered videos, would definitely be a non-tampered video. In the same way the testing video, which has the SL value higher than the highest SL value of non-tampered videos and the lowest SL value of tampered videos, would be detected as tampered video. For the SL values which are below than the highest SL value of non-tampered videos but are above than the lowest SL value of

Figure 13. Plot of average object area as statistical local information of 120 tampered, 120 non-tampered, and 100 testing videos of the database, in which our algorithm correctly classifies 99 videos and misclassifies one video subjected to frame removal attack

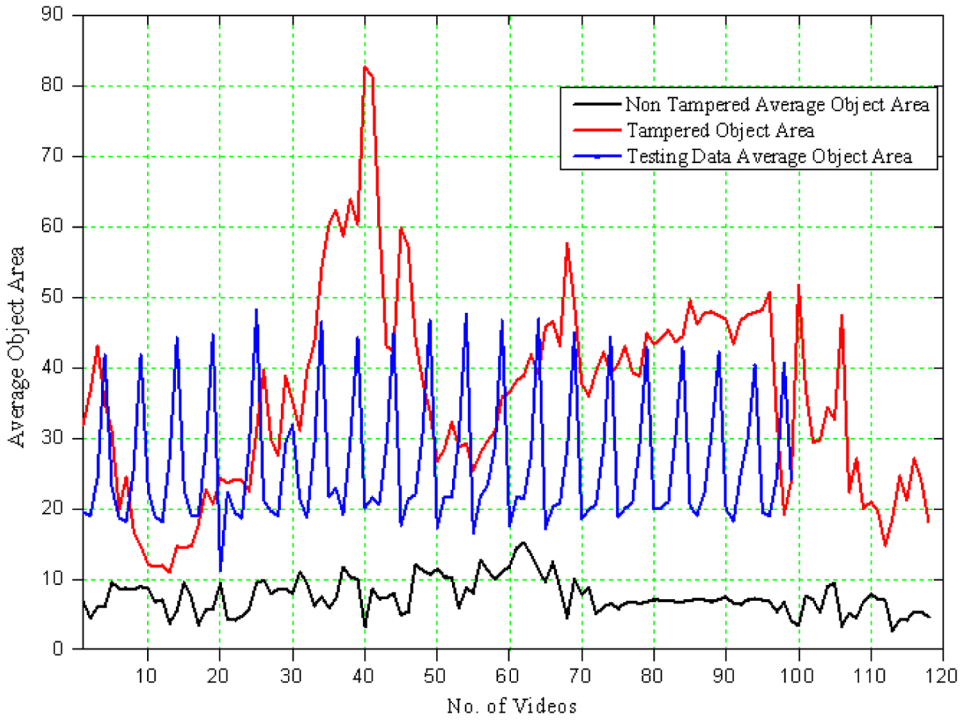
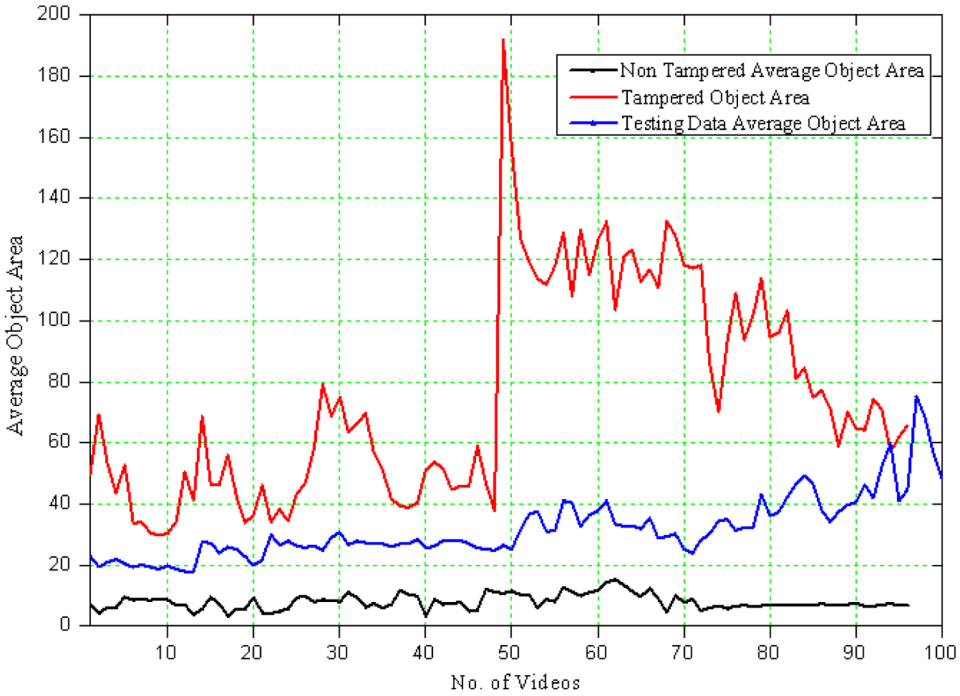


Figure 14. Plot of average object area as statistical local information of 96 tampered, 96 non-tampered, and 100 testing videos of the database in which the algorithm correctly classifies all the tampered videos subjected to frame addition attack

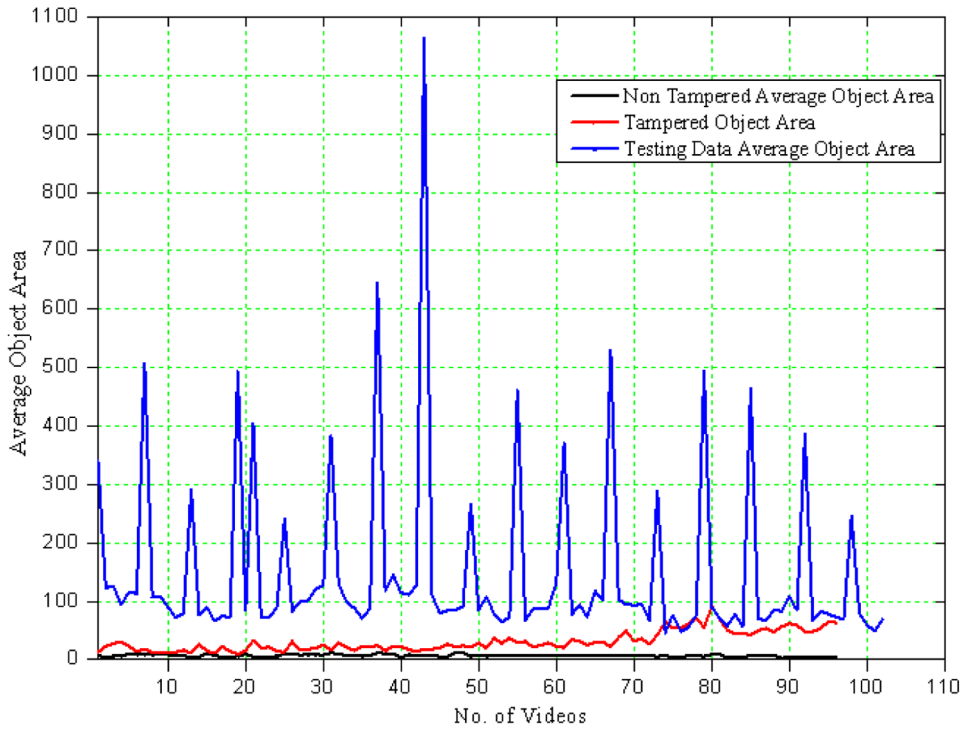


tampered videos, the testing videos may be detected as either tampered or non-tampered videos. In that case videos with the lower SL values would be treated as non-tampered videos and the videos with the higher SL values would be detected as tampered videos. These boundaries for tampered and non-tampered videos are automatically defined by our algorithm once the learning process completes and highest and lowest SL values of learning videos work as a threshold for testing videos. As shown in the graph of Figure 13, the SL values of almost all the testing videos are higher than the highest SL value (which is the threshold value) of non-tampered videos except one. It means that here our algorithm misclassifies only one tampered video as a non-tampered video, and correctly classifies 99 videos as tampered video.

RESULTS FOR FRAME ADDITION ATTACK

In frame addition attack, since the consecutive frames at the tampered positions in the videos have much difference (compared to each other), our algorithm gives better results for frame addition attack. Figure 14 shows the plot for average object area values as SL values for 96 tampered videos, 96 non-tampered videos and 100 testing videos of the database, subjected to frame addition attack. Here in this figure, the SL values of all the tampered videos are much higher than the SL values of all the non-tampered videos. So the learning is performed well. Our algorithm dynamically adopts the highest SL value of non-tampered videos as a threshold value. For the validation process we have taken 100 tampered videos.

Figure 15. Plot of average object area as statistical local information of 96 tampered, 96 non-tampered, and 103 testing videos of the database in which our algorithm misclassifies 12 videos subjected to spatial tampering attack



Our algorithm successfully classifies all the 100 videos as tampered videos, as not a single testing video has a SL value lower than or equal to the SL values of any non-tampered video.

RESULTS FOR SPATIAL TAMPERING ATTACKS

For spatial tampering, we have modified the spatial content of the frames of the video with the help of professional software and created the tampered videos for our video database. These tampered videos include almost all kinds of spatial tampering attack. In spatial tampering attacks, we basically consider the object addition and object removal attacks. In spatial tampering, sometimes changes, due to tampered objects, in consecutive frames are small enough to be ignored as compared to normal changes in consecutive frames. It depends upon the size and movement of the tampered objects in the frames. It also depends upon the size and movement of other non-tampered objects in the frames of the video. Here the tampered object is referred to as an object which is either removed from some frames or pasted to some frames additionally. If the tampered object is small in size and less in movement as compared to other non-tampered objects of the frames, then it creates small enough changes in consecutive frames, to be ignored and it cannot be detected as a malicious attack. While on the other hand if a non-tampered object, big in size (total area of all the pixels covered by it), moves very rapidly then it creates big enough changes in consecutive frames to be detected as a malicious attack. Therefore the proposed algorithm,

sometimes, does not give very good results for spatial tampering attacks. However, since our algorithm is a learning based algorithm, it gives overall good results for spatial tampering attacks. In Figure 15, the SL values of testing videos are much higher than the SL values of learning videos. We have taken 96 non-tampered and 96 tampered videos for learning purpose. Here the SL value line of tampered videos touches the SL value line of non-tampered videos at several points in x-axis. It means some of the tampered and non-tampered videos have same SL values. Therefore, the adoptive threshold value would be changed for the points, in x-axis, where the SL value lines of tampered and non-tampered videos touch each other. For these points, the highest SL value of tampered videos would be adoptive threshold value for testing videos.

Thus here two adoptive threshold value works, one for the points, in x-axis, where the SL value lines of tampered and non-tampered videos touch each other and another for the points, in x-axis, where the SL values of tampered videos are greater than the SL values of non-tampered videos. The highest SL value of non-tampered videos would be the adoptive threshold value for the later one. For the validation process we took 103 tampered videos. In the Figure 15, it can be seen that our algorithm misclassifies 12 videos out of 103 videos with a false acceptance rate of 11. 65% and correctly classifies 91 videos.

VALIDATION OF PROPOSED ALGORITHM

The proposed tamper detection algorithm is validated by using a video database which contains fifty videos. Our video database contains 50 originally recorded non-tampered videos with 2000 frames, each captured at 24 fps. The frame size of each video clip is 720×576 . This video data is used as the ground truth. Each video of the database is further split into 10 equal sized video of 200 frames. For each of the 50 ground truth videos of the video database, different tampered copies are created by subjecting them to different video tampering attacks Experimental protocols for validation process are as follows:

1. For each video, 10 copies are created with frame removal attack in which 1to 20frames have been dropped at random positions. For the frame addition attack, an additional video other than the 50 videos in the database is chosen. Frames of this additional video are inserted at random positions in the database videos to generate 10 tampered copies of each ground truth videos. For spatial tampering attacks we used professional software. With the help of this software we altered the contents of the frames of each ground truth video. This alteration is performed in various aspects, such as, object addition and object removal from the frames. Ten copies of each video of the video database are created, subjected to spatial tampering attacks. We, thus have total 50 ground truth videos with 500 non-tampered videos, 500 videos with frame addition attack, 500 videos with frame removal attack and 500 videos with spatial tampering attacks.
2. 624 videos from the video database are used to train the support vector machine, for frame removal, frame addition and spatial tampering attacks. This SVM training is performed for each kinds of attack separately with different tampered and non-tampered videos.
3. The remaining videos of the video database are used as the probe database to determine the performance of the proposed algorithm.

The performance of the proposed video authentication algorithm is evaluated with this experimental protocol.

All of the computations are performed using the hardware configuration of Pentium ® Dual-Core CPU 2.20 GHz computer with 2 GB RAM under MATLAB programming environment. The RBF parameter used in the proposed algorithm is computed empirically using the training video frames. The best suited value of RBF parameter (γ) among 1 to 5 is 3. The value of $\gamma = 3$, gives the maximum classification accuracy. We therefore used $\gamma = 3$ for classification on the probe data.

The results given in Table 1 summarize the performance of the proposed video authentication algorithm. For authentic videos and videos subjected to the frame addition attack of temporal tampering, our algorithm gives the result with maximum accuracy and yields 100% correct classification. For frame removal attack, a classification accuracy of 99% is obtained. For frame removal attack our algorithm misclassified one tampered video out of 100 tampered videos, because the object movements in the binary difference frames were very small. For spatial tampering attacks, the proposed algorithm gives the result with 88.35% accuracy and misclassifies twelve tampered videos out of 103 tampered videos. Thus the overall classification accuracy of the proposed algorithm is 98.38%.

According to steps 3-5 of our tamper detection algorithm, the SL values, obtained from video frames, are analyzed. This analysis gives the specific frames that have been altered. These results show the efficacy of our proposed video authentication algorithm for all kinds of tampering attack of temporal tampering and spatial tampering.

We also compared the performance of the proposed video authentication algorithm with the motion trajectory based video authentication algorithm (Yan & Kankanhalli, 2003), proposed by Wei-Qi Yan et al. Table 2 depicts a theoretical comparison of both algorithms. Motion trajectory based algorithm (Yan

Table 1. Classification results of the proposed video authentication algorithm for tampered and non tampered video frames

Tampering Attacks	Total Number of Videos	Number of Correctly Classified Videos	Classification Accuracy (%)
Non-tampered	500	500	100
Frame Addition	100	100	100
Frame Removal	100	99	99
Spatial Tampering	103	91	88.35
Total	803	790	98.38

Table 2. Theoretical comparison of the proposed video authentication algorithm with the motion trajectory-based video authentication algorithm (Yan & Kankanhalli, 2003)

Category	Motion Trajectory based Video Authentication (Yan & Kankanhalli, 2003)	Proposed Video Authentication Algorithm
Basic Concept	Master Key computation based on motion trajectory	Statistical Local Information is computed from video frames.
Classification	Using empirical threshold values and cosine correlation measure	Using Non-linear Support Vector Machine for classification
Advantage	Simple algorithm, It handles frame addition and frame removal attack	In addition of frame addition and frame removal attack, it handles frame alteration attack (Spatial Tampering).
Disadvantage	It cannot handle frame alteration and other attacks	Computationally expensive and a little bit slow algorithm due to the use of SVM and a video database.

& Kankanhalli, 2003) is fast and simple but unable to detect spatial tampering attacks (object addition, removal and modification in a frame). It also gives poor results in frame removal attacks of temporal tampering, when only three or four frames are dropped (in case of twenty-frame removal). It also gives unsatisfactory results in frame removal attack of temporal tampering, when object movements within consecutive frames of the video, are very less.

On the other hand, our proposed algorithm uses an intelligent technique, namely SVM classification which is able to detect both kinds of attack, spatial as well as temporal. Thus our proposed algorithm covers a wide range of tampering attacks with good classification accuracy and a minor increase in computational time.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

From entertainment to court decision, from broadcasting to surveillance, and from investigation agencies to smart classes, video applications have already infiltrated into many aspects of our lives. In the past decade, video based industry has flourished at an unparalleled speed. However, as a spin-off of this exciting development, many security issues have inevitably emerged. In video industry, in contrast to the copyright issue, which only concerns the video content providers, the issue of video content integrity or authenticity concerns not only the content provider, but also the content receiver. Thus, the issue of video content authenticity, sooner or later, will bottleneck video industry if it is not solved properly. Most of the existing video authentication algorithms use watermarking or digital signature based algorithms. Digital signature based algorithm can be deceived, if the location where digital signature is stored is compromised and watermarking based algorithms are not acceptable in court of law because they may alter the content of video during watermark embedding and extraction. To address these issues we have proposed an efficient intelligent video authentication algorithm which can detect multiple video tampering attacks. Our proposed algorithm computes the statistical local information of all of the binary difference frames of the given video and projects them into a non-linear SVM hyper plane to determine if the video is tampered or not. Our algorithm dynamically adopts the threshold values for the statistical local information of tampered video frames. It automatically opts the best suited threshold value for declaring the binary difference frames as tampered frames. The algorithm is validated on an extensive video database containing 1500 tampered and 500 non-tampered videos. The results show that the proposed algorithm yields a classification accuracy of 98.38%. In future we would like to expand our video database, which would cover some more critical conditions for video recording, like the videos captured in different light conditions such as in day light and night vision systems, and in a situation where the camera and objects are moving very fast, videos in critical weather conditions and the videos captured in hazardous condition, and apply the intelligent authentication algorithms for obtaining the results regarding all kinds of tampering attacks.

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KEY TERMS AND DEFINITIONS

Digital Signature: Digital signatures can be used for the purpose of authentication.

Fragile Watermarking: Fragile watermarking can be used for the authentication of the author or producer of the content.

Intelligent Techniques: Intelligent techniques use machine learning approach to solve the problems.

Support Vector Machine: Support Vector Machine, is a powerful methodology for solving problems in nonlinear classification, function estimation and density estimation.

Video Authentication: Video authentication is a process, which ascertains that the content in a given video is authentic and exactly same as when captured.

Video Database: A database which contains the videos is called video database.

Video Tampering Attacks: Video tampering attacks can be applied to modify the contents of a video data.

ENDNOTE

[1] Law Enforcement/Emergence Services Video Association (LEWA).

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Chapter 46
Young Children and Digital Media in the Home:
Parents as Role Models, Gatekeepers, and Companions

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ABSTRACT

This chapter presents an overview of the digital practices of young children (under 8 years old) in the home. At such an early age, parents are the main mediators of the contact with digital media, thus paying a preponderant role in shaping young children's practices, perceptions and attitudes. In this chapter, we present partial results of a European-scale qualitative project that followed a methodology based on grounded theory, using interviews to families as method. Our findings reveal different roles played by the parents – role models, gatekeepers, companions, and supervisors. We also found that these different roles are related to the parenting style and also to the parents' own digital practices, and most importantly to perceptions and attitudes towards digital media.

INTRODUCTION

Our society is profoundly shaped by the integration of digital technologies in our daily routines. Children are being born in homes filled with computers, smartphones and tablets, and they are increasingly being exposed earlier to digital media in the home, and consequently engaging with such devices. They are "digitods," they were born after the launch of smartphones in the market (2007) and their parents are usually experienced digital users themselves (Leathers *et al.*, 2013; Holloway *et al.*, 2015). Digital media are fully integrated in the family's daily routines (Kucirnova, 2011).

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However, most research on children and digital practices has focused on older children, mostly adolescents, who soon stood out as pioneers and trendsetters in the use of the Internet and mobile phones. Our research fills this gap by exploring the way young children (under 8 years old) engage with digital technologies in the home, looking particularly at family dynamics (Vatavu *et al.*, 2014; Plowman, 2015). Both the academic literature and industry reports show that young children have facilitated access to digital technologies at home, and parents are the main mediators of digital experiences at such a young age, as children learn directly from their help and support or by observation and imitation (Plowman *et al.*, 2008; Findahl, 2013; Genc, 2014).

BACKGROUND

There is a broad body of academic literature on parental mediation of media consumption, focusing particularly on young children and television (e.g. Dorr *et al.*, 1989; Sang *et al.*, 1993). This concept refers to the role played by parents as mediators of young children's engagement with communication media, thus shaping their practices and perceptions. Different facets of parental mediation have been explored, namely mediation styles, factors that may influence mediation styles, and the consequences of mediation styles for children's practices and perceptions.

There are different models of parental mediation styles, that Valkenburg *et al.* (2009) sum up in three categories: a) restrictive, corresponding to highly controlling parents in the sense of monitoring and limiting media use; b) instructive, referring to parents who are still controlling but more in the sense of teaching and advising; and c) coviewing, a concept used to describe negotiations, dialogue and search for consensus between parents and children regarding media engagement.

Recent research on parental mediation has addressed this phenomenon when it occurs with digital media. Livingstone (2007) was a pioneer, suggesting the concept of "parent regulation" to describe that parents often draw on family roles, particularly their dimension of authority, to negotiate rules and practices concerning media. Usually, there was an adaption of the rules already set regarding television for digital media. Proposals by other authors (e.g. Barkin *et al.*, 2006; Eastin *et al.*, 2006; Rosen, 2008) can be synthesized in two categories: whether parents tend to 'support' the children's digital practices, thus teaching and helping them overcome difficulties; whether parents tend to "control" their digital practices (at this age, control is more exerted over time of use than over content). Later on, previous mediation styles identified for television watching were applied to digital media: restrictive, active and co-use. Moreover, new mediation styles specific for digital technologies were added: monitoring and "helpdesk" (Nikken & Jansz, 2013).

DIGITAL PRACTICES OF YOUNG CHILDREN

Although most research on digital practices has focused on older children, in the past few years, as children are coming into contact with digital media at increasingly younger ages, a considerable body of academic literature and industry reports have been produced. Despite the different contexts – some international, some national – and methodologies – qualitative and quantitative – they all point to the same conclusions: young children have access to digital media very early and they are spending increasingly more time interacting with such media, to the detriment of others.

Quantitative research stresses penetration rates and time of use. For instance, in the US, 83% of families with children under 5 years of age own a tablet, 77% a smartphone, 58% a computer, 56% a console and 59% have Internet access (Kabali *et al.*, 2015). In the UK, 86% of children under 8 years old have access to a computer in the home, 69% to a smartphone and 40% to a tablet (Lauricella *et al.,* 2015). In the UK, children spend an average of 75 minutes a day watching TV, and their second favorite media is the tablet, when they use about 29 minutes a day; while in the US, 45 minutes a day was dedicated to watching TV, and 27 minutes to watching videos on mobile devices and more than 22 minutes using other apps.

Industry reports highlight a considerable growth in the use of the tablets. Among 5 to 7 years old children, tablet use grew from 11% in 2012 to 39% in 2013. In addition, 68% of 5 to 7 years old children own mobile devices, and 46% of 3 to 4 years old (OFCOM, 2013). Another report corroborates that 3 out of 4 children have access to a smartphone or tablet in the home, and the number of children under 8 years old that have their own tablet rose from 8% in 2011 to 40% in 2013 (CommonSense, 2013). The growth in penetration and use of mobile devices is mirrored by a decrease in other devices such as computers, consoles, and even the TV. In the UK, young children spend an average of six and a half hours a day in front of screens, but tablet-time is increasing and TV-time is decreasing (ChildWise, 2016). The report adds that the tablet is also replacing the computer and reports that 67% of children have their own tablet.

Another common finding is that the tablet is the absolute favorite of young children. Only 3% of children under 8 years of age have never used a tablet, and 25% of them have their own personal devices (Kabali *et al.*, 2015). The tablet is young children's favorite device. Other trends spotted are that as age increases, children have access to more digital devices, spend more time using them, and are capable of more complex and diversified uses (ChildWise, 2016).

Having established that young children are keen on using mobile digital devices, the literature also identifies their favorite practices. Children play games and go online to watch videos and listen to music (OFCOM, 2013; CommonSense, 2013). The favorite online destination of young children is YouTube, with 72% of the surveyed children visiting it everyday (Luscombe, 2015). The choices of devices and activities are strongly gendered among young children. Boys own more consoles and girls own more smartphones; boys enjoy games related to races, sports, adventure and fighting, while girls like fantasy, storymaking, dressing up and taking care of pets (OFCOM, 2014). On the academic side, the conclusions are similar: although the tablet is the favorite device of all children, the choice of apps tends to reflect boys and girls fictional universes of superheroes and princesses, respectively (Chaudron *et al.*, 2015).

PARENTAL MEDIATION

Parents tend to be generally permissive with the use of mobile devices in the home (Plowman *et al.*, 2008). The main reason for this is that this generation of parents are "digital natives" (Prensky, 2001) themselves, and most of them as the competent digital users and enjoy engaging with digital media. Thus, the primary source of parental mediation is imitation. The parents' digital media are available in the home, and young children observe how their parents engage with them, later mimicking their practices. There is a "mirror'" effect between the digital practices of parents and the ones adopted by children, highlighting the fact that the younger the children are, the more they tend to reproduce their parents' practices with digital devices (Lauricella *et al.*, 2015).

Another important reason for such permissiveness is that tablets are effective "babysitters" that keep the children entertained while the parents are busy with house chores or work (Dias & Brito, 2016). For

instance, 28% of the parents of children ages six months to four years, use the tablet as a replacement of direct interaction during bedtime, that is, they use the tablet to "tell" bedtime stories to children until they fall asleep (Kabali *et al.*, 2015). Thus, parents tend to be comfortable with allowing occasional use of their devices such as smartphones, laptops and tablets, and children have even freer access to their own personal devices, usually tablets and consoles (Plowman *et al.*, 2008; Findahl, 2013; Genc, 2014). This means that children are often left alone to explore digital devices independently (Livingstone, 2007; Plowman *et al.*, 2008; Bittman *et al.*, 2011; Kucirnova & Sakr, 2015). Children under five years of age tend to use tablets and smartphones for long periods everyday, and usually without any help from parents, or supervision (Kabali *et al.*, 2015).

However, at such an early age, although children are able to explore digital media independently, they frequently need guidance and help. When they encounter difficulties, young children first attempt to overcome it on their own, usually adopting a trial-and-error strategy; if they are unable to solve the problem independently, they resort to older siblings if they have them, and later to parents (Chaudron *et al.*, 2015; Dias & Brito, 2016). Parents play a crucial role in their adoption of digital media, as it is with them that children first experience digital media (Warren, 2003; Livingstone, 2007; Plowman *et al.*, 2008; Bittman *et al.*, 2011; Craft, 2013; Kucirnova & Sakr, 2015).

Despite this general permissiveness, there are some rules that are common in many homes, such as only being allowed to play after finishing homework and not being allowed to play for long periods of time or just before bedtime. In fact, parents control the devices that children are allowed to use and time of use, instead of monitoring the content to which children are exposed. Parents believe that such young children are not often exposed to online risks, because their skills and consequently use are rather limited: they do not go online frequently, and they do not interact with others on social networks. However, it is precisely on YouTube that children under eight years of age are more vulnerable to risks, mostly exposure to inappropriate content (Dias & Brito, 2016). Because of the touch-screen nature of mobile devices and the tailored functioning of YouTube, children can easily follow the platform's suggestions for content to watch, and most often children use their parents or older siblings' accounts, thus becoming exposed to content intended for adults or teenagers. In addition, children develop complex strategies for conducting searches, memorizing letters and shapes, and they are keen on finding the content they want (Hourcade *et al.*, 2015). If children are more competent than parents are aware of, parents are often oblivious to measures they could take to protect the children, such as YouTube "child mode" of filters, and most of them believe that blocking access and forbidding is ineffective, and that dialogue is the best way to protect children from online dangers (Dias & Brito, 2016).

There is also recent research on the variables that shape the parental mediation of digital media. Gender plays an important role as parents tend to be more permissive with boys and restrictive with girls. Also, mothers are generally more permissive and fathers more authoritarian (Goh *et al.*, 2015). Other socio-demographic features of the parents, such as age, educational background, level of internet usage, online experiences and perceptions and attitudes towards the Internet, are also important (Valke *et al.*, 2010). In general, parents with more digital skills, who use more digital media, and have more positive perceptions and attitudes towards these technologies, are more permissive. Negative experiences with older siblings also have an important weight on parental mediation (Nikken & Jansz, 2015). Family dynamics and factors such as proximity and intimacy between parents and children must also be mentioned (Rudy *et al.*, 2014). Valke *et al.* (2010) draw on previous work on television to propose a model that relates parental mediation of digital technologies to overall parenting style. They define two axes of parental mediation regarding Internet use at home – parental control and parental warmth

– leading to a matrix of four mediation styles: authoritative, authoritarian, permissive and *laissez-faire*. The authoritative style is the most frequent, combining high parental control with high parental warmth.

Researchers are also worried about how parental mediation styles affect children's digital practices and also overall perceptions and attitudes towards digital media. Children of permissive parents are more tech-savvy and more active online while children of authoritarian parents show lower levels of digital literacy (Valke *et al.,* 2010). The mediation style is a determinant for harvesting (or not) the potential of digital media for learning (Bittman *et al.*, 2011). Surprisingly, higher education of parents is not a predictor of co-use of digital media. It is the less educated parents that spend more time playing console or watching YouTube videos with their children (Connell *et al.*, 2015). Although the literature already reveals important information about parental mediation of digital media and the way it affects children, researchers seek further research on such a complex phenomenon (e.g. Tiller *et al*., 2003; Wang *et al.,* 2005; Barkin *et al*., 2006).

Despite the important role played by parents in the adoption of and engagement with digital devices, it must be considered that children are an active part in this mediation process. They may or not engage frequently with their parents – asking for help, for instance; or they may or not choose to explore digital media by themselves (Plowman *et al.*, 2015). The parenting style is, thus, dynamically negotiated between parents and children, and in permanent flux.

EMPIRICAL WORK

Methodology

Our approach is qualitative and follows the procedures for developing grounded theory suggested by Strauss & Corbin (1998). The engagement with digital media is explored along two dynamics: a) between the child and the family; and b) between uses and practices and self-reported. Thus, our study considers four research questions that result from the crossing of these axes: 1) How do children under the age of 8 engage with new (online) technologies? (individual use); 2) How are new (online) technologies perceived by the different family members? (family dynamics); 3) How do parents manage their younger children's use of (online) technologies? (parental mediation); and 4) What role do these new (online) technologies play in the children's and parents' lives? (awareness of benefits and risks).

This proposal presents national results from Portugal about the relationship between the parent's use and perceptions about digital media and their parental mediation style (Valcke *et al.*, 2010; Nikken & Jansz, 2015) that are a part of the wider project "Young Children (0-8) and Digital Technologies." This project included 180 qualitative interviews of families with children aged 6 or 7 years old in 2015. Our national sample is constituted by only 10 families with children aged 6 to 7 years old, which were selected according to theoretical models for obtaining a stratified sample, aiming at getting diversity in family composition, gender of the children, income, education and digital skills of the parents. Table 1 presents additional information about the families. The families were recruited using personal contacts of the researchers and social care institutions and they all live in the metropolitan area of Lisbon.

The methods used are a set of interviews with three moments - an icebreaker activity with the whole family and simultaneous but separate interviews with the parents and children – and observations collected with multiple activities – a schedule with stickers about daily routines, a card game about favorite activities, a grid for identifying apps, a digital tour given by the children, a chart of digital media use

Table 1. Socio-demographic information about the participating families

Family Code	Child Code	Other Members Code	Income	Ethnicity	Parents' Education	Parents' Profession
PT1	PT1b6 (boy)	PT1m36 (mother)	Low	Portuguese	PhD	Early childhood educator
PT2	PT2b7 (boy)	PT2f39 (father) PT2m39 (mother) PT2b3 (younger brother)	Medium	Portuguese	University	Mechanics consultant Environment consultant
PT3	PT3g7 (girl)	PT3m39 (mother) PT3f35* (father)	Medium	Portuguese	Tertiary University	Product Manager in Telecommunications Consultant in ICT
PT4	PT4b6 (boy)	PT4sf38 (stepfather) PT4m26 (mother) PT4g9 (older sister) PT4b7 (older brother) PT4b2 (younger brother)	Low	Portuguese	Secondary	Plumber and Firefighter Unemployed
PT5	PT5b6 (boy)	PT5f42 (father) PT5b11 (older brother) PT5b7 (older brother)	Low	Portuguese Spanish Spanish	Secondary	Unemployed
PT6	PT6b7 (boy)	PT6m41 (mother)	Low	Portuguese	Tertiary	Health assistant
PT7	PT7b6 (boy)	PT7f42 (father) PT7m38 (mother) PT7b1 (younger brother)	Medium	Portuguese	University	Civil engineer Civil Engineer
PT8	PT8b6 (boy)	PT8m40 (mother) PT8f42* (father) PT8g15 (older sister)	Low	Angolan	Secondary Tertiary	Unemployed Electrician/Plumber
PT9	PT9g7 (girl)	PT9m35 (mother)	Medium	Portuguese	University	Technician of Pathological Anatomy
PT10	PT10g6 (girl)	PT10m42 (mother) PT10f59* (father)	High	Portuguese Brasilian	University	Clinical Psychologist Dentist

Notes: Our coding system refers to the country (PT, Portugal), the role in the family (b, boy; g, girl; f, father; m, mother) and the age. The family members signaled with * are fathers who do not live permanently with the interviewed children or because they are divorced or because they are working abroad at the time. However, we decided to include information about them as they are present in the lives of the children and participate in the engagement with digital technologies.

built by the parents and several photos. All of this information was coded in a database according to a system of thematic categories and keywords, following the method of QCA - Qualitative Comparative Analysis (Boyatzis, 1998; Braun & Clarke, 2006), and ultimately analysed and discussed.

Although we are aware of the limitations inherent in studying such a small sample, our in-depth and holistic approaches to families and the selection of a stratified sample reinforce the relevance of the results. These are not generalizable, but provide enlightening insights about how digital technologies are being used in the intimacy of the home and the implications of such practices for family dynamics.

Findings and Discussion

In Table 2, we present an overview of the issues that this section addresses, namely the experience and skills with digital media both of the child and the parents, and the parental mediation style.

Table 2. Technology use by the children and parents and parental mediation style

	Technology Use by Child	Technology Use by Parents	Parenting Style	Quotes
PT1	PT1b6, High	PT1m36, Medium	*Laissez-faire* (low demands, low involvement)	*PT1m: Sometimes he asks questions and I say we have to search it on Google... the other day he asked how bridges were built underneath the water and I said we could look it up when we got home. But then we got home and forgot, because he only remembers these questions in the moment and then forgets. We do searches very rarely... In theory, I try to use the tablet as an information source, but in practice when we get home we don't actually do it...* *PT1m: If he is on the computer, he plays alone in the living room. I only go there when he has some difficulty, or when it blocks, or if the Internet fails.*
PT2	PT2b7, High	PT2m39, High PT2f, 39, High PT2b3, High	Permissive (low demands, high involvement)	*PT2b3: I want the tablet!* *PT2f: Look, it's not the weekend. You know that. When are you allowed to play with the tablet?* *PT2b3: At the weekend. But today is the weekend!* [It was Thursday] *PT2f: Almost... Maybe tomorrow I'll let you play a little bit...*
PT3	PT3g7, High	PT3m39, Medium PT3f35, High *divorced	Authoritative (high demands, high involvement)	*PT3m: I don't have the laptop at home, I keep it at work and I rarely bring it home. And she doesn't ask to use it. But when I do bring it, she watches videos on YouTube for hours. If I let her, I think that any child would, she would be there for hours. That is why I rarely bring it... I want her to have other experiences.*
PT4	PT4b6, High	PT4sf38, Medium PT4m26, Medium PT4g9, High PT4b7, High PT4b2, Low	Authoritarian (high demands, low involvement)	*PT4m: During school time, during the week, they are forbidden to touch the tablet, I don't allow it. They can only play on Friday and Saturday, if they don't have homework.*
PT5	PT5b6, Medium	PT5f42, Low PT5b11, Medium PT5b7, Medium	*Laissez-faire* (low demands, low involvement)	*PT5f: I don't even know what they do* [on the smartphone]... *Listening to music, I don't know... Sometimes they watch videos on YouTube and some are music videos.*
PT6	PT6b7, High	T6m41, Medium PT6f XX, High *divorced	*Laissez-faire* (low demands, low involvement)	*PT6m: I haven't quite adapted* [to digital technologies]*… I don't really like them. And that is an addiction; it becomes addictive.* *PT6m: There are no strict rules* [regarding device use] *because he…. He follows the rules.*
PT7	PT7b6, High	PT7f42, High PT7m38, Medium PT7b1, Low	Authoritative (high demands, high involvement)	*PT7m: During the weekend* [he is allowed to use the tablet]. *If he behaves very well I also allow him on Wednesdays, because that is the day of the week when he doesn't have homework. But it is rare. And during the weekend I try to control the time he plays. I don't let him play for hours.* *PT7m: We don't make the same mistake again* [allowing their youngest child to use the tablet without setting rules]... [laughter] *We don't allow him to do it.*
PT8	PT8b6, Medium	PT8m40, Low PT8f42, Medium PT8g15, High *Father emigrant	Authoritarian (high demands, low involvement)	*Interviewer: What kind of games does he enjoy?* *PT8m: Hum...* [PT8b6], *Which games do you like, son? Don't ask me because I don't know... Sometimes I watch him play, but...* *Interviewer: If he doesn't behave well, do you take the tablet away for a day?* *PT8m: Yes. I don't let him play.* *Interviewer: Does it happen frequently? Does that punishment work?* *PT8m: Look, this kid is impressive, he has a very strange temper. It doesn't really work because he says "I don't play today, I will play tomorrow"* [laughter]. PT8g15*: Sometimes my mother says that he has to turn it off, but there are no specific rules.*
PT9	PT9g7, Medium	PT9m35, Medium	Authoritative (high demands, high involvement)	*PT9m: I try to have her play, or chooses games, with which she ends up learning something.* *PT9m: She is aware there are videos* [online]... [laughter] *But I don't give her much autonomy with the videos because I want to be with her, so she doesn't watch anything that just comes on, I don't let her watch videos alone.*
PT10	PT10g6, High	PT1042, High PT10f59, High * father emigrant	Authoritative (high demands, high involvement)	*PT10m: She uses them more during the weekend* [digital devices]. *During the week, she doesn't really use them... But we don't have rules.* *PT10m: Most of the times, she ends up using the tablet when I am unavailable, so we don't really keep each other company.*

Chaudron et al., (forthcoming).

Notes: The family members signaled with * are fathers who do not live permanently with the interviewed children or because they are divorced or because they are working abroad at the time. The assessment of the levels of digital media use by parents and children was adapted from what Livingstone *et al.* (2015) used in the EU Kids online project for older children, considering high users those that use at least one digital device more than twice a day, medium users those who use at least one digital device once or twice a day, and low digital users those who use at least a digital device less than once a day. The classification of the parental mediation style follows the model from Valcke *et al.* (2010).

General Use of Digital Media

Young children enjoy using digital media, and their absolute favorite is the tablet, which is replacing the TV and the console to some extent. The main activities are playing games and watching videos on YouTube, and the choices extend to offline preferences, as children tend to choose games related to their favorite activities/sports and fictional characters/toys. Children's choices are strongly gendered: boys like adventure and fighting games with superheroes while girls like dressing, nails and make-up, princesses and taking care of virtual pets. Children know more about digital media than parents think, since they observe the parents and mimic their behavior. Parents emerge, therefore, as role models for children. For instance, in the homes where parents (usually fathers) were digital gamers, children often played with the console, and that activity was often performed together (e.g. PT2, PT4, PT7). Also, parents described intimate moments with children co-viewing YouTube, usually mothers watching tutorials and video-clips with their daughters (e.g. PT3, PT9, PT10).

However, co-use of digital media is not very frequent in the studied families. For parents, the tablet is often a "babysitter" or an "SOS," a strategy to keep children entertained when they are busy. This means that children experiment and explore alone, and only ask the parents for help when everything else has failed, thus becoming resourceful and savvy with digital technologies. They learn mostly by observing and mimicking the parents, and also by individual trial-and-error approaches. When questioned about how they learned certain skills, they answer "I did it alone!" or "I already knew how to do it!" Even younger children, who are not able to read and write yet, have their own strategies for finding content in the App Store, on Google Play and also on YouTube, based on icon memorization and following suggestions. Parents also report that they only have to show or teach once; children learn very easily and become increasingly autonomous. Older siblings play an important role, as they often teach the younger ones, but the roles of teacher and apprentice can be interchangeable (e.g. PT4, PT6). They also introduce the youngest to new apps and activities.

Parental Mediation Style

Our overview of the parental mediation styles follows the model by Valcke *et al.* (2010), a matrix of four styles according to the degree of control (demand) and involvement. Most families report low involvement of the parents in their children's digital activities, as children engage with digital devices alone. Parents justify their low involvement with the need to keep the children entertained while they do house chores or work from home, claiming that the tablet is the most effective way of keeping the children entertained and happy. Thus, it is by the end of the afternoon, between finishing homework and having dinner, that children have their "play time" with the tablet.

Interviewer: *When he plays with the tablet, is he alone or you are next to him?*
PT1m: *He is usually alone.*
PT10m: *Most of the time, she uses the tablet when I am unavailable, so we do not keep each other company.*

The parents also use this "babysitting" strategy outside the home. They bring the tablet for situations when they know children will be bored, such as long car trips. Also, mothers refer to their smartphone

as an "SOS," as they allow children to play with it when they get restless, misbehave or cause embarrassing situations.

Interviewer: *During waiting time, does he play? For instance, at the doctor...*
PT1m: *Yes.*
Interviewer: *He asks for the tablet or do you give it to him?*
PT1m: *It depends (laughter), usually I give it to him...*
Interviewer: *You do that to keep him quiet...*
PT1m: *Exactly, to keep him from destroying the doctor's office.*

One of the most common joint activities is gaming. Mothers often play dance and karaoke games on consoles, and watch YouTube videos about cake-making and make-up with their daughters, while fathers are their sons' companions in action and adventure games. Most parents enjoy these shared intimate moments and complain about not having more free time to dedicate to them.

Interviewer: *Do you like playing games with him?*
PT2f: *I do, the problem is that I don't have a lot of time.*

Another joint activity is Google searches, but this only happens in less than half of the families. Parents explain that school does not stimulate the use of digital devices for searching or doing homework yet, and they do not have time to explore it further. A few parents report situations where they feel that a search would be helpful and intend to do it later with their children, but end up forgetting or not having time. In fact, the potential of digital devices - especially the tablet - for learning is largely under-explored or even ignored. Children know a few pedagogical games but prefer others. We only found pedagogical apps installed in two families, and they were not used frequently (e.g. PT9, PT10).

PT9m: *I try to have her choose games that will lead her to learn something. I also let her play the ones for dressing princesses, I allow, but they are not the ones I find more interesting or important. I prefer that she plays games related to learning, such as puzzles and memory games… and even games where she needs a strategy to overcome obstacles and go to the next level, so that the games stimulate her in some way.*

In most cases, parents have a rather limited perception of the tablet or the smartphone, regarding them as toys or sources of entertainment, overlooking their pedagogical potential. However, some parents report higher involvement and benefit from the pedagogical potential of the tablet. For instance, PT9m told us she likes to be around when her daughter plays with the tablet, so that she can help her and influence her in choosing more pedagogical apps. Thus, parents can act as gatekeepers, selecting content and activities that they consider appropriate or beneficial for their children, and preventing access to what they find inappropriate or dangerous. PT9m is particularly concerned about YouTube, so the daughter is not allowed to use this particular platform alone.

PT9m: *I prefer if she plays with me.*
Interviewer: *For instance, she watches videos on YouTube, or she doesn't do that yet?*

PT9m: *She knows there are videos... [laughter] But I don't allow her to be very autonomous with the videos because I want to be with her, so that she doesn't just watch anything that comes on... But she knows we can go online and search for movies or short videos. However, she knows she must always do it with me, she is not allowed to do it alone.*

Actually, YouTube is a source of concern for parents, but most of them choose an occasional monitoring instead of a high demand/control. Parents monitor what the children are watching from time to time, and listen while they are busy with their chores, thus having some notion of the content their children are watching.

Interviewer: *And the videos, do you watch with her or do you let her watch alone?*
PT3m: *She almost always has the sound on. I let her have the sound on. If I don't like what I am hearing, and it has happened, I ask her "What are you watching?" Generally, it is always make-up and music, but once there was a make-up video to turn people into monsters or creatures and I was afraid it might scare her.*
Interviewer: *Do you pay attention to the videos she watches on YouTube?*
PT10m: *Look, when she plays with the tablet is when I am less available for her, but I end up keeping an eye on what is going on... So, between the living room and the kitchen, I ask her about what she is doing... I peek, I listen, I end up controlling but in a subtle way, without much pressure... but with a regular periodicity.*

Parents dislike playing the role of gatekeepers or rulemakers, they prefer being companions to their children. However, there are some rules regarding digital practices in most of the homes. The parents tell us they are negotiated with the children, and often are a consequence of some problem that occurred. However, the children perceive the rules as imposed by the parents. Most rules limit the time that children are allowed to spend using digital devices, as parents are more concerned with the consequences of excessive use – stress, frustration, hyperactivity, tiredness, lack of social contact, lack of outdoors activities – than with risks associated to content – violence, advertising, sexual content. Thus, children feel that these time restrictions are imposed by the parents, and most of them would like to play for much longer periods. Most children play between half an hour during the week, usually only after finishing their homework (as technologies are perceived as a distraction from schoolwork). Sometimes they also play after their hygiene, and before going to bed. During the weekend, the rules are less rigid and children can play for longer periods.

Some of the children are only allowed to use digital devices during the weekend. Usually, this strictness follows negative experiences. Some parents report that their children were too excited and nervous after playing for long periods, and they felt the need to set some rules. In family PT7, their son PT7b6 is only allowed to play with the tablet during the weekend, and the parents are careful not to expose their younger son to digital technologies too soon.

Interviewer: *How old was he [PT7b6] when he started using the tablet?*
PT7f: *Very early. (...) We were in Angola and he started to play with it very early.*
Interviewer: *And now his younger brother wants to play too, right?*
PT7f: *Hum...*
PT7m: *We're not going to make the same mistake... [laughter] We don't allow him to do it.*

The parents of PT7b6 also told us about another danger of leaving their son playing alone: he spent 50€ on paid apps.

PT7f: *Once, she [the mother] had her account set to make purchases, by default... If I buy something, it asks for my code, but if I shop more during the next half an hour, I can keep shopping and it won't ask for the code again. And we had an episode of three or four purchases in a row... And 50€ to pay for in apps... [laughter]*
Interviewer: *But did he do that?*
PT7f: *He did it! He bought one, and another, and another... He didn't need the code because the mother had just bought one app. And he kept browsing the app store and had a lot of fun buying games.*

Actually, not being allowed to buy paid apps was a common rule in all the families. Parents believe that there is such a big offer of free games that they don't have to pay for this kind of content. Besides, some of the children must ask permission before installing apps, or the parents use a password that they must insert in order to install apps, and in this way they are always up to date with the content their children come into contact with.

Although there are not strictly established rules, another form of high control is to deprive children of digital technologies as a punishment. Parents are aware of how much their children enjoy their tablets, so they use it for disciplining them, both as reward and punishment.

Interviewer: *Do you use digital media as punishment?*
PT2f: *If he doesn't behave properly, we take away his tablet. (...) There was a weekend when he misbehaved and I took away his tablet, that was it.*
Interviewer: *But it is the punishment that most affects him, or is it one among the others?*
PT2f: *It affects him a lot [laughter]. Yes, because he loves it, he loves to play.*

Despite these rules, there were two families where the parental mediation style was based on low control. Both mothers reported that they didn't need to set rules because their children didn't play excessively. Rules and control are related to the parents' perceptions of the dangers their children are exposed to. Parents believe that, at such a young age, the children are not very exposed to dangers because they rarely go online and they do not communicate with strangers. In addition, parents are not fully aware of the children's skills and practices. Nevertheless, children are exposed to dangers, particularly inappropriate content on YouTube.

Interviewer: *Have they ever watched something on YouTube that shocked them or scared them?*
PT7f: *Sometimes they are watching Spider-Man videos and the other one appears...*
PT7m: *The one with a skull.*
PT7f: *We must pay attention.*
PT7m: *Because when he sees him he doesn't even want to go upstairs alone if it is dark.*
PT7f: *Yes, when he watches that stuff we know we are going to have problems with him at night.*

Most parents believe that, in the face of online dangers, dialogue and monitoring are more effective than prohibitions, as they fear that forbidding might make children even more curious. For example, when PT10m noticed that her daughter had installed a violent game, she explained to her that those

games were not appropriate for her age, and the child stopped playing those kind of games. However, most parents did not feel the need to have this kind of conversation yet. Some mothers with daughters are more careful about social networks and have approached the subject with the children.

PT8m: *About friendships on Facebook, I talk to her. I explain the dangers. And she watches the news on TV. And I tell her "Do you see how dangerous Facebook is?" It has a lot of good things, you can make friends, ok. But she must be aware that a lot of people in there can take her on bad paths."*

PT4g9 has already asked her mother to create a Facebook profile, but the mother did not allow it, and explained to her that we never know who is behind each profile "asking for friendship." PT4m reports that if she catches her daughter on Facebook, she will forbid the use of all digital media: "internet, tablet, everything."

In the case of divorced parents, there were more visible differences in the parental mediation style and in the resulting practices. There were two cases of the fathers being high digital users and the mothers being low and medium digital users. As a result, the children used the devices for longer periods and for more diversified activities when they were with the fathers. Also, the fathers taught them how to perform certain tasks - for instance how to call the father via tablet - and often played with them.

Interviewer: *PT3g7 didn't mention digital technologies in her routine with her mother. She doesn't use them?*

PT3m: *It depends on which house she is in. When she is with her father, the first thing she does is go to the living room and grab the tablet. I have even talked to her stepmother and said "It is so weird watching her with you, she is a completely different child. She doesn't do this with me." She has very different behaviours and habits from one house to another. Including the tablet. I have witnessed it several times, the first thing she does when she gets to her father's home is ask, "Where is my tablet?. She goes to the living room, turns on the TV and plays with the tablet at the same time.*

Parents' Perceptions about Digital Technologies

In the previous sections, we have already presented some perceptions about digital technologies that are common to most parents: they undervalue their children's digital skills and believe that their digital practices are more limited than what they actually are; a consequence they believe that the children are not exposed to dangers at such an early age, when they in fact are. These perceptions (or misperceptions) are reflected in the control dimension of the parental mediation style (Valcke et al., 2010), as parents focus their monitoring and rule setting on time spent playing and only occasionally monitor the game selection and online content being watched. In addition, parents perceive digital media, particularly the tablet, as a "toy," and its main function as "entertainment," thus overlooking its pedagogical potential. This is reflected in the involvement dimension of parental mediation (Nikken & Jansz, 2015), as parents do not regularly engage in joint digital activities, and when they do the most common is playing games.

In our research we were able to spot other general perceptions about digital media that shape their parental mediation style. For instance, most parents acknowledge digital media is important – and even indispensable – for their children's future.

PT3m: *If I let her play with the tablet, I am helping her because she understands more easily how the future is going to be. She will live in a world where everybody is "cyber."*

According to the parents, digital media facilitates work and improves life in general. Parents stress quick and easy access to information and keeping in touch with distant family and friends as advantages that are afforded by digital technologies. Others mention their utility for schoolwork, for searches, and the fact that digital tools can promote the development of children, namely memory, hand-eye coordination, motivation for reading and writing, and mostly autonomy in exploring and problem-solving.

PT8m: *Today, children, I don't know why, they grow up very fast. They do things, they search for things that I cannot do. But my son is 6 years old and he does. I don't know why or how. For me, it is not normal. He does such things! There are things I don't need to teach him because he learns everything alone. On the tablet, on the smartphone. I don't even need to open my mouth because he says "I know because I have seen it on your smartphone!"*

Mothers PT3m, PT6m and PT8m discuss having trouble keeping up with their children's digital practices. In spite of these positive perceptions, parents are concerned about the changes in what their children understand as "play," when compared to what they regards as "play." Some mothers, as PT1m, PT3m and PT6m report that they would prefer if their children played more outdoors and used more of their imagination and creativity, but they also believe they could compromise their future skills and school/work performance if they prevented them from using digital media. Many of the parents - fathers and mothers - referred nostalgically to their childhood, spent playing outdoors with friends, living in rural areas, playing traditional games, building and inventing their own toys.

A big concern is the replacement of social contact by technologies, and the loss of social skills. Parents dislike that children prefer engaging with technologies to playing with other children, and fear for their socialization and ability to make friends. Some even mention that their child spends too much time playing and doesn't interact much with the rest of the family.

PT3m: *The negative side [of technologies] is the lack of social contact. I am afraid for those children, I know that there are a few, even the children of friends of mine, that spend the whole day on their PC, and they have difficulties in connecting with other people, have low social skills, and I think it is the technology that takes that away from them. (...) To the extent that I am able to, I will keep her in contact with less technology and more nature.*

Some parents also mention fearing that the children will become addicted to technologies. They also point out that the children become nervous, frustrated and too excited when they are playing games on the tablet for too long. Others observe that children are becoming less resilient, as technologies make everything easy and immediate for them. They do not try to overcome problems, or make an effort, or wait for something. They always look for the easiest and fastest way of getting the satisfaction they want.

These perceptions, which are often misperceptions, have a strong impact on the children's digital practices, influencing their perceptions of the parents' behavior as a model, the rules that parents set as gatekeepers, and the activities that they choose to share with the children as companions.

CONCLUSION

Regarding the relationship between the parents' digital practices – Valcke *et al.* (2010) mention the level of Internet usage and online experiences – and their parental mediation style, our results show that low users tend to have more extreme styles, ranging from *laissez-faire* to authoritarian (although the *laissez-faire* is the most frequent). This is mostly a result of their low involvement in the digital practices of the children, while regarding control they can be permissive or restrictive. On the contrary, parents with high digital skills and frequent and diversified digital practices are more likely to mediate the children's online practices, although their perspective on control may be more permissive or restrictive (it is usually more restrictive). Thus, the parents' digital practices have a stronger weight in their degree of involvement, while their degree of control/demand is shaped by their perceptions.

Nikken & Jansz's (2015) claim that perceptions and attitudes of the parents regarding digital technologies influence their parental mediation style is also corroborated by our findings, as parents who have more positive perceptions and attitudes tend to be more permissive, and parents with more negative views tend to be more restrictive. Whichever the case, their degree of involvement may vary, but it is high in most cases. When there is high involvement from parents, digital media are triggers of intimate shared moments and strengthen the relationship between parents and children. However, in the case of low involvement, digital media become individual spaces of intimacy for the children, who are free to explore, learn and play.

In spite of these findings, our qualitative approach also revealed that parental mediation is a dynamic process that not only depends on a wider set of variables and interdependencies, but is also in permanent flux. Parents and children learn from one another, explore new technologies and possibilities, and negotiate rules, in a process that develops more or less at the same pace than children's growth.

SOLUTIONS AND RECOMMENDATIONS

Our research identified some important gaps between the parents' perceptions and the children's digital practices, mostly resulting from parental styles based on a low involvement. These gaps are a discrepancy between the parents' perceptions about their children's digital skills and practices and the children's effective skills and practices, which go far beyond what the parents think; the lack of awareness of parents about the children's exposure to online risks and also different views about rules regarding digital media in the home and the way these rules are set (parents describe the process as a negotiation and children regard it as an imposition). On the contrary, parents and children do share one perception that is discrepant from reality: they regard digital media, particularly the tablet, as a toy, what leads them to overlook its pedagogical potential.

The phenomenon studied happens in the home, but we recommend the engagement of external stakeholders in order to overcome the discrepancies in perceptions and misperceptions identified. We consider that schools have a privileged position, deriving from their proximity to the families, to foster awareness, digital literacy, and digital engagement. However, schools need a wider favorable political and societal setting that is up to policy-makers to build. We recommend that schools work in articulation with families to promote awareness about dangers and risks, to promote informed, diversified and safe digital practices, and to fully integrate the learning of children in a holistic approach that includes both formal and informal settings and agents.

FUTURE RESEARCH DIRECTIONS

One of the main difficulties of researching young children is the need to adapt traditional research methods and techniques to their age, maturity and competencies. This chapter reports on a qualitative exploratory study that aimed to draw a snapshot of the role played by the parents in the children's engagement with digital media in the home. However, further research is needed, particularly longitudinal approaches. Also, innovative methods based on the affordances of digital media themselves may be developed and applied to collect non-self-reported data which can be contrasted with the self-reported data collected through traditional qualitative methods.

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KEY TERMS AND DEFINITIONS

Children 0-8: Children under eight years old. This age group, although very diverse, is characterized by not being proficient in reading and writing, which shapes their appropriation and use of digital devices. Also, they have less autonomy at this stage, and strongly depend on parents as role models and helpers for their digital practices.

Children's Digital Practices: The way in which children have access to digital media and appropriate them, integrating them in their daily routines. The specific uses and activities performed by young children with digital devices, and their cognitive and social implications.

Digital Native: Term coined by Prensky (2001) to describe the gap between those who had grown up in contact with ICT (Information and Communication Technologies, mainly personal computers, mobile phones and the internet), and who were completely at ease and proficient with these media, and those who had come into contact with it later in life, and who despite being able to learn and adapt, always felt like "immigrants" in this digital context.

Digitods: Term coined by Holloway *et al.* (2015) to refer to children born after the launch of smartphones in the market (in 2007), and who have therefore come into contact with touch technology at a very early age or since birth. Touch interfaces make a big difference in the access of young children to digital media and content, as they enable an easier way of interacting with devices.

Home Environment: When it comes to young children, their main locus of socialization and learning are the home and the school. The literature usually distinguishes these two settings considering the home an informal setting, as rules tend to be specific to each family's dynamics and often negotiated, and the school a formal setting, as rules and social conventions tend to be less negotiated and generally applied. Thus, we talk about the home environment as an informal setting for the appropriation of digital devices and for the development of digital skills.

Information and Communication Technologies (ICT): Term early used (around early 90s of the 20th century) to describe a set of technological innovations that enabled information processing and storage and also communication at a global scale. It refers mainly to personal computers, mobile phones and the internet. It can be broadly considered a synonym of digital media or digital technologies.

Information Society: Term early used (around early 90s of the 20th century) to describe a new social model that was being shaped by the widespread and frequent use of ICT (Information and Communication Technologies). Information Society highlights a significant difference regarding the previous social (and also economic and politic) model, the Industrial Society. Similar terms are networked society (Castells, 1996) and digital age (Levinson, 1999).

Parental Mediation: As young children are not very autonomous, the concept of parental mediation highlights the pivotal role played by the parents as mediators of the contact of young children with media. The concept was initially developed regarding the TV, and later applied to digital media. Parents decide on access, and also on practices. There are different parental mediation styles, ranging from permissive to restrictive, and with different degrees of support.

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Section 4
Utilization and Applications

Chapter 47
Abuse of the Social Media Brain: Implications for Media Producers and Educators

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ABSTRACT

Despite the criticism in the mainstream press regarding the use and abuse of digital and social media, its use has been increasingly encouraged and supported in schools and universities. This chapter examines the social media behaviour of techy-savvy undergraduate students at NHTV, University of Applied Sciences, Breda, The Netherlands, from the perspective of an independent documentary producer and educator, to determine whether any correlation between the amount of time spent online and the use of cognitive functions exists. Media producers require an audience capable of critical thought, and teachers educate future audiences to acquire the necessary cognitive skills. Hence, the chapter analyses how the viewer's cognitive functions impaired by the use of social and digital media affects the reception of media products. This further leads to a more critical concern about the educators' response to the challenges provided by social and digital media.

INTRODUCTION

In some recent research articles, Kohle and Cuevas (Kohle, 2012; Kohle & Cuevas, 2012; 2010) demonstrated that digital natives have and continue to adapt their viewing habits to social and digital media, challenging traditional content development, production and distribution methods. Social media marketing has become a buzz word—users, companies, charities and governments, all are exploring the use of social media. As happened during previous 'information revolutions', social media users and content creators are still in the process of developing the social media narrative. They are not only learning how to access social media networks (SNS), they are increasingly developing the capability to critically process

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online information, becoming social media literate. For example, social media has become and remains instrumental in movements such as the Occupy movement and the Arab Spring. The digital and social media revolution has become a game-changer on a global scale and is the most recent in the evolution of previous 'information explosions', such as the invention of broadcasting and print technologies, the invention of the alphabet, and language itself.

Recently, the negative aspects of social media moved into the focus of the mainstream press. Surveillance of social and digital media was highlighted once more by Edward Snowden (Branigan, 2013). Agencies such as SS8 (2011) and Glimmerglass (2011) are well described regarding their data collection activities on behalf of government and private clients. Intelligence Support Systems for Lawful Interception (ISS, 2013) offer a platform for companies such as SS8 and Glimmerglass to present their latest social media tools in intelligence gathering. Conferences take place across the globe and services offered include, but are not limited to: cyber security and lawful interception of data, as well as submarine cable landing stations, offering access to submarine optical cables that support millions of voice calls and internet traffic. SS8 specializes in 'accurate reconstruction of intercepted voice, text and internet activity' and the 'correlation of intelligence from Internet Protocol Data and Call Detail Records to full communications content' (SS8, 2013). How this can be done without violating the 1st amendment of the US constitution is debatable, not to mention international and national law for the rest of the world.

The topic of social media surveillance abuse on its own requires further investigation, but this would go beyond the scope of this paper, which does not focuses on social media surveillance and security issues, but on the impact of social media on the development of cognitive skills of digital natives and place it into a historical as well as social theory context.

BACKGROUND

This paper is relevant to media producers who continue to work in their profession and who have an interest in teaching. Familiarity with Marshall Mcluhan's (1995) media theory and Briggs & Burke's (2009) history of media is recommended. Macluhan argues that the "medium is the message". It is the media system itself which transforms society. Evidence suggests that the use and abuse of social media also has a detrimental impact on the development of cognitive skills among digital natives and immigrants alike. (Spitzer, 2012) At the same time digital natives are challenged to acquire new skills to navigate social and digital media; skills needed to become literate in the use of a new media technology, which in itself is influencing user behavior and the way content is produced. Data suggests that not only behavior is affected; the brain itself also undergoes significant changes.

Social media is not only the latest 'information explosion' in a series of evolutionary steps, since the invention of language (Kohle, 2013); it differs considerably from previous information explosion events, such as print and broadcast technologies in speed of information dissemination. This was discussed by Mcluhan, though the speed with which this new technology evolves and the extent to which it encompasses previous media technologies is beyond the scope envisaged by Mcluhan. Social and digital media are a paradigm shift when compared to previous information explosions, such as the invention of writing and the alphabet.

History teaches us that the introduction of new technology also brings with it undesirable side effects. Social media is no exception to this: it not only challenges the way media productions are developed, produced and distributed – evidence suggests social media is also playing a role in the way audiences

develop their cognitive skills. With regards to content for social and digital media, we take into account Mcluhan's idea on how content for new media originates from yesterday's technology. For example: content for TV is print; content for print is writing. We take a closer look at Mcluhan and examine his ideas within the context of social media. We then conclude this paper exploring uses and abuses of social media among digital natives from the perspective of a media producer and educator.

Research Methods

We critically examined the impact social and digital media has on cognitive functions among a group of digital natives and undergraduate students aged 18-22 at NHTV, University of Applied Sciences, Breda, Netherlands. A group of 77 undergraduate students was surveyed using a multiple-choice questionnaire to investigate their social media behaviour. The survey was designed to provide insight into the use of cognitive functions such as memory and orientation. All 77 students completed the survey.

We conducted a literature review of the arguments provided by critics, such as neuro-surgeon Prof. Dr. Manfred Spitzer (2012), as well as claims by South Korean researchers who have found evidence suggesting a correlation between the early onset of dementia among South Korean digital natives and the use of digital and social media. We further investigate phenomena such as cyber bullying and Facebook depression by reviewing relevant papers in the field. We then compare the outcome of our survey to arguments presented by critics, discuss the implications for documentary filmmakers within the context of Mcluhan's ideas on media theory, and summarize our findings accordingly.

Survey Results

The author of this study observed viewing habits of digital natives since 2009, following the Occupy movement, Arab Spring, describing the impact social media have had on digital natives and immigrants alike, as the ultimate information explosion. Abuse of social and digital media did not escape the authors' attention, i.e. use of social and digital media by agencies such as the NSA. In this chapter, we discuss the outcome of our survey, research into the impact of social media on cognitive functions and media theory. The classical definition of dementia is based on the loss of cognitive functions, memory and orientation (WHO ICD-10 Classification of Mental and Behavioral Disorders, 1992). Survey questions were designed to explore memory relating to literature read, news headlines noted, documentaries seen, and the ability to relate the campus location of NHTV to the Breda city centre. Our survey focused on the claims students made without judging the validity of the content of their claims. For example, it was not important for the survey outcome if students claimed they remembered the news headline: "Obama stops clandestine NSA internet surveillance", even if this news headline at the time of writing this paper was factually incorrect. The survey only captured the student's claim that they remembered something. We also added a control question, such as "What did you have for lunch yesterday?". If students were dement at the time of taking the survey, the answer to that question would more likely than not elude survey participants.

Only 4 out of 77 students participating in the survey stated that they spent less than 2 hours per day online. This small group claimed that they had the least difficulty staying focused during class and staying off-line during lectures. In stark contrast, 7 students claimed to spend 10 hours or more online per day: 6 students from this group stated that they had difficulties staying off-line during class and tutorials. 3 of the 4 of students claimed to spend less than 2 hours online and remembered the last documentary

they saw. Only 4 of the 7 students claiming to spend 10 or more hours a day online remembered the last documentary they saw. Data suggests that more online time using social media does not correlate with improved memory.

However, not all results were this clear. 6 of the 7 students from the group that spent 10 hours online, stated that they remembered news headlines, compared to 3 out of 4 students who claimed to spend 2 hours or less online per day. In this case the 10-hour online group's results were similar to that of the 2-hour online group. This could be due to a number of reasons, such as size of the sample group and cultural differences within an international setting. Another reason could be that students 'skim' news headlines using various sources, meaning that they are aware of newsworthy events but without do not have deeper knowledge of them. It would be desirable to repeat this survey on a larger scale to investigate these two groups in more detail. We did not observe a statistically significant difference between sexes.

45 out of the 77 students stated that they spend between 3-5 hours online every day. 47% claim that they experience difficulties staying offline during lectures and tutorials. 35% do not remember the last documentary they saw, 88% do not remember the last day they spent without internet access, 71% do not remember the title of the last book they read, and 40% could not place the location of the university in relation to the city center of Breda. Based on the above, nearly half of the students in this group could be diagnosed with a mild form of dementia: a degree of memory loss interfering with every day activities, the main function affected being the learning of new material (WHO ICD-10 Classification of Mental and Behavioral Disorders, 1992).

Having said all that, 97% of students remembered their lunch the day before, an indication that dementia is not yet an issue for digital natives between the ages of 18-22. But it is debatable whether students are exercising and further developing their cognitive skills considering the survey outcomes. Data suggests that retention of literature recently read, daily news and events or documentaries seen, is not improving among this group of students by means of social and digital media. A small group of students who spent less than 2 hours online a day read more, are better informed, more focused and less distracted by social media in the classroom when compared to students who are online longer. Control questions indicate that students are not dement, but distraction from social media poses a real problem: the majority of students who are online between 3-5 hours a day find it difficult to remain offline during lectures, remain focused, remember news events, literature and documentaries seen, or even when they were last offline.

MAIN FOCUS OF THE CHAPTER

Cognitive Functions: Effects of Social and Digital Media on the Brain

Manufacturers of tablets and mobile devices are keen to expand their market reach, increasingly targeting children and teenagers for their products as existing markets reach saturation. Sandvik, Smordal and Osterud (2012) argue that the use of tablets improved language learning in a kindergarten setting. Their data suggests that digital tools such as iPads provide an opportunity for 'children to engage in useful language interaction', though it remains unclear how the use of tablets at such an early age influences brain development. Similar studies claim that children aged 3-5 developed considerable vocabulary and phonological awareness (Chiong & Shuler, 2010). Still, even proponents of digital tools claiming ben-

efits in the development of language among 3-5 year olds are cautious and recommend further studies regarding this topic (Sandvik, Smordal & Osterud 2012).

Critics such as Manfred Spitzer (2012) and Psychiatrist Dr. Kim Dae-jin (Some teens are exhibiting signs of 'digital dementia', 2013) have described the early onset of dementia among social media users. They claim that digital and social media are hindering the normal development of cognitive functions in teenagers and adolescents. Similar articles have appeared in other mainstream papers, highlighting concerns over the use of social and digital media (Digital Dementia on the rise, 2013; Ryall, 2012). Social and digital media may not only hinder the physical development of the brain, if used inappropriately; researchers in the field of education examined online social aggression and abusive behavior in Australia (Burgess & Mcloughlin, 2011). They claim that the consequences of cyber-bullying can be more severe than face-to-face bullying because the physical separation of victim and aggressor does not lead to an end of bullying. The recent increase in cyber-bullying and the consequent suicide of a number of teenagers brings this issue once again into the public domain (Gadkari, 2013; Arkin, 2013; Ensor, 2013; Warren & Quigley, 2013). The psychological aspects of online social aggression warrant further investigation.

If true, a growing number of digital natives are at risk of not being able to fully develop their cognitive skills, exposing them to the onset of dementia at an early age. Society as a whole will need to bear the moral and financial costs associated with an increase of dement citizens in the future. Media producers rely on audiences equipped with well-developed cognitive skills in order to encourage and stimulate critical thought on the topic presented.

Spitzer (2012) argues that the indiscriminate introduction of mobile devices and digital media into the classroom at an early age and during adolescence has a detrimental impact on the development of cognitive functions. As a neuro-scientist and brain surgeon, he found a spot in the German public highlight as one of the more vocal critics of social and digital media. His writing style can be construed as polarizing; nevertheless, he provides a well-constructed argument, not entirely against social and digital media per se.

Instead, he advocates a more thoughtful and responsible use of social media. We know too little about the impact of social media use in the class room and in kindergarten. Media use combined (TV, music, games, computer, books and cinema) averaged at 7:38 hours per day in the US in 2009 (Rideout, 2010). Consequences of this amount of media consumption are not frequently examined by industry-funded researchers for obvious reasons. The London School of Economics surveyed 25000 9-16 year olds from 25 European countries (Livingstone, Olafsson, & Staksrund, 2013). They concluded that digital natives frequently visit sites inappropriate for their age, lacking the skills to navigate SNS's safely.

In response to these considerable threats to the safety of young people and teenagers, the industry has responded with self-imposed strategies that aim to minimize these risks, though little is known about the effectiveness of these strategies. Strasburger, Jordan and Donnerstein (2010) published similar results, making concrete recommendations to schools, the entertainment and advertising industries, as well as researchers and government bodies, on how to deal with the consequences of social and digital media 'abuse'.

The importance of well-developed cognitive functions is also highlighted by Woollett and Macguire (2006, 2011) in their investigation into the role of the hippocampus, a part of the brain associated with memory. Taxi drivers who regularly studied to memorize London street maps to pass the London taxi driver exam showed a measurable increase in the size of the hippocampus. Critics such as Spitzer claim that social and digital media makes it too easy to not practice and develop cognitive functions. Spitzer explains that the descent into dementia at a later age is very much determined by how well an individual's

brain developed during early, formative years: a person with well developed cognitive functions at his or her disposal is more likely to descend into dementia later in his or her life. Data suggests that lesser developed cognitive functions result in the early onset of dementia, though clearly more research is needed in this area.

His arguments are supported by reports from South Korean psychiatrists such as Kim Dae-Jin at Seoul's St. Mary's hospital (Baek Il-Hyun & Park Eun-Jee, 2012). South Korea's mobile device penetration is among the highest in the Western world (Media Trend Watch, 2012). Practitioners such as Kim Dae-Jin have noticed an increase in cases described as 'digital dementia': the deterioration of cognitive abilities not normally associated with the age group of digital natives. According to Baek Il-Hyun and Park Eun-Jee (2012), the South Korean Health Insurance Review & Assessment service also reported a significant increase in people suffering from cognitive problems since 2008. This increase correlates with the rise of the sale and use of mobile digital devices in South Korea.

Further evidence is provided by Zhou et al (2011), who measured the effects of internet addiction on the brain. Individuals addicted to being online are shown to have a different brain structure. After 50 hours of internet gaming, Lee Seung Seop collapsed and died of heart failure. Christakis (2010) concludes that parents and teachers are too complacent in dealing with this issue, and terms the separation of digital immigrants and natives the 'digital divide'. Those who need most guidance, namely digital natives, are cared for by digital immigrants who are unaware of the negative aspects of social and digital media.

Critics argue that social media discourages digital natives from developing their cognitive skills. The impact of learning on the brain and the consequent development of the hippocampus were already described by Wollett and Mcguire (2006, 2011). Digital natives are prone to 'outsource' information into the 'cloud' (Mell & Grance, 2011), their computer, laptop or mobile device, and it is reasonable to argue that they are not training their brain. For example, London taxi drivers could use a GPS based navigation system guiding them via the most suitable route to their destination. In turn, however, their hippocampus would be less developed, which, as critics claim, increases the likelihood of developing dementia earlier rather than later.

Data from our survey suggests that social and digital media do not improve cognitive functions, memory and orientation, especially when essential information is kept in a cloud instead of the brain. Social and digital media are part of a transformation process in society, and are physically measurable: South Korean and German researchers find that abuse of social and digital media have detrimental effects on the development of the brain (Spitzer, 2012).

The Medium is the Message: Or is It?

Social media can be compared to Mcluhan's famous light bulb analogy: the light bulb in itself does not have any content, but at night it illuminates an otherwise dark space for social activity. The internet, social, and digital media function very much in the same way: on their own, they have no content, but they have enabled users on an unprecedented, global scale to access and participate in a virtual space. It is reasonable to argue that this new online world is evolving into a global online collective consciousness.

Society is being transformed from a non-virtual world to encompass a virtual state, providing post-modern content via the social and digital media domain, which in itself is constantly changing: a key characteristic of post-modernity. Users no longer need to study and memorize a roadmap. This is

accomplished by the mobile device instead. Perhaps this is the next evolutionary step. Dunbar (2003) describes the human brain's limitation in dealing with more than 200 social contacts, when compared to the brain of other hominids. Watkins (2010) submits that it became necessary for early man to overcome this limitation by cultural means; for example, monumentalism and storytelling. The development of language also had a major impact on the brain's structure (Corbalis, 2009)—it increased in size and led to the development of episodic memory as humans developed the ability for 'mental time travel' (Tulving, 2002). Language allowed us to tell stories that required an understanding of time: past, present and future. Or in narrative terms: a beginning, middle and end.

Briggs, Burke and Mcluhan teach us that previous media technologies played a significant role in the transformation of society and culture. We also learn that with the introduction of each new technology the human brain underwent significant changes. For example learning the London roadmap results in an increased hippocampus for London taxi drivers, a significant and measurable outcome attributed to practicing memory as a cognitive skill. Critics are also quick to highlight negative aspects regarding cyber bullying, Facebook suicides, internet addiction and their observations on the development of cognitive functions and the brain. But what if that is all part of a natural evolutionary cycle? What if we are supposed to 'outsource' information onto a cloud and share it with the world? What if the next evolutionary step for Homo Sapiens Sapiens is to develop a global collective consciousness located in the cloud? On the other hand, if dementia occurs as a result of under-developed cognitive skills as Spitzer claims, what kind of society are we looking forward to? How will outsourcing crucial information to the virtual cloud world prevent the onset of early dementia?

Mcluhan (1995) argues that the 'medium is the message'. He submits that it is the medium that transforms society rather than the message it carries. It is debatable whether or not media is causing transformation, or if it correlates regarding change. His ideas describe the transformative effect of media on cultural and social aspects of society. Evidence suggests that a correlation exists between the development of the brain and the way users engage with media. Jung's (1981) ideas on synchronicity could provide another perspective on media and 'Zeitgeist'. It is therefore reasonable to argue that the "medium being the message" not only plays a role in the transformation of society, but also a causal or correlative function in the development of the brain, a topic that warrants further investigation.

Mcluhan understood very well the nature of the beast. For example, he advised his son Eric not to expose his granddaughter Emily to "hours and hours of TV", as he considered TV to be a "vile drug which permeates the nervous system, especially the young" (Morrison, 2013). Spitzer and his South Korean counterparts present evidence that suggests that not only TV but social and digital media in particular have a detrimental effect on audiences. Jacobs (2011) points out that Mcluhan was prone to make popular statements such as this, using a variety of media platforms such as print and TV – the medium he despised so much. Jacobs rightly questions Mcluhan's credibility if on the one hand he claims that media as 'the extensions of man's consciousness …. [hold] the potential for realizing the anti-christ", yet in the same discussion proposes that "we're standing on the threshold of a liberating and exhilarating new world". How could anyone take Mcluhan seriously after such a 180 degree turnabout?

Nevertheless, many of Mcluhan's assertions are visible within the social and digital media domain. There is a case to support his claim that 'yesterday's technology' provides content in the social and digital media domain. For example, Mcluhan describes the message of the moving image as a transition from lineal connections to configurations. Previous information explosions such as print transformed

a feudal society into a linear and conform society, which in turn paved the way for the French Revolution. He argues that content distributed by each new technology has its origins in the previous medium, for example the content of writing is speech that of print is writing, and so on. The key difference with social and digital media though is that it encompasses all previous forms of media in a virtual space: language, writing, print, film and interactivity.

For example, Jencks (2009) concludes that 'branded terrorism' could be considered a post-modern pre-announcement of murder, after discussing Lyotard (1992). Lyotard describes the characteristics of modernity vs. postmodernity in graphic detail. Auschwitz as a death camp was a highly structured mass-production place of murder, well organized, a well-kept secret, the epiphany of a modern, totalitarian society. G. W. Bush's pre-announced attack on Iraq, on the other hand, could be described as branded terrorism, the post-modern equivalent. Current events in Syria and the Obama administration's justification to intervene also fit this category. Mcluhan also observed that the introduction of each new technology speeds up cultural and social processes in society. The speed with which social and digital media has invaded real and virtual spaces confirm this. In fact, the speed with which social media evolves is such that by the time this paper is published, it may already be outdated. It is not surprising to observe an increase of 'old' messages being distributed via digital and social media, such as social aggression in the form of bullying, aptly named cyber-bullying as it takes place online.

Mcluhan provides a reasonable theory explaining how previous media technologies provide content for new ones. With the arrival of electronic media he foresaw the 'global village'. Social and digital media move beyond the scope of his vision; all pervasive content is reaching a global audience at an ever increasing speed, yet messages have remained the same. Previously, teenagers and adolescents were bullied at school and at home, either in person or by means of an anonymous note or letter.

Cyber-Bullying and Facebook Depression

The latest fashion among bullies today is to bully peers online. 'Facebook depression' and 'Cyber bullying' are known online phenomena. Moreno at al (2011) observe that out of some 200 students surveyed, 25% displayed depressive symptoms. 2.5% met the criteria for a major depressive episode (MDE).

Hannah Krasnova of the Institute of Information Systems, Berlin, surveyed 600 individuals to find that one in three felt worse after visiting a social networking site (SNS) (Krasnova et al, 2013; Sifferlin, 2013). Krasnova describes how Facebook users experience envy when visiting sites of peers and comparing their own lives accordingly. Krasnova demonstrates that users frequently perceive Facebook as a stressful environment. The post-modern online world is constantly changing and thus challenging users and content creators to continuously update and apply their social media skills.

Moreno's group provides further insight regarding Facebook users who decide to go public with their depression, which may not be rooted in the use of a SNS alone, but other circumstances. His group comes to a positive conclusion in their evaluation of Facebook as a platform for users to express depression: social networking sites could become a tool in dealing with depression, though this would require more regulation of SNS's. Pediatricians too have noticed the negative impact of SNS's in the lives of children. Schergin and Clarke-Pearson (2011) investigated this problem and have made specific recommendations to pediatricians dealing with the negative effects of social and digital media. Still, cases of Facebook suicide are on the increase and make headlines, with calls from concerned parents and consumer watchdogs to review and improve existing legislation regarding social media abuse and cyber bullying.

FUTURE RESEARCH DIRECTIONS

Social media and internet use has been a major issue as social space has been taken over by the virtual world. This research not only opens further consideration into the cognitive process of social media use, but the role of social media in the educational spectrum. The new learning curriculum incorporating digital technologies and virtual learning, pose challenges both to the students as well as the teachers. For a viable and effective teaching and learning module, understanding the (adverse) effect of social media use and student's concentration level is important. Hence this research initiates a humble step towards it. The date can be further used and explored in a wider scale for further indulgence into the social media research.

CONCLUSION

Why is this important to media producers and educators? Media producers need to be aware of the social media narrative developing among digital natives in order to develop, produce and distribute content to the appropriate target audience, using ethically justifiable methods. Social and digital media as a new medium implies that content of previous technologies provides content for it, according to Mcluhan. This is essential knowledge producers need in order to develop, produce and distribute content via social and digital media.

Educators, though working in a different environment, need to understand social and media technology equally well to meet their educational mandate. They develop a different kind of narrative for an audience consisting of students. Most of them are digital natives in the process of becoming versed in social media. Producers, educators nor society as a whole can afford to only note and apply the advantages of social and digital media, such as crowd-funding, social media marketing and self-distribution. Motivation to investigate the negative side of digital and social media is not coming from industry and remains neglected. Society as a whole will have to bear the costs of the negative effects of social and digital media regarding the development of an individual's cognitive function.

Though tempting, not all content should be marketed via social media and apps to younger audiences. The guidelines are not yet available to all stakeholders, though the calls to review and regulate social media practices are increasing. Industry funded research is not likely to accomplish this on its own. A media market based on generating revenues alone is not likely to implement anything else but voluntary guidelines regarding the use, implementation and marketing of social and digital media tools aimed at digital natives at home and in the classroom. Educators are advised to critically evaluate the benefits of social and digital media, and put in place guidelines that protect users and require them to practice their cognitive skills until more research in this field shows otherwise.

Our survey shows that social and digital media has become an integral part in the lives of digital natives; increasingly, digital immigrants find it difficult to escape this new technology as well. Students are using social and digital media to deal with the information tsunami they are faced with on a daily basis. For many, including digital immigrants, it has become impossible to process the amount of information presented online and via traditional media in any other way. As a consequence, information is no longer processed at a deeper level, but absorbed superficially instead. Critics argue that using social and digital media in this way does not improve the development of cognitive skills, making it even more difficult for students to acquire new knowledge and retain it in the long-term.

Producers need to carefully consider the means that should be used to develop, produce and distribute their programme to avoid unwitting support regarding the use of technology unsuitable for the intended target audience. There is a need to better understand the new emerging digital native culture. Understanding and critically examining Mcluhan's ideas in this area helps obtain the big picture. Reaching an audience is a challenge for the best of producers, but even more so without an understanding of the narrative unfolding among digital natives and digital immigrants alike.

Teachers are equally challenged when communicating with their students via SNS's, while producers are constantly searching for new ways to engage with their audience online. Expectations of online content and viewing behavior have changed significantly. In 2010, the average YouTube video, selected from among 2.5 million video clips, analysed was 4 minutes and 12 seconds in length (Inside YouTube Videos, 2010). Understanding this emerging narrative among digital natives provides numerous challenges to producers, such as length of programme, gamification, interaction and participation, format, i.e. short-form webisodes, and/or traditional long-form formats. The Scottish Film Institute is exploring new ways to meta-tag content, provide audience interaction and distribute their catalogue using technologies such as Popcorn and Distrify (Wistreich, 2012; Kempas, 2012).

New job descriptions are emerging, such as the Producer of Marketing and Distribution, social and digital media being one of the tools to develop, distribute, market their product and engage with audiences. Teachers are frequently challenged in the classroom, populated by students who are texting, skyping and facebooking. Almost half of the students in our survey stated that they found it difficult to stay offline during class. The negative effects of multi-tasking have been described in the literature, and educators are struggling to deal with the consequences of social and digital media in the classroom. Producers are dealing with this new reality by exploring new ways to reach audiences in the multi-screen-verse.

The unfolding social media narrative is increasingly making headlines because of tragic events, such as the death of a 17-year-old teenager in the UK (Teenager's death sparks cyber-blackmailing probe, 2013). According to Barbara Brams (2013), 75% of adolescents have a social network profile, which is accessed by more than half of them every day. They increasingly share private information online, disregarding privacy and safety concerns (Madden et al, 2013). Even though they still prefer face-to-face contact over social media, digital natives are increasingly exposed to cyber-bullying, resulting in depression, social isolation and suicidal thoughts (Hinduja & Patchin, 2010). Educators are challenged to pay more attention to social media; though for many, this technology is scary and unknown territory. Nevertheless, if parents fail to spot suicidal thoughts, the teacher may be the next in line to deal with the problem, but not if she or he disengaged from the social media narrative.

Bullying and suicide are not new to mankind; the social media phenomena has developed into a global platform, with its own culture, language, narrative and interaction that is not well understood by digital immigrants, such as parents, teachers, social workers, government bodies and media professionals themselves. While digital natives are exposed to the good and bad of social media, digital immigrants are trying to figure out how to deal with this new technology, leaving digital natives to deal with the consequences of social media with little or no guidance.

Social media has taken on its own dynamic pace and the rest of the world is lagging behind trying to work out how to react to his new global challenge. Viewing social and digital media from Mcluhan's perspective, we recognize the post-modern content in a post-post-modern technology. Constant change has become the norm, one might even argue that we are observing the death of post-modernity—whereas the pre-announced attack on Iraq based on branded terrorism was still effective, taking into account the weapons of mass destruction lie presented by the Bush administration, the current US administration is

facing a great deal more resistance when applying the same kind of post-modern strategy to deal with Syria. Social media offers greater transparency to all stakeholders, though it will only have any benefits if users are still in control of their cognitive skills.

The Occupy and Wall Street movements demonstrate all too well how digital natives and immigrants alike have understood social media and its post-modern content. It shows how users of social and digital media have developed a new form of media literacy for this new medium, accelerating the transformation from a post-modern into a post-post-modern society. Mcluhan's ideas on media encompass this process; though social and digital media are not only encompassing the post-modern 'Zeitgeist', they contain all previous media technologies at an ever increasing speed.

Producers need to understand Mcluhan's ideas better to fully appreciate the transformation, social and digital media is facilitating for society and at an individual level. The world is in the midst of this process, audiences, users and producers are becoming media literate in this new technology. Institutions, organizations and governments are adapting swiftly to this new challenge and they are learning their lessons, reacting in typical post-modern fashion to the challenges online. Producers are more likely to adapt quickly in order to reach their target audience during this transformation. Small and medium-sized businesses are better suited to act and react to these challenges. Due to their size, they are able to act and react faster when compared to their large, modern and post-modern counterparts.

Educators, on the other hand, are required to work within hierarchies that managed to survive centuries of transformation, i.e. the introduction of print and broadcast technologies. This paper itself is a testament to the positive aspects of social media in such an environment: i.e. access to libraries and online sources, as well as the potential to collaborate at the research level with scholars across the globe made it possible to discuss and exchange new knowledge via this new virtual space. Educators are advised to actively become part of the social media narrative and provide clear guidelines on the use of social media in the classroom.

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KEY TERMS AND DEFINITIONS

Cognitive Skill: It refers to the human capacity of processing the thoughts like memorizing, differentiating, learning, speaking and understanding information/data.

Cyber-Bullying: It's synonymous to digital abuse whereby anyone with the aid of digital technologies harass and threaten other users.

Dementia: Impaired intellectual faculty like lack of memory, concentration and judging power.

Digital Abuse: The use of digital technologies like social networking sites and digital gadgets (through SMSs, photographs or online messages) to bully and harass anyone.

Digital Natives: It represents a generation who are born or bought up in a digital era who are well-versed in the technological aspect and whose daily endeavor revolves around these technologies.

Social Media: It is a virtual medium through which the users can communicate, interact and share information with the fellow-users and indulge in a social networking. Facebook, YouTube, Second Life, Twitter etc. are some examples.

Virtual Space: It is a computer simulated environment where people interact.

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Chapter 48
Multimedia Quality of Experience

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ABSTRACT

This chapter introduces the overall concept of multimedia Quality of Experience (QoE) over the Internet. It presents all the elements of multimedia QoE ecosystem and emphasizes their roles in determining the user satisfaction. The chapter also presents different multimedia transmission components and how these components contribute to successful transmission of the media content. In addition, some key performance indicators relevant to the multimedia QoE are presented with more emphasis on network and application level indicators. Furthermore, different QoE estimation methods and techniques along with QoS/QoE learning algorithms are presented. Finally, the chapter includes some of the future challenges and issues related to multimedia QoE.

INTRODUCTION

The multimedia era started in the middle of the last century, when the television appeared and people got used to watch TV shows and movies at home. Moreover, with the VCR, DVD and Blue-ray disks and players, viewers could use the TV set to watch recorded material. In parallel, in the late 90s internet video service started. This was a time when video Internet technologies were merely innovation and

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novelty. Due to the technological limitations with dial-up connections and slow modems, it was hard to achieve good transfer rate and superior quality. In addition, the limited graphics processing power at that time prevented wide adoption of high quality videos. However, with the proliferation of broadband Internet and the tremendous increase in processing power, multimedia technologies boomed (Motorola, 2012). The combination of high speed Internet and sophisticated powerful devices introduced a completely new way for multimedia consumption through Internet. It was the boom of "Over the top" and "Video on Demand" services.

Moreover, the advancement in different concurrent digital multimedia technologies and the proliferation of smart mobile terminals with their application ecosystem have exponentially increased the popularity of Internet multimedia services. Multimedia services are a key player in current ICT business. It is expected that video traffic will reach 66% of the global mobile traffic by the year 2015 with one million minutes of video content crossing the Internet every second (Cisco, 2011). At the same time, video consumers are getting more demanding about the quality of multimedia content. Therefore, in order to satisfy users' demands with acceptable viewing quality, it is utmost necessary to monitor their satisfaction.

Traditional approach of measuring the user satisfaction relies on Quality of Service (QoS) parameters collected from the network. In this case, the QoS parameters are monitored and controlled in order to provide a satisfactory level of service quality. Different QoS parameters like bandwidth, delay, packet loss etc. are essential metrics for determining the service quality from technical point of view. However, QoS parameters do not necessarily reflect the user's satisfaction and feelings towards a particular service. In order to accurately address the human perception of the service quality, a new concept of measuring the *Quality of experience* (QoE) is involved.

The QoE refers to "*the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state*" (Brunnström et al., 2013). Accordingly, the QoE is a subjective metric and can vary due to the user expectation and context. Moreover, the QoE is a reliable indicator for service providers and telecommunication operators to convey overall end-to-end system functioning (client, terminal, network, services infrastructure, media encoding, etc.). Furthermore, it is a multi-disciplinary approach when determining QoE, which involves user psychology, engineering science, economics etc. The QoE depends on different elements (i.e. content, network, application etc.) that directly or indirectly affect the user's perception towards the multimedia service. These elements should perform at their best to provide high user experience. However, the diversity in these elements makes the QoE estimation rather complex and unpredictable.

It has been shown that multimedia customers are willing to pay for better quality of experience with multimedia services (Accenture, 2012). The success of paid VoD services (not to mention that of Netflix) is just a simple proof. However, customers get intolerant if a multimedia service is not satisfactory and they easily shift to other options, if their needs are not fulfilled. Therefore, the user satisfaction is utmost important for retaining customers and has become the main differentiator for the success of network operators and service providers. Correspondingly, network operators and service providers should accurately estimate and monitor the multimedia QoE in order to track the performance and quality of a particular service.

In the following sections, we consider different components of the multimedia QoE ecosystem and their roles in the multimedia QoE. We present different multimedia transmission components and highlight some key performance indicators relevant to the multimedia QoE. We also explain different multimedia

QoE estimation methods and techniques along with the QoS/QoE learning algorithms. Finally, we discuss some of the future challenges and issues related to the multimedia QoE.

MULTIMEDIA QoE ECOSYSTEM

Quality of Experience (QoE) is an important indicator for network operators and service providers to help them assessing the user acceptability towards a particular service or a particular application. As the paradigm is shifting towards user-centric evaluation of service or application performance, the real time estimation of QoE is becoming a necessity for network operators and service providers in order to attract and bind users to their service.

Generally, QoS parameters are used for evaluating the quality of multimedia transmission that does not necessarily reflect the user satisfaction with an overall service. The QoS parameters reflect network and service level performance; however, they do not address the user's reaction to the service or to the application. On the other hand, QoE is a multi-disciplinary metric, which is evaluated subjectively and can vary according to the user expectation and context. Moreover, it is an overall end-to-end system effect (client, terminal, network, service infrastructure, media encoding, etc.) that depends on a number of factors and cannot be simply measured.

Multimedia QoE ecosystem incorporates all the possible components that directly or indirectly affect the user's perception towards the multimedia service. Figure 1 shows different components that play an important role in determining the user's perceived QoE. The diversity in these components makes the QoE estimation rather complex and unpredictable.

Role of Each Component in Multimedia QoE Ecosystem

Each component of a multimedia QoE ecosystem determines the effectiveness of the service. A component's behavior depends on the performance of other components and their behavior can affect the overall multimedia QoE. The multimedia service provider should monitor, evaluate and adapt these components according to different service requirements in order to offer a better experience. The success of a multimedia service depends on how well all these components are behaving in the ecosystem. Hereafter, the role of different components of the multimedia QoE ecosystem is described.

Content

If the original multimedia quality is unsatisfactory, then the QoE at the destination is also unsatisfactory. In order to have a better multimedia QoE, the multimedia content should be of high quality. Some of the characteristics of multimedia content and their descriptions are listed in Table 1.

Different content characteristics represent the diversity of multimedia content and their properties influence the multimedia QoE. However, content characteristics like higher bit rate, frame rate and resolution increase the complexity of video encoding and require higher network bandwidth for getting better QoE. Moreover, different multimedia devices and applications should support different content characteristics for a smooth playback.

Figure 1. Multimedia quality of experience ecosystem

Table 1. Multimedia content characteristics and their descriptions

Content Characteristic	Description
Bit rate	*Bit rate in terms of video transmission refers to minimum rate at which video bits are transferred from a source to a destination. The higher is the multimedia bit rate, the better is the multimedia quality.*
Frame rate	*Multimedia frame rate refers to a number of multimedia frames presented per second. The higher is the frame rate, the smoother the video appears and hence, the better is the video QoE.*
Resolution	*Video resolution refers to the number of pixels in both directions (width and height) of a video frame. A higher frame resolution yields to a better video quality.*
2D/3D	*Video types i.e. 2D/3D, refers to visual dimension of a video content. These content types have different service and network requirements.*

Network

Network represents the segments from the content servers, the core and distribution segments and the access network with a combination of copper, fiber and wireless links. In order to experience better multimedia QoE, transmission conditions at the network end should be reliable. The network condition is represented by the QoS parameters. Each multimedia service has its own QoS requirements. Some of the network QoS parameters and their descriptions are presented in Table 2.

Table 2. Network QoS parameters and their descriptions

QoS Parameter	Description
Packet loss rate	*Packet loss rate is the ratio of the total number of packets lost in transmission compared to the total number of packets sent. The higher is the packet loss rate, the lower is the multimedia QoE.*
Burst loss	*If a group of consecutive packets are lost then the burst loss is defined as a burst packet loss. A higher burst loss results in a lower multimedia QoE.*
Jitter	*Jitter is the variation in the packet inter-arrival delay. Higher jitter results in a lower multimedia QoE.*
Bandwidth	*Bandwidth is the amount of information that can flow in a network during a specific period of time. To some extent, the higher is the network bandwidth, the higher is the multimedia QoE.*
Packet error rate	*Packet error rate is the ratio of the total packets received with errors to the total number of transmitted packets. The higher is the packet error rate, the lower is the multimedia QoE.*

The variation in time of the network conditions will directly impact the network QoS parameters, and thus, the multimedia QoE.

Users

Each individual user has his/her own perception towards the multimedia quality. User attitude and expectation towards multimedia services play a vital role in determining the quality of service. Multimedia QoE can depend on different user profiles such as age, sex, interest, skills, frame of mind, experience, etc. For example, if a person is young and sportive, he/she might be inclined to sport content and his/her perception towards the QoE of sport content can be different than for a movie content. Thus, it is necessary to categorize users and to analyze their needs.

Environment

Different environmental conditions can impact how users perceive the multimedia service content. Multimedia QoE can vary according to when, where and with whom the service is used. For example, multimedia QoE will be different when the multimedia service is used while commuting, in a cafe, at home or in a bar. These places offer different levels of external noise that can directly or indirectly impact how a user perceives the service. Moreover, time of a day (morning, afternoon, evening, etc.) also has an impact on the user multimedia experience. It was observed that for the same multimedia content, a higher level of user experience was obtained in the afternoon and in the mid-day (Msakni & Youssef, 2013). Also, the results obtained from lab tests (having controlled environment) and crowdsourcing experiment for multimedia QoE differ (Shahid et al., 2014).

Device

Multimedia content can be consumed through different devices such as television, personal computers, laptops, tablets, mobile phones, etc. These devices offer different level of screen size resolution as well as different sound quality to the users. Therefore, the user experience can vary when different devices are utilized. For example, the user experience of watching a video content on a personal computer (PC)

at a fixed distance differs a lot from that when watching it on a handheld mobile device, where one has a possibility to move (Khan et al., 2011). Subjective tests for multimedia QoE conducted by (Khan et al., 2011) on PC and mobile handset revealed that, for the same content, almost all users preferred the PC over the mobile handset.

Application

Multimedia content can be consumed as a video-on-demand (VOD) service, over the top (OTT) service, broadcast service, etc. These services provide different multimedia applications for usability and interactivity. Multimedia applications should be self-intuitive and easy to use for getting the higher QoE. In the study performed by Bernhaupt et al. (2007), it was discovered that the usability rating is higher when the service is easier to use. Moreover, every application has its own video buffering scheme, encoding and decoding, which can affect the playback of multimedia content and the overall multimedia QoE.

Each component of the ecosystem plays an important role in determining how users perceive the multimedia quality. If any element of the ecosystem is imbalance, the overall multimedia ecosystem is disturbed with lower QoE. This implies that concerned parties involved in the multimedia content distribution should be very careful in monitoring, evaluating and adapting these corresponding components for getting the higher QoE.

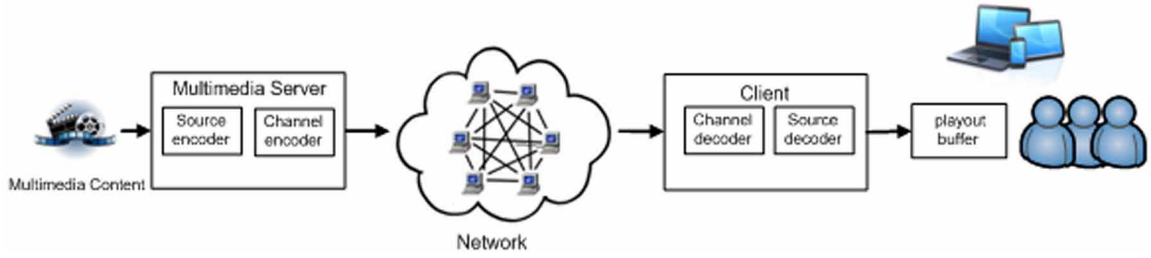
MULTIMEDIA TRANSMISSION AND KEY PERFORMANCE INDICATORS

Nowadays, multimedia traffic is the major source of traffic over the Internet. It is used for different purposes such as entertainment, education, advertisement, etc. Internet technology boosted the growth of multimedia by providing a transmission platform from where each individual can stream the content to their devices. However, Internet is the best-effort service and is shared by various data greedy applications, which means that multimedia traffic is vulnerable to various network perturbations. To overcome this time varying nature of Internet's network quality, different operators provide dedicated service (in the form of SLA agreement) to the managed multimedia services such as IPTV and VOD. However, most of the multimedia services are Over-the-Top (OTT) and need to share the same bandwidth with competing applications. Below, we study different aspects of multimedia transmission over the Internet.

Multimedia Transmission over the Internet

Figure 2 illustrates different components of multimedia transmission system over the Internet. The raw analog multimedia contents are huge in size and can consume large amount of network resources. To compensate this, analog multimedia contents are digitized and compressed by video compression and audio compression algorithms in the source encoder and stored in the multimedia server. Upon the client's request, the multimedia content is retrieved from the server and the channel encoder adapts the multimedia stream to network QoS requirements by adding redundant information for error recognition and correction. After that, the multimedia stream is transmitted (streamed) to the client terminal over the Internet. Multimedia stream can suffer from different types of perturbation like packet loss and delay due to congestion. At the client terminal, a channel decoder performs the error detection and correction and transmits the digital data to the source decoder. The digital data received from the channel decoder

Figure 2. Multimedia transmission



are transformed into continuous waveform in the source decoder, which can be viewed or listened when using different players at the application layer. To compensate the network jitter, different multimedia players implement a playout buffer. The playout buffer stores some multimedia content in order to have a smooth playback.

Different streaming protocols for data transmission are used over the Internet. Streaming protocols control the data transfer between the multimedia server and clients. The most popular streaming protocols, used for multimedia Internet transmission, are HTTP over TCP and RTP over UDP. We further explain the characteristics of these protocols.

RTP/UDP Based Streaming

The Real Time Transport Protocol (RTP) (Schulzrinne et al., 2003) is one of the popular and most used streaming protocols for multimedia transmission. Most of the IPTV and VOD services use RTP/UDP based multimedia steaming. RTP is transmitted over UDP and is basically used for real-time transfers. As Avermedia (2013) remarks, TCP is unsuitable for real-time transfers due to high delay. RTP works in conjunction with the Real Time Control Protocol (RTCP), which operates at the session layer. The main function of RTCP is to provide a feedback on the quality of the data distribution (McGath, 2009). However, when using UDP, data packets often have difficulties when getting through firewalls and network address translators (Biernacki et al., 2012). UDP is an unreliable protocol and the multimedia streams can suffer from packet loss, which might cause distortion of the multimedia content.

HTTP/TCP Based Streaming

Nowadays, most of the OTT video streaming applications use HTTP/TCP as a transport mechanism for multimedia streaming. This happens because HTTP/TCP can easily pass through firewalls and routers. In addition, it does not require special proxies or caches. HTTP media streaming is easier and cheaper to deploy, since web streaming can use generic HTTP solutions and does not require specialized servers at each network node (Biernacki et al., 2012). However, the use of TCP for streaming has some shortcomings. Due to the TCP congestion avoidance mechanism, it produces transmission rate which is saw-tooth shaped and has high variation. Also, due to TCP reliability, retransmission of lost packets occurs, which introduces additional transmission delays. To cope up with this short term bandwidth variation of TCP, streaming services deploy playout buffer (Seyedebrahimi et al., 2013). The use of TCP guarantees the reception of all packets to ensure no video impairment. However, due to severe network conditions,

multimedia transmission can freeze for a long time. Also to cope up with different network conditions, various adaptive HTTP-based video deliver schemes have been developed (RGB Networks, 2011). In adaptive HTTP based video delivery, video contents are encoded in different data rates and are stored as small fragments (a few seconds each) on the server. It has an ability to switch between different data rates based upon network conditions and other variables (RGB Networks, 2011). This will eliminate undesired freezing events at the client terminal however, reducing the multimedia quality, namely, the resolution. Different implementations of adaptive HTTP based video delivery are *Apple's HTTP Live Streaming* (HLS), *Microsoft's Silverlight Smooth Streaming* (MSS), *Adobe's HTTP Dynamic Streaming* (HDS) and *Dynamic Adaptive Streaming over HTTP* (MPEG-DASH) (RGB Networks, 2011).

Impacts of Different Transmission Components on Multimedia QoE

Different components are involved, when a multimedia content is being transmitted from the server to a client. Each of these components has its own effect on the multimedia QoE. Out of these different components source encoding, network and playout buffer have a significant effect on the multimedia QoE. In the following section, we explain some of these components and their effects on the multimedia QoE.

Source Coding

A source encoder converts the uncompressed raw media signals into bit streams. However, the size and the bitrate of this bit stream are huge. Therefore, different compression techniques are used in source coding to make the source data light weighted with the lowest possible bit rate in order not to exceed the available network bandwidth. The compression is performed in such a way that the same data can be easily reproduced at the decoder. However, data compression adds visible distortion and artifacts to the multimedia quality, since a lot of redundant information is lost. Moreover, the highly compressed multimedia streams are easily susceptible to network impairments. Examples of video compression standards are MP3, MPEG-2, H.264, H.265, VC-2, etc.

Network

Today's Internet services rely on unreliable and best-effort network. The network bandwidth available between the source and the destination is unknown in advance and can change over the time. Therefore, there is no guarantee for the bandwidth, the packet loss, the burst loss and the jitter for having a good multimedia quality. Moreover, multimedia streams are the most sensitive to the network perturbations and the effect of network perturbations can range from distortion-less to intolerable distortion. The impact of network perturbation on multimedia content streaming can result in a frame loss, freezing, pixelization, etc.

Playout Buffer

A multimedia service requires a multimedia player at the client terminal. Most of the players employ a playout buffer to compensate the jitter in the network. If the playout buffer gets empty, the playback of the multimedia stream gets interrupted. The size or the length of the playout buffer can determine start-up time or freeze events of the multimedia stream. If the length of the playout buffer is high, then the

start-up time will be high; that means users need to wait longer time before playback. On the other hand, if the length of the playout buffer is small, the buffer gets empty fast and there will be a risk of freezing events. Therefore, it is required to design the playout buffer smartly. Till now, there is no systematic guideline for buffering strategy and dimensioning of player buffer size. However, hereafter we outline video buffering strategies as discussed in (Sonnati, 2011).

- **Standard Buffering:** In the standard buffering strategy, the player maintains one buffer threshold level (buffer size). To start playback, the player continuously downloads the content up to this threshold and when the threshold is achieved the playback starts immediately. In parallel, the player downloads the video content in order to maintain this threshold. However, if the download bandwidth drops below the video data rate, data available in the buffer decrease continuously. This will empty the buffer and playback stalls until the buffer fills up again to the particular threshold. The main limitation of the standard buffering scheme is that the player needs to have larger buffer threshold level to compensate longer bandwidth drops. This leads to a longer prebuffering time, which can affect the user QoE.
- **Dual-Threshold Buffering Strategy:** To avoid the limitations of the standard buffering scheme, the dual-threshold buffering strategy maintains two buffer threshold levels. The lower threshold level is chosen to start the playback fast, while the higher threshold level is chosen to compensate longer bandwidth drops. In this scheme, when the buffer level reaches the lower threshold it starts playback and increases its buffer threshold to the higher threshold level. Therefore, in the good network conditions, the buffer grows continuously to achieve the higher buffer threshold level, which can be used in the future to compensate sudden bandwidth drops. However, if the buffer is empty due to adverse network conditions, then the lower value of buffer threshold is triggered for fast start.

Indicators (KPIs) for Multimedia Quality

Key performance indicators (KPIs) are parameters that indicate the overall success or the quality of a particular service. In case of multimedia services, KPIs indicate the overall quality of the multimedia service. The measurement of KPI parameters at different transmission points can help to identify and to locate the problem. In general, multimedia KPIs are classified into two groups namely: *Network level and Application level KPIs.*

Network Level KPIs

Network level KPIs are the QoS parameters associated with the network layer that indicate the quality of a multimedia service. Different packet level information (i.e. IP level information) is used to measure network level KPIs. Some of the important network level KPIs are described below.

Packet Loss Ratio (PLR): It is the ratio of the total number of packets lost in transmission, compared to the total number of packets sent. The higher packet loss ratio allows concluding that the network has problems. Multimedia traffic is highly susceptible to the packet loss ratio.

PLR is defined as follows:

$$PLR = \frac{N_{loss}}{N_{send}}$$

where N_{loss} is the total number of packets lost and N_{send} is the total number of packet sent.

Block Error Rate (BLER): BLER is the ratio of the number of erroneous blocks (transport blocks) received to the total number of blocks sent. Transmission errors significantly influence the BLER. When the BLER in the system increases, the multimedia quality decreases.

$$BLER = \frac{\sum Transport\_blocks\_with\_error}{\sum Transport\_blocks\_send}$$

Bit Error Rate (BER): BER is the ratio of the number of bit errors to the total number of bits sent. It is mainly caused due to noise and interference in the system. If BER in the system increases, multimedia quality decreases.

$$BER = \frac{Number\_of\_bit\_errors}{Total\_number\_of\_bits\_sent}$$

Average Delay: It refers to an average time needed for a packet to reach from a source to a destination. It can be measured in *ms* (milliseconds) or *μs* (microseconds). Larger delay results in the increase of a start-up time in the multimedia playback.

$$End\_to\_End\_Delay = Packet\_receive\_time - Packet\_send\_time$$

$$Average\_delay = \frac{\sum \left(Packet\_receive\_time - Packet\_send\_time \right)}{Total\_packet\_received}$$

Burst Loss: If a group of consecutive packets is lost, then this fact is defined as burst packet loss. The larger is the burst loss, the greater is the multimedia quality degradation. A single burst loss can impact a single video frame or can propagate to a number of video frames.

Jitter: It is the change in the packet inter-arrival delay. Jitter shows how much the latency changes from packet to packet. A low jitter indicates good and uninterruptable connection. A high jitter is a sign that there is congestion in the network. If we consider RTP protocol specified in RFC3550 (Schulzrinne et al., 2003) *Jitter* is calculated as follows:

If S_i is the RTP timestamp from packet *i*, and R_i is the time of arrival in RTP timestamp units for packet *i*, then for two successive packets *i* and *i*-1, inter-arrival delay *D* can be expressed as:

$$D_i = \left(R_i - R_{i-1} \right) - \left(S_i - S_{i-1} \right) = \left(R_i - S_i \right) - \left(R_{i-1} - S_{i-1} \right)$$

The inter arrival jitter is calculated continuously according to the formula:

$$J_i = \frac{\left(15 * J_{i-1} + \left|D_i\right|\right)}{16}$$

Throughput: A throughput refers to the number of bits received during a time unit and is measured in bits per second (bps). The higher is the multimedia content steaming throughput, the better is the multimedia service quality. If the throughput is less than the required multimedia bit rate, the multimedia quality degrades. For example, if throughput is less than desired multimedia bit rate, then the congestion occurs and packets are lost.

Number of Duplicate Packets: If the same packet is received more than once, it is considered as a duplicate packet. When duplicated packets appear, this means that there are some configuration errors in the network or some devices are defective. If the number of duplicate packets increases, the multimedia quality decreases.

Number of Reordered Packets: A packet is considered as reordered, if the sequence number is smaller than the sequence number of the packet previously received. If the number of reordered packets increases, the multimedia quality decreases.

Application Level KPIs

Application level KPIs are the performance parameters that are directly associated to the application layer and the presentation of a multimedia content. Some of the important application level KPIs are described below.

Resolution: Resolution is taken into account when a video multimedia content is considered. Video resolution refers to the number of pixels in both directions (width and height) of a video frame. It is represented in width × height format. Different video formats such as HD (1280× 720), SD (720× 480), QCIF (176× 144), etc. have their own video resolutions. The higher is the video resolution; the better is the video quality. It is noteworthy that the low resolution videos are preferred for handheld devices and the higher resolution videos are preferred for bigger display screens.

Frame Rate/Sample Rate: Multimedia frame rate refers to a number of video frames presented per second. The higher is the frame rate, the smoother the video appears i.e., the better is the video QoE. Video frame rate is measured in frame per second (fps). In case of audio, a sample rate is used, which is measured as the number of audio samples carried per second (Hz).

Encoding Rate: Multimedia encoding rate refers to the data rate at which the multimedia files are encoded. Multimedia files are generally encoded in Constant Bit rate (CBR) or in Variable Bit rate (VBR). The higher is the bit rate, the higher is the image quality. However, the higher bit rate adds more complexity to the system and requires a larger network bandwidth. This parameter is measured in bits per second.

Freezing Time: The duration of time, when the multimedia playback stops, is called a *freezing time*. This phenomenon occurs, when the application's playout buffer is empty. For smooth playback, application's playout buffer should be always full so that video frames/ audio samples can be always available for the playback. The higher is the freezing time, the lower is the multimedia QoE. This parameter is measured in seconds.

Freezing Frequency: The number of times that the multimedia playback stops or freezes is referred as a freezing frequency. If the freezing frequency increases during the multimedia playback, then the multimedia QoE decreases.

Blurriness and Blockiness: These are applicable for a video content. If there are insufficient bits available to represent details of image, blurriness and blockiness occur. This phenomenon is basically caused due to the compression techniques.

ESTIMATION OF MULTIMEDIA QUALITY OF EXPERIENCE

Multimedia services and applications have grown exponentially in the last years. Different multimedia services like IPTV, VOD, OTT video, video conferencing, etc. are very common in a massive Internet market. To gain a prominent market share, different vendors are competing with each other. Such competition includes cable television, Internet service providers, traditional and emerging telephony carriers, etc. On the other hand, multimedia costumers are expecting to access a high quality service on any device they are using (PC, smartphone, tablet). A user gets intolerant if the multimedia service is not satisfactory and he/she easily shifts to other options if his/her needs are not fulfilled. This requires the service provider to deliver the best multimedia quality to the customers under heterogeneous network conditions as well as for different terminals' capabilities. In these challenging scenarios, it is critical to guarantee an appropriate QoE for end-users. This requires efficient QoE estimation and monitoring techniques to track the performance of the multimedia service in terms of user's perception.

The QoE estimation methods can be implicitly categorised into *subjective* and *objective* methods. Subjective methods consist of many participants viewing sample multimedia and rating its quality according to a predefined quality scale depending on their personal perception. On the other hand, objective methods are used to measure the QoE, based on objectively measured network/media parameters. Different limitations of subjective and objective methods are listed below.

Limitations of subjective methods:

- Testing environment requires strict attention.
- Real-time implementation is difficult.
- Process is hard for automation.
- Subjective estimation is costly and time consuming.

Limitations of objective methods:

- These methods are hard to correlate with human perception.
- Objective methods may require high calculation power and time.
- When using objective methods, it is hard to integrate all quality affecting parameters in the model.

As listed above, both methodologies have their own shortcoming; to overcome these shortcomings, various hybrid approaches that combine both subjective and objective methodologies are proposed. For example, in different approaches such as those presented in (Rubino et al., 2006; Kushik et al., 2014; Pokhrel et al., 2014; Pokhrel et al., 2013) the authors use a dataset, which represents the relationship between objective QoS parameter values and the subjective QoE. Following this, different intelligent

systems (Rubino et al., 2006; Kushik et al., 2014; Pokhrel et al., 2014; Pokhrel et al., 2013) are trained with this subjective dataset to objectively evaluate/predict the QoE. Several researchers have shown that such hybrid approaches can objectively reflect the subjective mean opinion score of users with the reasonable accuracy.

Below, we describe some QoE estimation techniques that can be used when estimating the QoE for a speech or for a video content.

Speech QoE Estimation

Speech QoE estimation refers to the quality estimation of an audio/speech signal originated from different sources like TV or movie while talking, interacting, singing, etc. Speech QoE estimation can be classified into two groups which are subjective and objective QoE estimation methods.

Subjective QoE Estimation

The subjective speech estimation requires controlled environment. The test environment should be soundproof so that no external noise affects the experiment (ITU-T Recommendation P.800, 1996) and the participants involved in the experiment should not have any hearing problems. Different methodologies for subjective speech QoE estimation are described below.

Mean Opinion Score (MOS): One of the most common subjective speech QoE estimation methods is the Mean Opinion Score (MOS) method. In this method, participants are asked to rate the overall quality of a multimedia speech/audio being tested, without being able to see the original reference. Absolute Category Rating (ACR) is used for rating the quality. The MOS score of a multimedia sample is simply the average of the scores collected from subjects/users (ITU-T Recommendation P.800.1, 2006). Table 3 shows the MOS scores and categories.

Degraded Mean Opinion Score (DMOS): The Degraded Mean Opinion Score provides the numerical score to the annoyance or to the degradation of a speech quality based on human subjects. In the subjective test, the panel of listeners is fed with the reference speech and listeners evaluate a sample speech based on the reference one. The Degraded Category Rating (DCR) is used for rating the speech quality (ITU-T Recommendation P.800.1, 2006). Table 4 shows the DMOS scores and their corresponding categories.

Comparison Mean Opinion Score (CMOS): In the comparison mean opinion score method, the participants are provided with both reference speech and sample speech to be assessed in a random order. They are unaware about the order of the reference speech and the sample speech to be assessed. This

Table 3. MOS scores and its categories

MOS	Category	Category
5	Excellent	Imperceptible
4	Good	Perceptible but not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 4. DMOS scores and categories

DMOS	Category
5	Degradation level is inaudible
4	Degradation level is audible but not annoying
3	Degradation level is slightly annoying
2	Degradation level is annoying
1	Degradation level is very annoying

method uses seven scales ranging from -3 to +3 to compare the speech quality (ITU-T Recommendation P.800.1, 2006). Table 5 below shows the CMOS scores and their categories.

Pairwise Comparison (PC): In the pairwise comparison method, participants are provided with all possible combinations of the speech samples to evaluate. Participants listen to two consecutive speech pairs one after another and they are asked to decide which sample has the better quality. Participants provide the score in terms of their preferences. Preference values are converted to regular quality values (MOS scale) using different algorithms (Li et al., 2013). Table 6 provides the comparison between different speech QoE estimation methods.

Table 5. CMOS scores and categories

CMOS	Category
3	Much better
2	Better
1	Slightly better
0	About the same
-1	Slightly worst
-2	Worst
-3	Much worst

Table 6. Comparison between different speech QoE estimation methods

	MOS	DMOS	CMOS	PC
Explicit reference	No	Yes	No	No
Hidden reference	No	No	Yes	No
Scale	ACR	DCR	CCR	Preference
Listening session (minutes)	20 (ideal) 40 (max)	20 (ideal) 40 (max)	20 (ideal) 40 (max)	20 (ideal) 40 (max)

Objective QoE Estimation

The objective speech QoE estimation methods evaluate the speech quality based on media, network and terminal physical parameters. According to the availability of original speech quality metrics, the objective speech QoE estimation can be classified into intrusive and non-intrusive (Falk et al., 2005) techniques.

Intrusive Method: The intrusive measurement depends on some distance metric between the input (clean) and output (degraded) speech signals to predict the subjective MOS (Falk et al., 2005). This methodology requires input parameters from original speech signals for the quality estimation.

Non-Intrusive Method: The non-intrusive methods are passive in nature and do not require reference signal for the quality estimation. This technique is based on estimating the speech quality based on the metrics from the degraded speech only (Falk et al., 2005). Table 7 lists various implementations of intrusive and non-intrusive methodologies for the speech QoE estimation (Côté, 2011).

Video QoE Estimation

Video QoE estimation refers to the quality estimation of a video signal originated from different sources (movies, sports, cartoons, etc.). Similar to the speech QoE estimation, the video QoE estimation can be classified into two categories, which are subjective and objective estimation techniques. Different methodologies for subjective QoE estimation of video signals are described below.

Subjective QoE Estimation

Subjective video quality estimation methods require an appropriate test environment. General environment conditions for a subjective laboratory test and a test at home are defined in (ITU-R Recommendation BT.500-13, 2012). Moreover, each user should be screened for (corrected-to-) normal visual acuity on the Snellen or Landolt chart, and for normal colour vision using specially selected charts (Ishihara, for instance) (ITU-R Recommendation BT.500-13, 2012). The participation of at least 15 participants is considered as statistically reasonable for this kind of subjective tests (ITU-R Recommendation BT.500-13, 2012).

Double Stimulus Continuous Quality Scale (DSCQS): In the DSCQS method, participants are required to give scores to multiple video sequence pairs. These pairs consist of original and test sequences of duration of around 10 seconds each. The pairs are shown in alternating fashion. These sequences are shown twice and in a random order. Participants are unaware which sequence is an original and which one is a test sequence. They rate the quality on a scale from bad to excellent. This scale has an equivalent scale from 0 to 100. The difference between these two scales is used to remove the uncertainties caused by the material content and/or viewer's experience (ITU-R Recommendation BT.500-13, 2012).

Table 7. Objective speech quality estimation methodologies and implementations (Côté, 2011)

Methodologies	Implementations
Intrusive	IS, Seg.SNR, CD, BSD, TOSQA, P.AAM, PSQM, PAMS, WB-PESQ, PESQ, DIAL
Non-intrusive	INMD, CCI, P.563, ANIQUE

Double Stimulus Impairment Scale (DSIS): The DSIS method (ITU-R Recommendation BT.500-13, 2012) differs from DSCQS by showing multiple video sequence pairs only once and the original sequence is always shown before the test sequence. If longer test sequences (for example, over 10 seconds) are shown when using the DSIS or DSCQS method, the time between the original sequence and the test sequence can be increased. Furthermore, it can be hard to rate the sequences accurately and a psychological "recency" effect can be noticed (Alpert & Evain, 1997).

Single Stimulus Continuous Quality Scale (SSCQE): In the SSCQE method, a video sequence of around 5 minutes is shown to the participants. Each participant needs to evaluate the video quality instantaneously by continuously adjusting the slider in each 1-2 seconds. The DSCQS scale (from Excellent to bad) is used in this case (ITU-R Recommendation BT.500-13, 2012). The reference video sequence is not provided to participants. One may notice that in this case it is difficult to compare scores for different test sequences as well as to provide the overall quality rating for a particular test sequence. Moreover, the scores provided by end-users can be also affected by a "recency or memory" effect (Alpert & Evain, 1997).

Simultaneous Double Stimulus Continuous Evaluation (SDSCE): In the SDSCE method, two video sequences, the original and the test, are simultaneously shown to participants. Participants will check the difference between these two sequences and rate the quality by moving the slider of a handset-voting device using a 0-100 scale. If the difference between the two sequences is null, then the slider should be at the top i.e. 100, while when the quality difference is maximum, the slider should be at the bottom, i.e. 0. Participants are unaware which sequence is the original and which one is the test sequence (ITU-R Recommendation BT.500-13, 2012).

Subjective Assessment Methodology for Video Quality (SAMVIQ): Most of the methodologies discussed above were developed to perform the subjective test in a TV or similar environment. However, the SAMVIQ method can be used for PC and for mobile environments. Participants are shown different versions of the same video sequence and when all the sequences are rated, the following sequence content can be then accessed (ITU-R Recommendation BT.1788, 2007). In this case, the participants can access any version of the sequence and they can replay, start or stop, change or keep the current score if they prefer. Participants are allowed to view one version at a time, and they use the DSCQS method for rating the sequence. Figure 3 illustrates the test organization in the SAMVIQ.

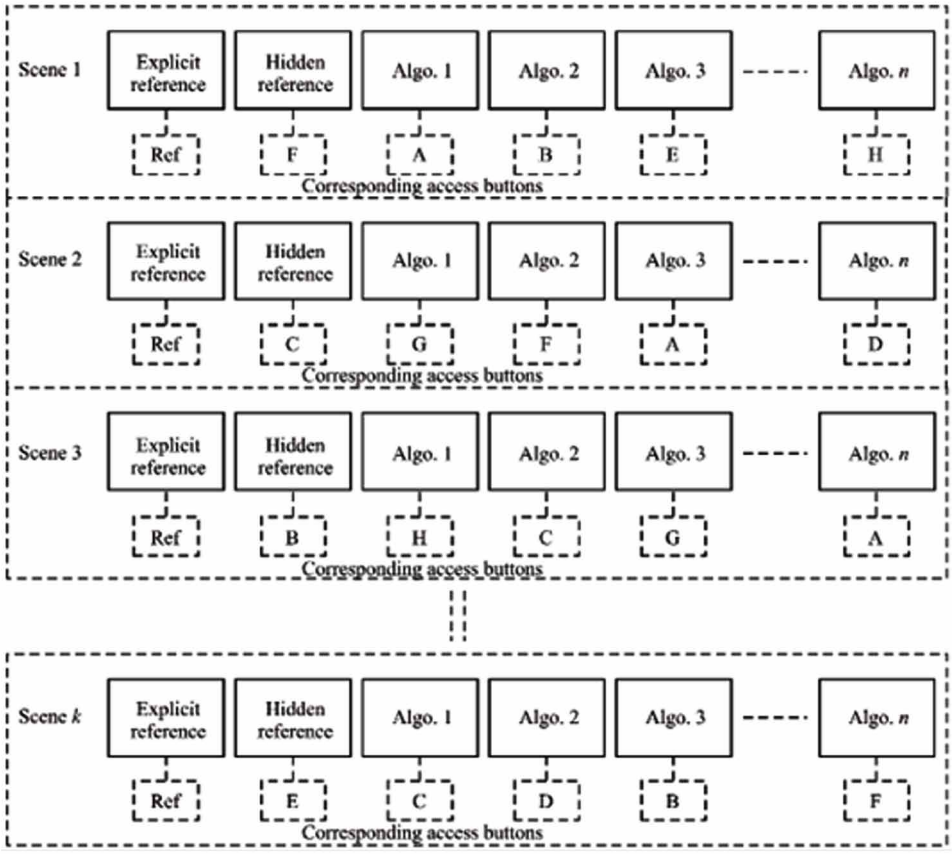
Pairwise Comparison (PC): This methodology is preferred when participants are not always capable to express their view by means of exact rating score. The PC method tries to evaluate all possible combinations of two samples. In the pairwise comparison methodology, participants are shown video sequence pairs one after another. The duration of each video sequence is around 10 seconds. Participants observe the quality of these two video sequences one after another and based on their perception they select the video sequence with higher quality, i.e. provide the preference (ITU-R Recommendation P.910, 1999). Preference values are converted to regular quality values (MOS scale) using various algorithms (Li et al., 2013). Results can be stored in a so called comparison matrix (C).

Table 8 illustrates the comparison between various video subjective test methodologies.

Objective QoE Estimation

Objective video quality estimation methods are based on media, service, and transmission parameters. These methods mostly rely on mathematical models that can be used when estimating the multimedia QoE based on some objective parameters. The lack of human presence increases error margins for the

Figure 3. Test organization in SAMVIQ (ITU-R Recommendation BT.1788, 2007)



Box 1. Comparison matrix (C)

i/j	C_1	C_2	C_3
C_1	0	3	1
C_2	3	0	2
C_3	5	4	0

where, "$C_{ij} = n$" means that condition C_j was preferred over C_i, n times.

corresponding estimation. However, the estimation process can be automatic, and thus can be performed fast enough. Therefore, service providers and network operators are mostly interested in a tool that can objectively reflect the subjective mean opinion score (MOS) of users with reasonable accuracy.

Objective methods can be classified in three groups (ITU-T Recommendation J.143, 2000) according to the availability of original video sequence for estimation; those are full reference method, reduce reference method, and no reference method.

Full Reference (FR): In the full reference method, the distorted sample is compared with the original sample including per-pixel processing and temporal/spatial alignment. The comparison between the

Table 8. Comparison between different video subjective test methodologies (ITU-R Recommendation P.910, 1999; ITU-R Recommendation BT.500-13, 2012)

	DSIS	DSCQS	SSCQE	SDSCE	SAMVIQ	PC
Explicit reference	*Yes*	*No*	*No*	*Yes*	*Yes*	*No*
Hidden reference	*No*	*Yes*	*No*	*No*	*Yes*	*No*
Scale	*Bad to excellent*	*Bad to excellent*	*Bad to excellent*	*Bad to excellent*	*Bad to excellent*	*Preference*
Sequence length	*10s*	*10s*	*5min*	*10s*	*10s*	*10s*
Picture format	*All*	*All*	*All*	*All*	*All*	*All*
Presentation of test material	*I. Once* *II. Twice in succession*	*Twice in Succession*	*Once*	*Once*	*Several times*	*Several times (in pairings)*
Minimum participants	*15*	*15*	*15*	*15*	*15*	*15*
Display	*Mainly TV*	*Mainly TV*	*Mainly TV*	*Mainly TV*	*Mainly PC*	*Mainly PC*
Possibility to change score	*No*	*No*	*No*	*No*	*Yes*	*No*
Continuous quality evaluation	*No*	*No*	*Yes (moving slider)*	*Yes (moving slider)*	*No*	*No*

original and distorted samples is then used by measuring device (algorithms) for QoE estimation. Figure 4 below illustrates the full reference method.

Reduce Reference (RF): The reduce reference method is somehow between the full reference and no reference methods. It is developed to predict the multimedia quality based on only partial information about the original sample. In this case, partial information indicates the features extracted from the original sample. Figure 5 below illustrates the reduce reference model.

No Reference (NR): The no reference method uses a degraded signal for the quality estimation and does not rely on any information about the original reference sequence. Due to the lack of an original

Figure 4. Full reference model

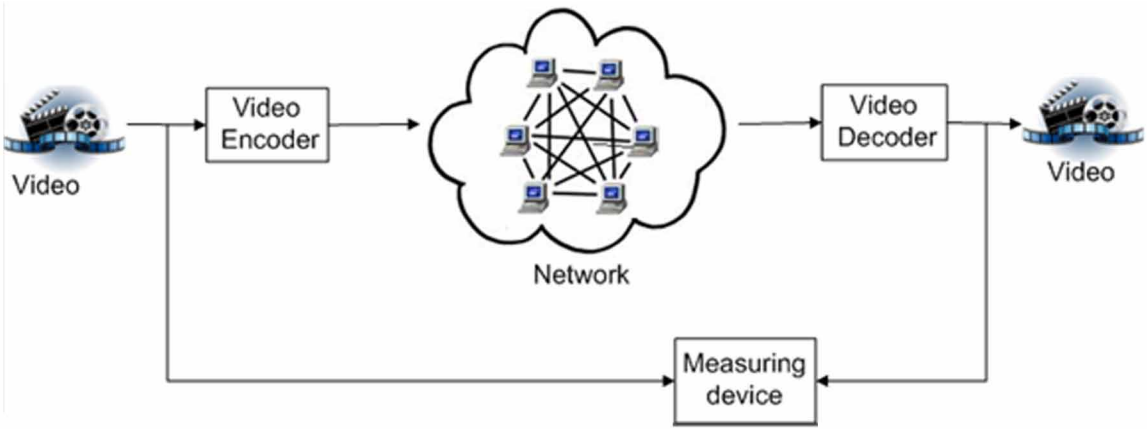
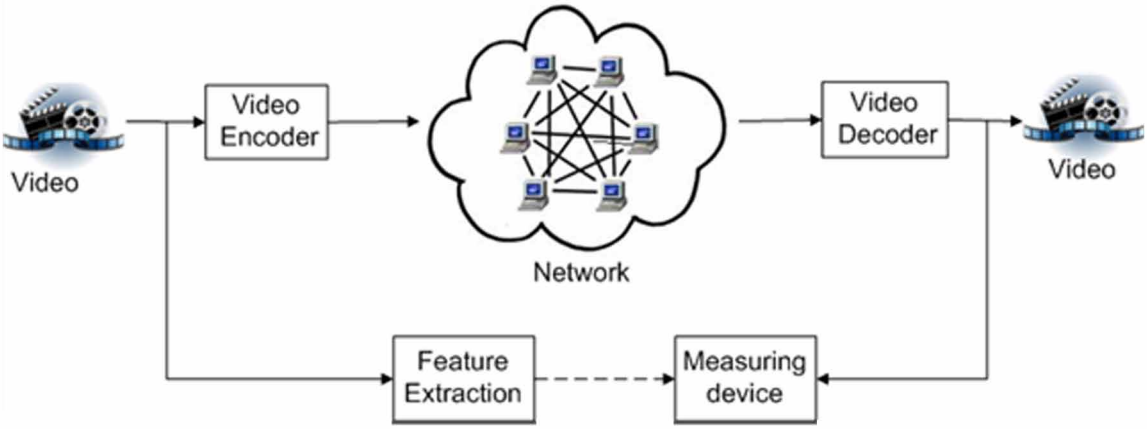


Figure 5. Reduce reference model



sample for the comparison, the accuracy of NR methodology is less than that of the FR or RR methods. Figure 6 below shows the no reference model.

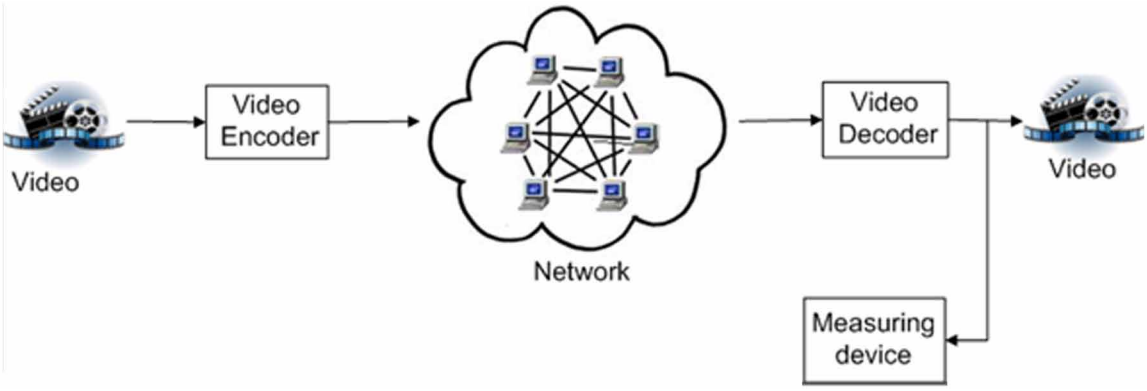
Common Objective Techniques Used for the Multimedia (Video/Audio) QoE Estimation

There exist various models for objective quality estimation of a multimedia traffic. These models are classified in five different groups based on the application scenario, as well as on the objective input metrics. Different models available for the objective quality estimation assessment are listed below (NTT, 2014).

Media Layer Model: The media layer model utilizes media signals as inputs for the multimedia QoE estimation. This model uses content-dependent features (noise level, interruptions, etc.) for the QoE evaluation. Intrusive speech quality estimation methodology along with FR and RR video quality methodologies falls into the media layer model.

Parametric Packet Layer Model: The packet layer model relies on the information gathered from IP and RTP headers (IP/RTP packet loss, IP/RTP jitter, etc.) for the multimedia QoE estimation. This model

Figure 6. No reference model



is efficient for estimating the "in-service quality". The reason is that the computational complexity for this technique is not very high, as it does not require media signal to be decoded for the estimation purpose.

Bit Stream Layer Model: The bit layer model exploits the information gathered from the payload bit stream before decoding and the packet header information for estimating the multimedia QoE. This model often needs to decrypt the encrypted multimedia payload. Therefore, it can have high computation complexity.

Hybrid Model: The hybrid model utilizes several or all of the above methodologies for estimating the multimedia QoE. It exploits as much information as possible to estimate the multimedia quality; therefore, it is considered as one of the most effective models for the multimedia QoE estimation.

Parametric Planning Model: The parametric model relies on network and terminal quality design and management parameters (e.g., coding bit rate, packet loss rate, etc.). These models typically use a mathematical formula, representing the quality estimation as a function of different parameters (Joskowicz et al., 2010).

Figure 7 illustrates the scope of various objective quality estimation models, while Table 9 presents the comparison of different objective quality estimation models with existing standards.

SUBJECTIVE TEST ENVIRONMENT

Subjective tests involve human participants and requires appropriate environment to perform such testing. Test environment should be unbiased, should not be affected by external noise, and should be close to real world scenario. Most of the research works use lab environment for subjective tests. However, crowdsourcing environment is getting popular as well (Shahid et al., 2014). Below, we discuss laboratory and crowdsourcing environments in detail.

Laboratory Environment: The laboratory experiment provides a controlled environment for performing subjective tests for evaluating the multimedia quality. Different parameters associated with the test such as noise-level, distance between screen and users, screen size, etc. can be easily controlled according to the requirements. However, lab based experiments have limitations, such as 1) high cost in terms of time and labor 2) limited participants diversity (Yen et al., 2013). A laboratory experiment takes weeks for preparing tests, recruiting users, scheduling time slots for supervising the experiments. Also users

Figure 7. Scope of different objective quality estimation models

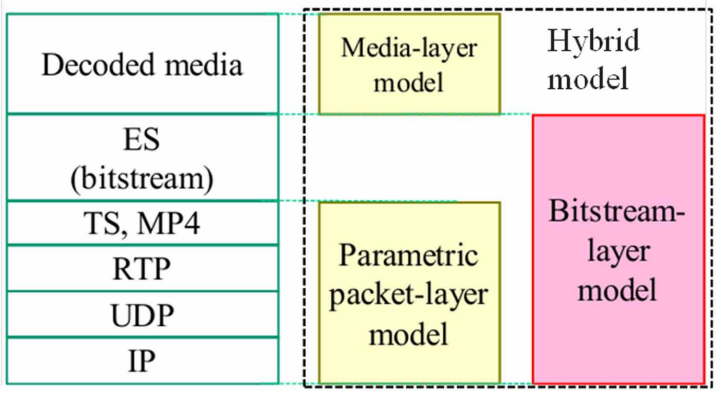


Table 9. Comparison of objective quality estimation models with existing standards (Takahashi et al., 2008)

	Media-layer Model	Parametric Packet-Layer Model	Parametric Planning Model	Bitstream Layer Model	Hybrid Model
Input information	Media signal	Packet header	Quality design parameters	Packet header and payload	Combination of any
Primary application	Quality benchmarking	In-service nonintrusive monitoring (e.g. network probe)	Network planning, terminal/application designing	In-service nonintrusive monitoring (e.g. terminal-embedded operation)	In-service nonintrusive monitoring
Speech/Audio (Standards)	ITU-T P.862, ITU-R BS1387	ITU-T P.564	ITU-T G.107	-	ITU-T P.CQO
Video (Standards)	ITU-T J.144 [SD], ITU-T J.vqhdtv [HD], ITU-T J.mm** [PC]	ITU-T P.NAMS [IPTV]	ITU-T G.1070 [videophone], ITU-T G.OMVS [IPTV]	ITU-T P.NBAMS [IPTV]	ITU-T J.bitvqm [IPTV]
Multimedia (Standards)	ITU-T J.148				

need to be physically present in the laboratory to perform the test (Yen et al., 2013). Generally lab tests are performed at the university or research laboratory, so the participants for the test are either students or researchers. This can limit the diversity of participants: most of them are boys who are young, well-educated, etc.

Crowdsourcing Environment: In the crowdsourcing environment, subjective experiments can be performed from a distance and there is little control over the participant's environment. It is computer software assisted method that is generally performed on a web platform. This methodology mainly involves collecting subjective assessment of quality through ubiquitous streaming via the Internet. Different screen test and cheat detection mechanisms are employed in a crowdsourcing experiment (Gardlo et al., 2014; Hossfeld et al., 2014) to make the test reliable and resilient. Crowdsourcing based subjective experiments have gained attention to replace needs of lab-based tests and these experiments offer promising correlation with the former (Li et al., 2013). This allows an investigator to get opinions from a vast variety of subjects, in a time-flexible, test-data size scalable, and swift manner (Shahid et al., 2014). Different crowdsourcing software available for multimedia subjective test are *QualityCrowd* (Keimel et al., 2012), *PC-Video-Test-Interface* (PC-Video-Test-Interface 2014; Shahid et al., 2014), etc.

QoS/QoE LEARNING ALGORITHMS AND SELF-ADAPTIVE MODELS

In this section, we briefly discuss four self-adaptive models that can be used for the automatic QoE evaluation when the values of QoS and/or QoE attributes are known. The QoS parameters reflect the objective network and service level performance and they do not directly address the user satisfaction of the delivered service or application. On the other hand, QoE has become an important indicator, useful for network operators and service providers to help them understand the user acceptability towards a

particular service or an application. The paradigm is shifting towards user-centric evaluation of a service or an application performance. To attract or bind users to a service, real time estimation of QoE is a must for network operators and service providers. Therefore, it is necessary to derive a correlation between the QoS parameters and the QoE, so that it can be used to identify the impact of different QoS parameters on the QoE of the users and moreover, to estimate the QoE objectively. However, the relationship between QoS and QoE is hard to estimate, since this relationship is not linear. Moreover, the higher QoS level does not always yield the higher QoE value.

Various QoS/QoE correlation algorithms can be found, for example, in (Rubino et al., 2006; Mushtaq et al., 2012; Wang et al., 2010). The relationship between the QoS and QoE metrics has a number of applications, including multimedia, web, etc., when assessing an end-user satisfaction with a given service (Wijnants et al., 2009; Mushtaq et al., 2012; Pokhrel et al., 2014).

A number of continuous and discrete models are developed for the automatic evaluation of user satisfaction but nevertheless, no one can prove the accuracy of these models. However, nowadays, people study human cognitive processes very carefully and try to elaborate a model that behaves similar to brain neurons. Since a human mind is known to be nondeterministic, just now it is not possible to get a formal algorithm of the human behavior. That is the reason why researchers turn their attention to self-adaptive models and learning algorithms. The advantage of such models is the learning or training possibility. In this section, we briefly discuss four self-adaptive models that are based on machine learning algorithms and can be used to automatically evaluate the user satisfaction with a given multimedia service based on the known values of quality of service parameters. All of the self-adaptive models rely on pre/post conditions that can be expressed in terms of IF-THEN operator such as:

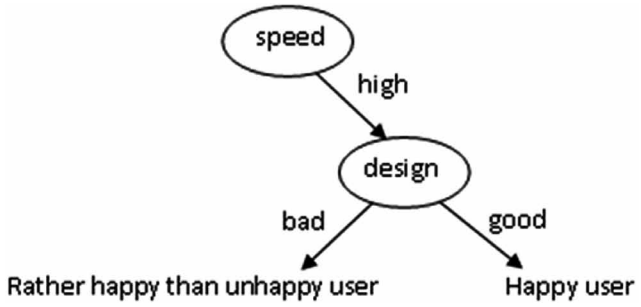
- If the service works fast then I am rather happy with this service;
- If the design of the service is bad then I am unhappy with this service;
- If the speed of the service is high AND the design of the service is good then I am happy with this service;
- If the speed of the service is high AND the design of the service is bad then I am rather happy than unhappy with this service.

We further discuss how such pre/post conditions can be used in order to derive a self-adaptive model and a corresponding learning algorithm.

Decision Tree Based QoE Estimation

One of the machine learning algorithms is based on a *Decision Tree* (Mitchell, 1997). The decision tree for a multimedia service is a tree, which nodes correspond to service parameters (attributes) while edges are marked with different parameter values (scores) (Mitchell, 1997). Each tree level corresponds to a single service parameter which can be evaluated by scores. The leaves of the tree correspond to different values of the user satisfaction. The decision tree can be derived based on IF-THEN conditions where a path labeling each branch of the tree to a node with a given QoE value corresponds to the conjunction of conditions under IF operator. For example, the condition "*If the service speed is high AND its design is good then I am happy with this service*" corresponds to the path from the root of the tree to a leaf that traverses nodes labeled by speed and design with outgoing edges labeled by high and good, correspondingly (Figure 8).

Figure 8. An example of decision tree for a multimedia service



The decision tree can be learnt based on deriving IF-THEN conditions by adding additional paths. As usual, such pre/post conditions are derived based on experimental results or following some expert opinions. The decision tree provides an algorithm for evaluating the user satisfaction if and only if it is completely specified. Those paths in the tree that are not specified by the conditions have to be somehow defined in order to predict the user satisfaction in this undefined situation. Thus, the purpose of specifying undefined paths is to "guess" what a user would like or dislike under appropriate conditions. Binary decision tree can be represented as a disjunctive normal form (DNF) or sum of products (McCluskey, 1965) where each conjunction corresponds to a path from the root to a leaf. For example, a conjunction that corresponds to the path that leads to the leaf "Happy" can be fast $\wedge$ popular. The complexity of such a tree is exponential w.r.t. the number of quality parameters, and grows fast when each service parameter is evaluated not by two but by more values. That is the reason why one looks forward to a scalable representation and manipulation of such Boolean formula (normally, DNF). One of possible ways to effectively represent such formula is to use a logic circuit. Similar to a decision tree, the initial logic network is derived based on statistics that are gathered from experts, developers and end-users who agreed to provide a feedback about the service quality. The circuit accepts the service parameter values encoded as Boolean vectors and outputs the Boolean vector that corresponds to the encoded QoE value. We describe the logic circuit-based approach in detail in the following section.

QoE Prediction Based on Logic Networks

In this subsection, the approach based on Boolean formula that is represented by a corresponding logic circuit is briefly described (Kushik et al., 2014a; Kushik et al., 2014b). The translation from the Boolean formula to a logic circuit is made by the use of a look-up-table/truth table (LUT). The QoE prediction approach relies on logic circuit learning and we first discuss how the initial circuit can be derived and then turn to a learning procedure itself. Consider a multimedia service W and a collection of service parameters $p_1, p_2, \ldots, p_k$ that are used for the QoE evaluation. For the sake of scalability, we consider each parameter p_i value as a nonnegative (unsigned) integer, bounded by the maximal value M_{p_i}, p_i–*value* $\in \{0, \ldots, M_{p_i} - 1\}$. In order to evaluate the QoE of the service W, written $QoE(W)$, a logic circuit S is derived. Inputs of the circuit S correspond to service parameters $p_1, p_2, \ldots, p_k$ which values are encoded as Boolean vectors of length $]\log_2 M_{p_i}[$, where $]t[$ denotes the minimal integer that is not less than t; thus, the number of primary inputs of S equals $\sum_{i=1}^{k}]\log_2 M_{p_i}[$. The circuit calculates the $QoE(W)$

value for given integers p_1_value, p_2_value, …, p_k_value and $QoE(W)$ that is bounded by the maximal value M_{QoE}, $QoE(W) \in \{0, \ldots, M_{QoE} - 1\}$ also represented as a Boolean vector. The length of a corresponding Boolean vector is $]\log_2 M_{QoE}[$, as $]log_2 t[$ bits are needed to represent an unsigned integer t. Therefore, the circuit S has $\sum_{i=1}^{k}]\log_2 M_{p_i}[$ primary inputs and $]\log_2 M_{QoE}[$ primary outputs.

In order to derive the initial circuit S, we use statistical data gathered from multimedia service experts as well as by the automatic evaluation of service parameters and/or from end-users, who have an experience of using the service W. The logic circuit S that is derived based on the provided statistics, evaluates and predicts the QoE value of the multimedia service W for any values of input parameters. In order to derive an LUT for the statistics, each user score is converted into Boolean vectors and the corresponding line is added to the LUT. Then circuit S is synthesized from a partial system of Boolean functions.

Once a circuit S is derived, the circuit can be used for evaluating the QoE of the multimedia service. The circuit accepts Boolean vectors as inputs representing current values of considered parameters and the output is a Boolean vector corresponding to an integer that evaluates the QoE value. As we are interested in self-adaptive models, we discuss how such circuit can be modified if the circuit behavior does not match new statistical data that can appear when a new end-user agrees to leave his/her feedback about the service quality. Therefore, the circuit behavior has to be modeled under a corresponding input **i** and if the result produced by the circuit differs significantly from the expected one then the circuit has to be resynthesized. Such difference can be specified as a confidence interval that can be derived for a multimedia service with the use of various heuristics as well as the knowledge of experts and/or service provider.

If the output **o** produced by the circuit S does not belong to the corresponding confidence interval then the circuit is resynthesized. Two options are possible: a) the line specified in the LUT of the circuit S has the wrong output $\mathbf{o}'$, in this case the output is changed to **o**; b) the corresponding line is not present in the current LUT, in this case, the new line is added. In both case, the circuit is resynthesized w.r.t. the modified LUT.

Additional experimental research is also needed to evaluate the optimal length of confidence interval for different services, since the length of confidence interval significantly influences both, the accuracy of predictions and the computational complexity contradicting each other. The bigger is the length the less resynthesis steps are needed, along with reducing the accuracy of circuit predictions. Studying optimal values of such length intervals remains one of challenging issues for further authors' investigation.

Neural Network for the QoE Prediction

Neural networks are widely used for solving various problems in the artificial intelligent area. Such networks are used in the "machine learning sense" and all the neurons of the network are assumed to be artificial and can be modified by a "teacher" in a given way. Neurons are connected to each other and these connections also can be learned. Usually neural networks without feedbacks are considered and in this case, the network can be divided into levels. Each network level can be treated as a collection of states and a network accepts inputs and produces the output. Usually, for each neuron there exists a formula that calculates its output according to weighted inputs that is used when coming to the next level via weighted edges. Two-level neural networks are often considered which have very simple neurons that calculate the output according to some threshold of weighted inputs; the input weight corresponds to a

link weight this input comes through. Weights usually are integers or rational (for example, for Hopfield network, Kohonen network, etc.).

A neural network accepts values of input (QoS/QoE) parameters and depending on the neuron definition and on the weights of distributed connections the network produces the output (the QoE value) (Al-Masri & Qusay, 2009) by changing states from level to level. At the initial step, the network connections are set based on the initial statistics, i.e., on the set of given input/output pairs. A network learning process consists of modifying weighted connections (or a set of nodes) of the network based on new knowledge (more statistics, for example). In other words, when new statistical data appears the network can learn how to modify its connections and possibly, nodes in order to have the correct behavior. Thus, a problem of gathering statistics appears again, since the size and diversity of the learning data set impacts the accuracy of the QoE estimation in the prediction phase. The goal of a modeling process is to derive a network that can predict output with high confidence, when an input is applied.

One of a good alternative to artificial neural networks is a fuzzy logic that is also good for modeling human behavior. Similar to neural networks different self-adaptive models can be derived based on fuzzy logic calculus. In this following subsection, we briefly discuss how fuzzy logic formula can be learnt in order to correctly calculate a degree of the user satisfaction for a given set of QoS/QoE parameters.

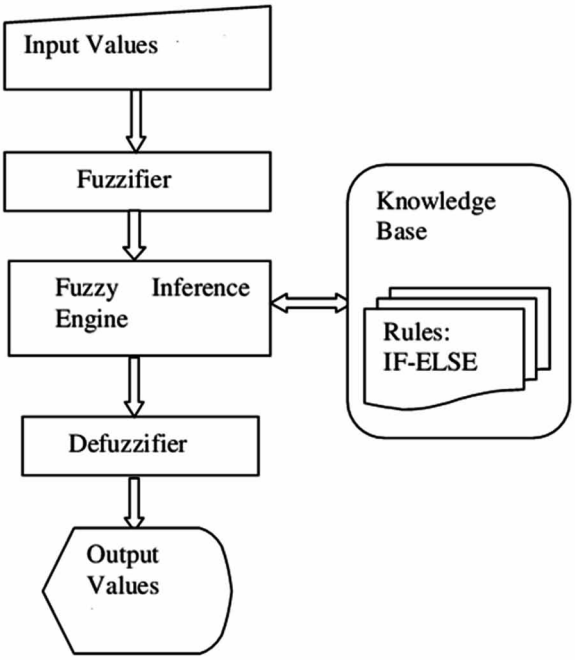
Fuzzy Logic for the QoE Prediction

Fuzzy logic has been introduced by Lotfi A. Zadeh (Zadeh, 1965) in 1956 and it extends the classical set theory to so called *fuzzy set* theory. In the general set theory, a set A can be specified by its *characteristic function* χ, and the set A contains an element a, i.e., $a \in A$ if $\chi(a) = 1$, otherwise $\chi(a) = 0$ and $a \notin A$. If A is a *fuzzy* set then the χ function is not a classical predicate but its value belongs to an interval between 0 and 1, i.e. $\forall\ a\ \chi(a) \in [0, 1]$. In this case, the χ function shows the degree *how likely that the statement* 'a belongs to A' *holds*. In other words, differently from classical Boolean algebra, a partial truth is introduced in the fuzzy logic where the truth degree may range between *completely true* and *completely false* (Novák et al., 1999).

Fuzzy logic expert system is one of the well-known estimation/prediction techniques that is used for making decisions with imprecise information in various fields (Baghel & Sharma, 2013). The aim of the fuzzy logic expert system is to draw a concise result based on ambiguous information. Fuzzy logic expert system has three main components, namely *fuzzifier*, *fuzzy interference engine* and *defuzzifier* as shown in Figure 9 (Attaullah et al., 2008).

The *fuzzifier* contains the membership functions (fuzzy sets). In the *fuzzifier*, input parameters (service parameter values) are mapped into membership functions to determine the membership of these parameters to appropriate fuzzy sets. The *fuzzy inference engine* contains a collection of IF-THEN rules, which are obtained from experts or learnt using other intelligent techniques. The justified inputs taken from the fuzzifier (i.e. membership values) are applied to the antecedents of the fuzzy rules. The obtained value is then applied to the consequent membership function (i.e., the output QoE membership function). In other words, the consequent membership function is clipped or scaled to the level of the truth value of the rule antecedent. If more than one rule is triggered from one set of input parameters, the outputs of all the rules are aggregated into the *aggregated output fuzzy set*. The *defuzzifier* is used to perform a *defuzzification*, namely a single output value is obtained from the defuzzifier with the use of the *aggregated output fuzzy set*. There exist various defuzzification techniques (Ross, 1995) such as the centroid method, the weighted average method, the maximum method, etc.

Figure 9. A fuzzy expert system



The fuzzy expert system significantly depends on the membership functions and the inference rules. The more accurately the membership functions and inference rules are specified the higher is the prediction ability of the expert system. Therefore, in order to effectively apply the fuzzy logic expert system for the QoE estimation, one has to carefully specify the membership functions as well as the inference rules. These membership functions and inference rules can be derived based on subjective data set; namely statistical data gathered from end-users and/or based on experts' knowledge and recommendations.

Once the initial machine (fuzzy expert system or a logic circuit) is derived, one may use it to predict the QoE value. However, the new statistical data can also play a role in 'upgrading' the system by increasing its prediction ability. To improve the fuzzy logic expert system, fuzzy membership functions and inference rules are updated based on the new subjective data set. One may notice that such improvement requires a 'teacher' to be involved in the machine learning process. That is the reason why it is hard to implement a 'real' self-adaptive algorithm or a 'real' self-adaptive fuzzy expert system. In other words, usually, the fuzzy expert system is not adapted automatically when the new statistical data appear; nevertheless, preliminary experimental results (Kushik et al, 2014) prove the high prediction ability of the fuzzy expert system, when estimating the QoE for multimedia services.

Evaluation Metrics for QoE Prediction Techniques

In this section, we shortly discuss how QoE prediction techniques can be evaluated with respect to two main criteria: prediction accuracy and self-adaptability. The prediction accuracy refers to the ability of the model's estimated score to match that of the subjective QoE. Therefore, for a model to have high prediction accuracy, the score difference should be minimal. On the other hand, self-adaptability refers to the ability of the model to adapt to new dataset. An efficient model should automatically adapt

(re-organize) to the new dataset without much complexity and time. However, both accuracy and self-adaptability depend highly on the size and coverage of the learning dataset and the number of considered input parameters. Furthermore, in spite of the fact that machine learning algorithms and self-adaptive models are widely used for evaluating user satisfaction, almost all these models rely on statistical data provided by high quality experts and/or collected from ordinary users. Collecting these statistics is the most critical task since it requires time and cost. Moreover, when training a self-adaptive model there are a number of additional points specific to the learning algorithms that need to be considered such as, defining the number of branches of a decision tree or designing membership functions and inference rules of a fuzzy expert system. As the QoE prediction techniques differ significantly for various multimedia applications and services, we further present some particular cases.

QoE IN 3D VIDEOS

The popularity of three dimensional (3D) videos is increasing from cinema to home entertainment. There is a huge industrial push in order to bring 3D video into a home (Wang et al., 2012). Moreover, 3D broadcasting and 3D video services have already been introduced around the world. One of the major concerns for the wide adoption of such technology is the ability to provide sufficient visual quality, especially if 3D video is to be transmitted over a limited bandwidth for home viewing (i.e. 3DTV) (Huynh-Thu et al., 2010). Therefore, there is a huge amount of research interest on improving the QoE of 3D videos. While considering the quality of 3D videos, image quality as well as user safety are considered as a important factors. 3D video QoE is mainly affected by three factors (NTT, 2014):

- Content production factors: camera performance, video shooting conditions, effect of picture frames, etc.
- Video compression and deliver factors: video format, coding schemes, transmission line errors, etc.
- Viewing environment factors: display schemes, viewing angle, ambient light, etc.

It is also necessary to consider biological effects of 3D videos such as eyestrain, visually induced motion, sickness, etc.

Methodologies for 3D Video QoE Assessment

3D video QoE assessment methodologies can be classified into four groups:

1. *Subjective assessment method* that is based on assessing the quality by viewing a questionnaire. As an example, one can consider DSCQS (Double Stimulus Continuous Quality Scale), ACR (Absolute Category Ratio), Factor analysis, SSQ (Simulator Sickness Questionnaire), VAS (Visual Analogue Scale) and other methods.
2. *Physiological assessment method* that is based on assessing the response by measuring various physiological data. Examples are: Measure brain activity, Measure bio signal (heart rate, breathing, dilation of pupils, accommodation, eye-blinks, skin potential activity), etc.

3. *Performance assessment method* that is based of assessing performance on specific tasks, i.e. response time, fatigue etc. As an example one can consider ATMT (Advanced Trail Making Test) measurements.
4. *Objective assessment method* that is based on objective measurable metrics. Examples of these methods can be found in (Ozbek & Tekalp, 2008; Yasakethu et al., 2008; Mittal et al., 2011; López et al., 2013; Han et al., 2014; Sohn & Ryu, 2014).

QoE in Dynamic Adaptive Streaming over HTTP (DASH)

In the bandwidth variant network environment, the basic HTTP download/streaming seems to be inappropriate since the video streaming suffers from considerable amount of freezing events. Therefore, in order to provide smooth video streaming, video stream needs to adapt according to the network environment to avoid freezing at the best possible video quality, which is achieved by dynamic adaptive streaming over HTTP (Stockhammer, 2011; Sodagar, 2011). This technology is used by different video streaming application such as You Tube, Netflix, etc.

DASH technology was developed under MPEG and is also known as MPEG-DASH. The MPEG-DASH standard was published as ISO/IEC 23009-1. It specifies XML and binary formats that enable delivery of media content from standard HTTP servers to HTTP clients and enable caching of content by standard HTTP caches (ISO/IEC 23009-1.2, 2012). In this technology, video is stored in different versions, i.e. at different bitrates at the multimedia server. These video versions are segmented in chunks such that the segment boundaries are aligned in time. Each terminal (DASH client) decides to download a particular version based on the device capabilities and network conditions. This decision can be made at frequent dispersed time instant during the streaming of the video (Sánchez et al., 2011). Hence user experiences quality variation (bit rate switching) during the video playback instead of freezing. However, if the video streaming is at the lowest bit rate and the network degrades further, then freezing occurs.

The QoE estimation in DASH is complicated. Traditional subjective and objective methods based on UDP for video quality estimation might not work well with DASH based video streaming. Recently there has been some work done with respect to QoE estimation of DASH, however, finding a reliable metric for QoE estimation remains a challenging issue.

Some of the works on the QoE estimation of DASH can be found in (Thang et al., 2012), (Robinson et al., 2012), (Mok et al., 2012), (Oyman & Sing, 2012), (Yitong et al., 2013), (Alberti et al., 2013), (Eckert et al., 2013), (Shahid et al., 2014), etc.

MULTIMEDIA QoE STANDARDIZATION BODIES

There are different multimedia QoE standardization bodies, industry forums and others that work on different aspects of multimedia QoE. These include definitions and terms of reference, requirements, recommended practices, test plans, and many more (Winkler, 2009). Some of the most active ones are discussed below.

Video Quality Experts Group (VQEG): This Group (VQEG, 2014) works in the field of multimedia QoE assessment (particularly video). It was founded by ITU-T and ITU-R group members in 1997. The group works in the field of video quality assessment and investigates different new and advanced subjective and objectives methods and measurement techniques (VQEG). Moreover, they plan, test and

validate objective quality estimation. VQEG is an open group and does not require fees, membership applications and invitation to join. Some of the past projects of VQEG groups are FRTV Phase I, FRTV Phase II, multimedia phase I, RRNR-TV, etc. Some of the active projects of VQEG groups are 3DTV, Audiovisual HD (AVHD), HDR (High Dynamic Range Video), Hybrid Perceptual/Bitstream JEG-Hybrid, MOAVI (Monitoring of Audio Visual Quality by Key Indicators), Quality Recognition Tasks (QART), RICE (Real-Time Interactive Communications Evaluation) and Ultra HD (VQEG).

ITU-T: The ITU-T (for Telecommunication Standardization Sector of the International Telecommunications Union) is the primary international body working in the field of standardization of telecommunications equipment and systems. ITU-T is a part of ITU (International Telegraph Unit) (ITU, 2014). This organization is based on public-private partnership and requires membership to be involved in. There are different study groups inside ITU-T that works for multimedia quality standardization. ITU-T Study Group 9 is focused in studies of cable television and quality assessment methods for video and multimedia services. ITU-T, Study Group 12 (SG12) is mainly studying QoE requirements and assessment methods for multimedia services including IPTV (Takahashi et al., 2008). A joint group has been established, i.e. Joint Rapporteur's Group on Multimedia Quality Assessment (JRG-MMQA) to harmonize the work of these two study groups. IUT-T works in all the area of multimedia QoE assessment, i.e. speech, audio, video and multimedia (combined) and has developed different standards for a quality assessment of multimedia for example ITU-T J.148, ITU-T P. NBAMS, ITU-T P.862, etc.

ATIS IIF: The ASTIF-IIF is working with Industry segments to define necessary standards and specifications for IPTV network architecture, QoS and QoE, Security, and Interoperability (ATIS-IIF, 2014). It requires membership for involvement. Different partners working together in ATIS IIF include service providers and manufacturers, content and entertainment providers, manufacturers, and the entire IPTV industry ecosystem. The Quality of Service Metrics Committee (QOSM) inside ATIS IIF works in different issues related to QoS and QoE in IPTV services. It has issued different documents related to QoS and QoE in IPTV services such as ATIS-0800008, ATIS-0800004, etc.

CONCLUSION

Multimedia QoE assessment and monitoring is essential to deliver an optimized end-to-end high QoE service. This requires a deep understanding and efficient identification of different objective and subjective parameters that impact the user experience. Multimedia content delivery is a large and continuously evolving field that involves various actors from content service providers to Internet service providers and to content consumers (users) themselves. Therefore, a comprehensive QoE assessment requires the understanding, the role and impact of these actors on multimedia content from delivery till consumption (Barakovic & Skorin-Kapov, 2013). A multi-disciplinary approach involving different measures at the server, network, application or user levels for a wide range of objective (QoS) and subjective (user perception) metrics is necessary for building QoE assessment models. A typical process for building such model includes:

- Conducting subjective lab or crowdsourcing tests to evaluate user perception in different scenarios. As the number of impacting parameters is relatively high, the objective of subjective tests is used to measure user acceptability with respect to a limited number of parameters such as screen size change, player buffering strategy, or network conditions change, etc.

- Building correlation model to map between parameters (for example, QoS parameters) measured during the subjective tests with the QoE scores given by subjects. This phase is considered as the learning phase.
- Evaluating the QoE based on the model against user scores to measure its accuracy.

FUTURE RESEARCH DIRECTIONS

The QoE assessment model requires extraction of QoS parameters from different points of the network. For this perspective, the measurement of potential QoS parameters plays a crucial role in providing the required input data for the quality estimation model. Such measurements can be achieved by installing network monitoring probes on key points of the network. These tools deploy *Deep Packet Inspection* (DPI) techniques to extract relevant parameters from the network traffic. When the traffic is encrypted, DPI needs to decrypt the content in order to extract relevant parameters. In most of the cases, this operation is simply impossible. Therefore, new models using statistical properties of the network traffic need to be designed.

Furthermore, with the push for personalized and user centric services, there is a pressing need for QoE estimation probes capable of processing high speed network links in real time to extract the QoS parameters and to correlate them with the user perceived QoE. However, the relationship between QoS and QoE is fuzzy and non-linear. To address this issue, there are large numbers of intelligent algorithms proposed in the literature. However, there is still room for innovative mechanisms to efficiently correlate QoE from QoS, in real-time. Finally, efficient QoE management systems aim at reacting before the user even notices the quality degradation (Hossfeld et al., 2012). This requires an efficient feedback loop that can detect, locate and react in real-time to degraded network conditions by controlling or reconfiguring different components of the QoE estimation system. Big advances have been made in this direction, however, open questions such as when, where and how to react still need to be addressed.

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KEY TERMS AND DEFINITIONS

Crowdsourcing Video QoE Estimation Method: In crowdsourcing video QoE estimation methods internet crowd is asked to perform video QoE experiments using web platform.

Dynamic Adaptive Streaming over HTTP (DASH): DASH is a standard developed by ISO (International Organization for Standardization) for adaptive streaming using convectional HTTP web servers.

Key Performance Indicators (KPIs): KPIs are the parameters that indicate the behavior or performance of any service.

Mean Opinion Score (MOS): MOS represents the average score of all the participants in a subjective assessment.

Objective Video QoE Estimation Method: Objective video QoE estimation methods use objectively measured network/media parameters for estimating video quality.

QoE Learning Algorithms: QoE learning algorithms are intelligent learning algorithms that learn the relationship between multimedia QoS and QoE to predict the QoE objectively.

Quality of Experience (QoE): QoE is the degree of satisfaction of users of a service.

Quality of Service (QoS): QoS is the measure of service quality from the network perspective.

Subjective Video QoE Estimation Method: Subjective video QoE estimation methods use human participants to rate the video quality. Human participants rate the video quality based on their viewing perception.

Three Dimensional (3D) Video: The advancement to 2D videos by adding the illusion of depth perception.

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Chapter 49
Concept Maps, VoiceThread, and Visual Images:
Helping Educators Spawn Divergent Thinking and Dialogic Learning

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ABSTRACT

The context of this chapter has its roots in an educational movement that recognizes the importance of preparing youth for living and working in a global community. Central to this is a belief in 1) engaging students in collaborative learning, 2) developing cultural sensitivity, 3) using digital media for communication and creativity, and 4) transforming pedagogical practice to foster reflection, divergent thinking, and creativity. The question addressed in this chapter is how teachers can use digital media and visual images to spawn divergent thinking and dialogue in a global learning context. This chapter presents a case analysis to examine evidence of inquiry-based collaborative learning and three-dimensional thinking among students when using digital images and collaborative software in a global partnership project.

INTRODUCTION

Story!, Design!, Creativity!, Divergent Thinking!, Complexity!, Exploration!, Curiosity!, Empathy! These are just some of the 21st century skills that business and international educational policy leaders suggest are essential for learning and working in a globally connected society. Already many of us, in particular children and youth, have experienced this transition from left-brain dominated communication (text-based) to right-brain communication (visual and spatial) through the Internet and other social media. The growing use of images and video on the Net, for example, is shaping a new way of thinking and communicating that is more divergent and creative. Through social media we are learning to collaborate, expanding our perspectives and stimulating new questions about life, society, and each other. Researchers have found exciting benefits from this networked, visual communication culture that supports the development of 21st century skills and creativity (Nilson & Nocon, 2005; Offir et al., 2008;

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Schlais & Davis, 2001). Despite this, other international studies (Jerald, 2009) have found little evidence of pedagogical innovation taking place at the classroom level that reflects the above skills and attributes. In general, the majority of schools remain on the outside of this media equation (Snyder, 2007). The dominant learning model is most suited to left-brain analytical thought, while the workforce calls for greater right-brain activity (Pink, 2005; Silverman, 2004). Many now recognize the need to explore pedagogical opportunities that today's media affords innovation in learning.

One of the questions worth asking then is "what can educators do differently to develop learning environments that support holistic learning stemming from inquiry, exploration, creation, and collaboration through the use of digital media? While technology has been used in many classrooms around the world for the past decade or more, many teachers still report that they lack the skills and knowledge to think differently about the use of digital media to support pedagogical innovation (Snyder, 2010). We need to provide teachers with examples of how digital media can be applied pedagogically to stimulate, among other things creativity, diversity of thought, exploration and collaboration. Visual literacy and divergent thinking tools, such as concept maps, can be a helpful step in that direction (Wegerif, 2007). Studies are now reporting the dynamic changes that occur in learning when social software and images are used as part of the curriculum and tools for learning (Beaudry & Wilson, 2010; Stokes, 2001).

In 2010, The Gulf Oil Spill Crisis pilot (GOSP) was developed to support cross-cultural collaboration and pedagogical innovation in 14 schools in Nanshen China and Florida USA. The pilot emerged in response to research findings from the Global Partnership Project (Snyder, 2010). Little evidence was found in student online exchanges that reflected exploration, collaborative learning, and divergent thinking when communication took place predominantly through a text-based learning platform. To support pedagogical innovation, the GOSP pilot introduced the use of digital storytelling (Lambert, 2006) with concept maps (Beaudry & Wilson, 2010; Niesyto et al., 2003) and VoiceThread in an online learning community (Harasim, 1989; Sorensen, 2002). This model was guided by a transformative pedagogical approach that shifted the focus from teacher-driven to student-driven learning (Mezirow, 1997). The intent was to help teachers and students explore the use of collaborative learning media to promote reflective and dialogic learning (Abbey, 2008), as well as divergent thinking through visual literacy. This chapter presents a comparative analysis between the two projects periods examining differences in student exchange and the nature of inquiry when using concept maps and visual images as compared to text-based communication. The purpose is to contribute perspectives on how teachers can use digital media in their classrooms to support 21st century learning skills and help promote critical thinking, creativity and collaboration.

BACKGROUND

In 2007, The EU Commission on education identified eight key competencies that support program development within education, of which digital competence, global awareness, and social skills are included (European Commission on Education, 2007). The call stretches the focus from technology as a mere tool, to technology as a context for interacting and learning. The Commission (2007) states that, "ICT skills comprise the use of multi-media technology to retrieve, assess, store, produce, present and exchange information, and communicate and participate in networks via the Internet" (p. 22). Similarly, U.S. educational programming is guided at the present by an umbrella initiative called Framework for 21st Century Learning (2009), which promotes an integrated model of core subjects, digital media and

technology skills, life and career skills, and with learning skills such as communication, creativity, collaboration and critical thinking. These two educational agendas and others alike around the world recognize the importance for schools to redesign their educational programming in ways that integrate pedagogy, technology, and workforce preparation. They suggest it no longer is sufficient to focus solely on core subjects, for social skills, digital literacy and visual literacy are essential for preparing youth for the kind of divergent, inter-connected, networking, and creative work that is demanded of business for the future workforce.

Messages from the business community echo these educational agendas as well, and at the same time caution us about the gap between need and reality. Jerald (2009) reported in a study examining 21st century business skills that creativity, communication, divergent thinking, and collaboration are essential and need to be more fully developed in school curricula. Unfortunately, they report, the dominant educational model is overloaded with a focus on well-structured problems; students are not prepared to meet the real world of complex problems that require new ways of seeing and thinking. Moreover, reports Jerald (ibid), students are exhibiting difficulty presenting their thoughts and ideas, and lack a sense of passion and focus in their thinking. This would suggest that it is time for educators to take stock in the research on learning styles, brain based learning, and arts and education to understand more fully what teachers can do to integrate right-brain learning activities in the classroom and spawn divergent thinking, curiosity, creativity, and dialogic learning among students. And further, learn how visual images can be used to facilitate communication and learning across cultures where spoken and written language are often barriers.

The time has come, according to Pink (2005), to take advantage of the arts, and in particular visual thinking, to inform pedagogical development and programming in schools to open space for imagination and divergent thought. He claims that society is engaged in a paradigm shift from a left-brain dominated focus to a focus on the whole new mind, in which the left and right brain work in partnership with each other. The heavy emphasis on productivity and effectiveness in the industrial age, he suggests, is being replaced by a need among humans to have greater social connections, spirituality and creativity. He, and others (Snyder, et al., 2008) propose that the jobs of the future will be more focused on artistry, empathy, emotion, design, invention, counseling, ethnography, networking, and global. These jobs incorporate right brain activities, including, design, story, symphony, empathy, play and meaning (Pink, 2005). According to Silverman (2004),

Visual-spatial learners are individuals who think in pictures rather than in words… They are non-sequential, which means that they do not learn in the step-by-step manner in which most teachers teach. They arrive at correct solutions without taking steps, so "show your work" may be impossible for them. They may have difficulty with easy tasks, but show amazing ability with difficult, complex tasks. They are systems thinkers who can orchestrate large amounts of information from different domains, but they often miss the details. They tend to be organizationally impaired and unconscious about time. They are often gifted creatively, artistically, technologically, mathematically or emotionally. (p. 2)

Unfortunately, as research shows, schools have difficulty addressing the needs of right-brain visual learners because they are designed from a left-brain dominant model (Cochrane, 1999; Silverman, 2004). According to Silverman (ibid), "the school curriculum is sequential, the textbooks are sequential, the workbooks are sequential, the teaching methods are sequential, and most teachers learn sequentially" (p. *XXX*). What is important is for educators to seek ways to build learning environments that embrace

both the left and right brain and also encourage dialog and collaboration. Building brain-friendly learning environments engages both brains and is stimulated by challenge and feedback, as well as artistic expression (Galyean, 1983; Pink, 2005; Respress & Lufti, 2006*).*

Advances in Web 2.0 technology create possibilities for educators to develop classroom practices that promote 21st century skills including creativity, critical thinking, collaboration, empathy, and reflection. Needed is a pedagogical framework that helps teachers utilize the technology in ways that stimulate creativity and divergent thinking through discovery and inquiry. Traditional classrooms that reflect the left-brain dominated learning environment are guided by a pedagogical approach that assumes the teacher as knowledge bearer (ISTE, 2000); Knowledge is expert driven and in order to obtain knowledge one needs to learn from those who have it. Transformative learning (Mezirow, 1997) environments are guided by the pedagogical principles of among others, Dewey (1938, 1998), Vygotsky (1978), and Kolb (1984) who suggest learning occurs best when it is social, interactive, reflective, multisensory, collaborative and designed around a student's own questions. Such learning environments promote a balance between left-brain and right-brain activities as learners utilize a variety of media and art forms to explore phenomena as well as learn the basics in the core subjects.

A missing link for educators in the age of technology and social networking, I would suggest, is the use of visual images and representation that naturally invite open and creative thinking, as well as collaborative media that calls for students to work together on shared questions. Studies suggest (Snyder, 2010) that it is not enough to put students in learning groups and ask them to find information about problems or issues. This approach is limited in its linear orientation and is not sufficient to help students master the kinds of right-brain skills and competencies that are being called for by business today (Pink, 2005; Silverman, 2004). Whole brain learning requires a stimulus that invites thinking, exploration and curiosity (Dewey, 1998) and a forum for representing ideas as they grow. Visual thinking is a key ingredient in opening new doors for such learning to occur. It creates possibilities to incorporate both left-brain linear, logical thinking, and right-brain spatial and divergent thinking, while representing complex relationships in a variety of mediums.

The Arts, Visual Literacy and Creativity

Proponents of arts education have for years been seeking to help educators and politicians understand the significant role of the arts for holistic learning (Eisner, 2002; Greene, 1995; Rabkin & Redmond, 2004). According to Respress and Lufti (2006) "the arts pay off most expansively in basic reading skills, language development, and writing skills. Increases in general academic skills also show up and appear to reinforce these specific literacy-related developments. These skills emphasize focus and concentration, skills in expression, persistence, imagination, creativity and inclinations to tackle problems" (p. 26). Dickinson (2002) demonstrated interesting relationships between different art forms and thinking and reasoning. For example, music has a strong correlation to spatial reasoning, which is used in mathematics, while drama helps stimulate problem solving, concentration and analytical reasoning. And dance increases self-confidence, tolerance and appreciation for others.

Eisner (2002) and Greene (1988, 1995) focus on the use of the arts to stimulate imagination. Eisner (ibid) contends the arts "provide not only permission but also encouragement to use one's imagination as a source of content. Unlike in the sciences, where imagination is also of fundamental importance, in the arts there is a tradition that does not hold the artist responsible for 'telling it like it is'" (p. 82). Working with imagery can help foster a kind of divergent thinking that is essential for creativity and

imagination. It is in this role that visual literacy becomes significant for helping bridge the gap between business needs and student preparation for 21st century work. While the arts have remained external to the core curriculum and pedagogical practice in most educational systems, the growing use of images for communication on the Internet is causing us to take a second look and rethink the importance of visual literacy for 21st century living and work.

"A picture is worth a thousand words" is an old saying that can be heard around the world in a variety of languages. It reminds us that there is power in images that cannot be captured in words. Visual communication is a language of its own, and it is universal, like music. Moreover, and more significantly, interpreting images allows for divergent thought for there is no single right answer to the meaning of an image (Eisner, 2002). Images are everywhere, in our landscape, in museums, on TV, books, and on the Internet, and it is now becoming clearer that visual literacy needs to be developed in order to participate in knowledge sharing and development in the 21st century (Stokes, 2001). Visual literacy is the ability to read and interpret messages conveyed through visual images, as well as producing images for an audience (Bamford, 2003; Yenawine, 1997). It provides for a deep and reflective understanding of a topic or concept in a way that text-based representation does not invite in particular because reading and communicating with images involves critical thinking and multi-modal learning that stimulate deep learning.

Housen (2002) states that aesthetic thought strongly correlates with critical thinking and creativity and new cognitive growth as students observe, speculate and reason on the basis of evidence. Her work has led to the development of Visual Thinking Strategies (VUE, 2001), which she describes as a discovery process in which questions about images serves as the basis for dialogue. She states, "Discussions are initiated by questions phrased to provoke many thoughtful responses to what is seen in the images. Responding leads to active and extended involvement. The questions students ask become reflective —the basis for thinking critically" (VUE, 2001, p. 2). Starting with visual images, students begin to explore by asking, "what's going on in this picture," which serves as the basis for opening dialog for learning. Further exploration leads to the next level of questioning, "what do you see that makes you say that" and then finally, "what more can we find." These open, exploratory questions lead students into a reflective dialogue that stimulates divergent thought and creativity.

Within the context of cross-cultural sharing and learning, the arts, and in particular visual communication, can play a significant role in both communication and development of cultural sensitivity as youth explore common questions from different perspectives using a shared language of visual representation. Bamford (2009) suggests that the arts can serve as a cultural agent, helping students to develop an understanding of human experience and cultural identity and explore issues in a dialogic space that stimulate creative solutions. Working with imagery provides students a focal point for generating questions that are more divergent in nature, and foster exploration rather than argumentation and proof. Such questions invite dialogic learning (Shor & Freire, 1987) in which youth explore questions and perspectives in collaboration with one another, rather than arguing a particular point of view. It is through reflection, critical thinking and dialogue that creativity and knowledge transfer are supported (Frijters et al., 2008).

Collaborative Learning Software

Collaborating and working with diverse perspectives in an exploratory manner is not easy and automatic for all students. Often students need help finding ways to represent their ideas, communicate their thoughts, or organize information to see relationship between concepts or perspectives. Moreover, students need tools to help them develop collaborative inquiry. Two useful tools that are analyzed in this

chapter are VoiceThread and Concept mapping. VoiceThread is a collaborative multimedia tool in the form of a slideshow that allows users to interact with the context via text, voice, audio and video. As a pedagogical tool, VoiceThread creates conditions for student introduction, reviews of literature, reflection, brainstorming and digital storytelling. Its use in education is growing, and in particular it offers a multi-modal option for youth to explore, communication and collaborate around ideas. Brunvand and Byrd (2011) suggest that, "interface and feature set are well-suited for promoting student engagement and motivation, as well as helping students develop as independent learners" (p. 30). They promote the tool based on its flexibility to offer both synchronous and asynchronous learning, as well as a storage facility of ideas that can be accessed at a later date. Its intended use makes VoiceThread a useful tool for both collaboration and peer learning. Gillis et al. (2012) applied VoiceThread with young children to support language development, and found that it supported expressive language through storytelling, receptive language through listening to stories, comprehension through story retelling, and inferencing. They conclude VoiceThread to be a significant technology for its multimodal interactive ability including, voice, photo, and text, that engage students in active learning and expression.

Burden and Atkinson (2008) state that while VoiceThread was not originally designed for education, its application for learning is significant in relation to 21st century skill building. In particular they highlight strengths of VoiceThread as a social software for supporting 1) "connectivity and social rapport," 2) "collaborative information discovery and sharing," 3) "content creation," and 4) knowledge and information aggregation and content modification" (p.122). They point out, however, that it is not the software itself that stimulates a collaborative inquiry based learning, but rather it affords teachers the opportunity to support students in engagement. Benefiting from VoiceThread, among other social software, requires careful planning and stimulation on the part of the teacher to facilitate students' use of the software´.

Concept mapping is a higher-order thinking tool that has been used as a graphic organizer to help reflect and represent relationships between concepts (Novak & Canas, 2008). Nesbit and Adesope (2006) report that they were initially used as "advanced organizers, priming students for learning by activating prior knowledge and illustrating relationships with new concepts" (p. 413). Since then, the application of concept maps in education has developed in a variety of directions and is often used to support both collaboration (Gaines et. al., 1995) and divergent thinking. For students who have difficulty communicating their ideas in text-form, concept maps function as a spatial learning tool and offer visual learners possibilities to both explore the relationship between thoughts and represent them on paper, albeit in another form than pure text.

Research on concepts maps and learning demonstrate significant gains in retention and transfer. Nesbit and Adesope (2006) state that

In comparisons with activities such as reading text passages, attending lectures, and participating in class discussions, concept mapping activities are more effective for attaining knowledge retention and transfer. Concept mapping was found to benefit learners across a broad range of educational levels, subject areas, and settings. Much of this benefit was due to greater learner engagement, occasioned by concept mapping in comparison with reading and listening, rather than the properties of the concept map as an information medium. (p. 434)

Clearly stated here is the possibility that concept maps afford student engagement that is different from typical student involvement in class discussions. In part, the key lies in the construction of information

and ideas students generate through the concept maps, unlike when they engage in a verbal dialogue. Beaudry and Wilson (2010) provide further evidence of the use of concept maps for student engagement. In their study of the use of concept maps and formative assessment, they reported that students experienced a progressive mapping model, including collaborative learning phases, to be a strong factor in their learning. They claim that concept maps "are products that facilitate interactions of multiple forms of literacy, bringing thinking, writing, visualizing together with listening and speaking" (p. 7). Their argument supports the use of concept mapping and visual representation to stimulate a dialogic learning model that can promote critical thinking skills, questioning skills and deep reflective learning.

Findings from those who have worked with and studied the use of concept mapping, voice thread and visual images paint a picture for educators that demonstrates possibilities for creating learner-centered environments that spawn divergent thinking and creativity through the use of arts and technology. The next section of this chapter presents an analysis of data on the Gulf Oil Spill Project (GOSP) to explore the evidence of changes in student engagement, thinking and learning comparing the use of concept maps and voice threads with text-based exchange in Moodle.

THE GLOBAL PARTNERSHIP PROJECT

In 2009 the Global Partnership Project (GPP) formed to support international school partnership in China, USA, and Sweden. The GPP's mission was to help advance education through cross-cultural learning and collaboration for the development of global citizenship and pedagogical innovation (Snyder et al., 2010). Twenty-two school teams participated during the first two years (N=36 schools) from China, Sweden and the U.S. engaged during which educators were encouraged to build cross-cultural learning groups with their students through the support of communication technology (Moodle, ooVoo and Skype) to address global issues. The GPP was designed around an entire academic year with the fall term focused on helping students get acquainted using both Moodle and Skype. The curriculum was designed by the teachers in the three countries to support learning about global issues within the context of the curriculum focus in the partnering schools. The general framework began with a unit on "getting acquainted" in which students were asked to present themselves to each other in Moodle. The next unit focused on a community presentation by each school sharing something unique about their school or community and everyday life. The third unit was designed to stimulate global collaborative learning around a selected global theme, including water, the environment, or recycling. Research on this project (Snyder, 2010) showed that while student awareness for global issues increased and curiosity for different cultures expanded, little collaboration took place between students, in large part due to the text-based, linear nature of Moodle in which teachers were the main communicators.

In response to these findings, The Gulf Oil Spill Project was designed to advance pedagogical development in the GPP introducing visual images and collaborative tools including concept maps and voice threads (Beaudry et al., 2011). The pilot project title was conceived from the content, context and process of the intended learning model: *Gulf Oil Spill Project: Cross-cultural Digital Story-telling (GOSP)* and eight project goals that were identified. The project was designed to support collaborative learning in cross-cultural learning communities. The pedagogical framework that underpinned the project was drawn from transformative learning theory (Mezirow, 1997), visual thinking (Niesyto et al., 2003), intercultural competence development (Deardorff, 2004) and online collaborative learning (Sorensen, 2002). Three primary tools were introduced including a visual image data repository, VoiceThread and Webspiration,

which is a collaborative concept mapping tool. The tools were designed for use in a discovery model designed (Beaudry et al., 2011) that reflected four stages of learning for transformation: investigate through photos and information, create (digital stories), share (on concept maps and voice thread), and evaluate the information collaborative for knowledge transfer. The model is illustrated in Figure 1.

METHODOLOGY

This chapter examines how communication exhibited by students in a global learning context differs when using concept maps and visual images as compared to text-based responses, and explores any differences that are visible in the dialogic nature of the inquiry that ensued. Articulating a specific method that was used in this analysis is not a clear-cut process, for the focus of this chapter lies in between two worlds. On the one hand the study is a phenomenological exploration of changes in classroom-based learning that takes place in a cross-cultural learning context with different uses of digital media and concept mapping. At the same, it is not a pure phenomenological (Lancy, 1993) study in the classic sense, given that the focus is on patterns of change in the kinds of questions and communication that students engage in using digital technology, rather than on their experience with the technology. At best it can be described as a comparative collective instrumental case study (Stake, 1995), borrowing from Stake (ibid) and from Denzin and Lincoln (1994). Stake (ibid) defines an instrumental case study as a method to examine a particular question by studying a particular case. The case itself is not the object of study, but rather the vehicle through which a researcher can understand a situation, phenomenon, etc. to answer a question. When several cases are used as study objects to examine a question, the case becomes collective. I have chosen to include the use of the term "comparative" since this particular study examined differences in the types of questions and cross-cultural communication that occurred between students who participated in a global partnership project over a three-year period.

Data for purposes of this analysis were selected from student communication during the two project periods. In total 12 school partnerships were represented in the first project phase (GPP) with a total of 3 schools in each partnership team from China, USA, and Sweden (N=36 schools). Seven school partnerships participated in the pilot project (GOSP) with a total of 14 schools arranged in seven teams. Due to several logistical factors related to language and technology, the cross-cultural exchange dimension was

Figure 1. Digital work flow model (copyright Beaudry, Burden, Keuchel, Snyder, 2011)

not developed. Data were not available from the schools in China, and of the participating American schools, data were available from four schools out of seven. Data were then selected from the remaining schools that had demonstrated student work relevant to the purpose of this chapter, which included three middle partnerships from the first project phase, represented by schools in both the USA and China, and three schools in the USA from the pilot phase: one middle school and two elementary schools.

Selected data used in this analysis included: Seventeen concept maps from one seventh grade class in the USA (GOSP 7), seven VoiceThreads from two middle school classes in the USA, and text-based dialogue exchange in Moodle from a three middle school partnership in both USA and China. Individual interviews with 7 teachers in the U.S. were conducted via Skype and one focus group with all participating teachers in Florida (N=12) was conducted via Flashmeeting. Due to language barriers, communication with the teachers in China was limited and did not permit for a focus group or online survey.

Data were analyzed using a semantic approach to examine the content of communication as well as the form and structure, and social interaction of images, ideas and text. Erikson's (2007) Thinking Classroom model was applied to identify questions as either two-dimensional, reflecting fact-based knowledge, or three-dimensional questions that are conceptual and provocative. Two-dimensional questions relate to convergent, non-dialogic learning, and three-dimensional questions relate to divergent and critical thinking. The Digital Work Flow model was applied to explore the ways in which student communication showed evidence of inquiry-based dialogic learning using digital media.

FINDINGS

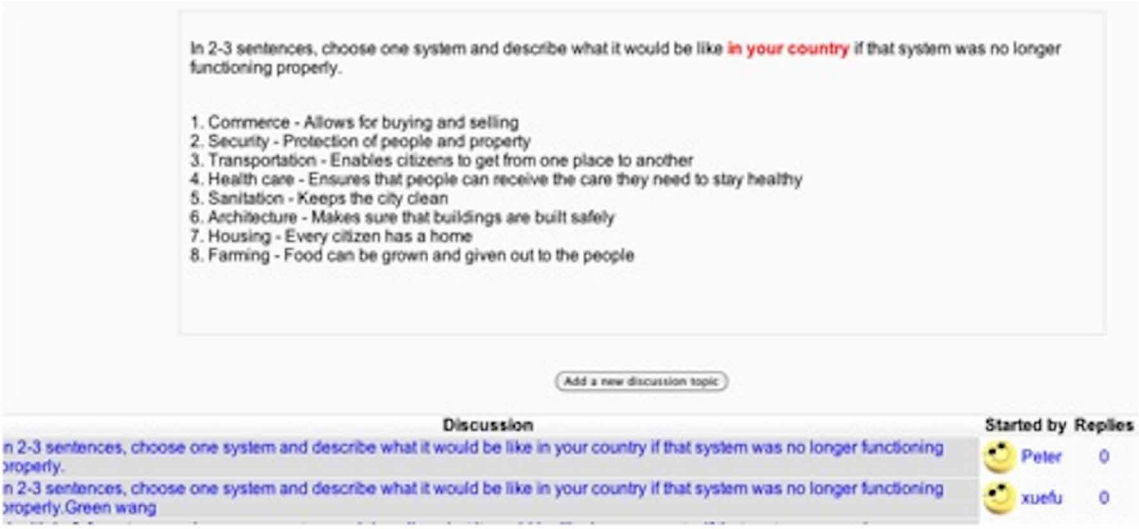
Findings are presented with respect to the two project phases of GPP and GOSP. The first analysis explores student inquiry and collaboration within the context of a teacher-driven curriculum that was carried out in a predominantly text-based communication platform (Moodle). The second analysis explored student inquiry and exchange in a student-driven model in which visual literacy tools (concept maps and voice thread) dominated the form and structure for communication. Following these findings, an analysis is provided that compares differences in student learning and explores potential reasons for the differences that can help to answer the question posed in this chapter: "what can educators do differently to develop learning environments that support holistic learning stemming from inquiry, exploration, creation, and collaboration through the use of digital media?

Moodle Discussion Forums and Text-Based Exchange

Examining text-based data from the first phase of the project, it is clear that when students engaged in learning by responding to teacher questions in a discussion forum, the communication was limited to fact-based responses for personal beliefs. Little to no dialogue occurred between students, and when it did, it was limited to one or two sentences. Rarely did students ask any questions of each other more than, "what do you think"? and, "tell me what it is like in your country."

The first example, found in Figure 2, depicts the type of questions that teachers asked as organizers for learning. Here we see that the question asks for facts and does not invite any particular kind of inquiry. The phrasing, "describe what it would be like if that system was no longer functioning properly" does not necessarily elicit inquiry from students. Moreover, the Moodle discussion forum was organized so that each student had a separate discussion forum in which to post. This required each student to open

Figure 2. Screenshot of Moodle online discussion forum



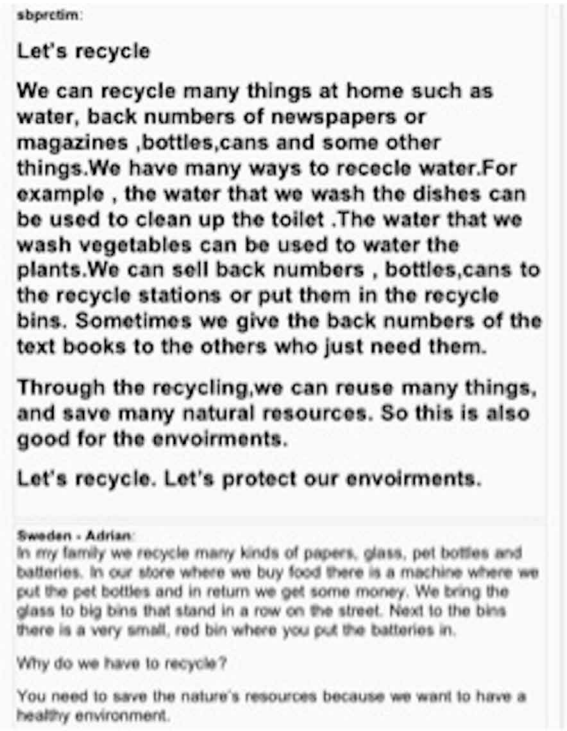
the individual discussions and post to each one, as opposed to seeing the entire discussion thread as a dialogic space. This one-to-one communication structure appeared to affect the type of exchange between students, as evidenced by the little to no commenting on the different threads.

In another example, teachers identified two project themes: Earth and Carbon Emission, and asked students to generate questions that they could then work on together. The Moodle environment was identical to that depicted in Figure 2 above. One student responded to the question about Earth with a simple comment, "I think more people should recycle and maybe we would have less earth related issues!" Another group prepared a power point slide that focused on "how to reduce your footstep" using data from different Internet sources that point to the need to use energy saving features in your home, for example, use cleaner transport or choose sustainable building materials. No exchange or dialogue followed the posting of this power point in Moodle.

Following this activity, teachers then chose to post a new question on Moodle: "What do you recycle at home"? and "how do you recycle at home"? The stated objectives from the teachers were for "learners to give examples of renewable and non-renewable resources and explain the differences between the two categories of resources, 2) generate a list of non-traditional uses for a given object or material, and 3) address problems that come with a nations prosperity and growth." Students began to post in a common discussion forum their responses to the questions. What is evident from the postings, as highlighted in Figure 3, is that students merely answered the question, rather than engaging in an exploratory dialogue together. Furthermore, the content of their postings does not reflect deep learning. Rather it was descriptive of what they already do at home to recycle.

In another school partnership, students used word documents to communicate their thoughts and ideas about an environmental issue in response to a teacher-initiated question posted in Moodle: "What kind of global issues can we explore together? Post a question or comments about an issue and let's talk about it." Following this question, teachers had identified two thematic areas in which they intended for students to respond to the initial question. The themes included the environment and water resource

Figure 3. Online text-communication in Moodle between two students


sbprctim:

Let's recycle

We can recycle many things at home such as water, back numbers of newspapers or magazines ,bottles,cans and some other things.We have many ways to rececle water.For example , the water that we wash the dishes can be used to clean up the toilet .The water that we wash vegetables can be used to water the plants.We can sell back numbers , bottles,cans to the recycle stations or put them in the recycle bins. Sometimes we give the back numbers of the text books to the others who just need them.

Through the recycling,we can reuse many things, and save many natural resources. So this is also good for the envoirments.

Let's recycle. Let's protect our envoirments.

Sweden - Adrian:
In my family we recycle many kinds of papers, glass, pet bottles and batteries. In our store where we buy food there is a machine where we put the pet bottles and in return we get some money. We bring the glass to big bins that stand in a row on the street. Next to the bins there is a very small, red bin where you put the batteries in.

Why do we have to recycle?

You need to save the nature's resources because we want to have a healthy environment.

management. The theme of environment generated dialogue between six students representing the schools in Sweden and the U.S. In one of the postings, a student asked questions of their partners:

What do you think we should do about the environmental problems of the world?

How do you think the world will look like in 20-30 years?

Do you think there will be new and dangerous diseases that may lead to thousands of people dying due to the rise in temperatures?

Some people think that they do not care about the environment and that everyone takes it too seriously. What should we do to change that kind of person and get them to understand the importance of global warming?

Responses by other students to these questions included, 1) "I think you are right. We need to help out the earth. I do not think we residents have a choice about fossil fuels, but we can walk and other things that will help"; 2) "what I think we should do about the environment crisis is we should pay attention to the small things like riding your bike to the store instead of driving a car. We could trade our old light bulbs for environmental friendly ones. I think that if we start paying attention to the small things now,

later on our world will start to mend itself back together, but the Earth cannot mend itself on its own, so let's start going green!"

In this online exchange, the initial questions asked by one student indicated three-dimensional thinking in that they suggested an awareness of implications for the future based on the current environmental issues, for example: "do you think there will be new and dangerous diseases that may lead to thousands of people dying due to rising temperatures?" The relationship identified the connection between rising temperatures, disease and death. It appears from the responses that the format for communication did not invite exploration or dialogue, as none of the responses were in direct relation to the questions. They reflected a collegial perspective, but no collaboration, dialogue, or reflection that was stimulated by the posting.

Another student in the same partnership posted their comments individually in a word document, asking questions of their school partners at the end of the letter. They wrote the following:

The environmental problems are something that I think we should start thinking more about. Before when I was younger I didn't care so much about it so much but now I can't avoid it. Something that our country can do is to stop produce so much environment pollutions things. I don't think that I as a private person can do so much to change the environment problems and not my parents either. Now some questions to you.

Do you care much about the environment problems?

Do you try to do something to change the problems?

How much does your country care about the problems?

How much do your parents care about the problems?

Have you noticed some different about the climate now and for some years ago?

The types of questions raised in this posting reflect mostly convergent thought and two-dimensional thinking focusing on facts and skills for how to care for the environment. The affective nature of the questions suggests potentially divergent thinking, but this is not evident since there is no dialogue to follow or follow-up. It is conceivable that if these students had another forum for connecting, and were encouraged to dialogue, their questions could support creative inquiry. However, in the text-based forum the questions became mostly rhetorical.

These examples suggest that while students may possess skills in inquiry, using them to facilitate deep learning requires more than just posting thoughts. It requires a forum, process or method that invites exchange and exploration, as well as testing concepts. In relation to the first set of questions posed by the teachers on Earth and Carbon Emission, only one student responded in the U.S. to the question about Earth, and one class in China to the question about Carbon emissions. In a separate question to the same schools about recycling, only seven students responded representing two different schools. This would suggest that the discussion forum model in combination with a teacher driven curriculum framework, was not enough to evoke dialogic learning, curiosity and divergent thinking among students.

Concept Maps and Visual Images

In contrast to the first phase of the project, the second phase (GOSP) employed a transformative pedagogical approach grounded in student-inquiry in which teachers served as facilitators. The concept maps, VoiceThreads and visual images were used as stimuli and platforms for communication for student inquiry and collaboration. To begin, students were asked by their teachers to choose between one and 3 photos from a photo bank of 12 photos, each from the Gulf Oil Spill and the Yushu Earthquake. Using a Visual Thinking Strategy model they then asked students the question, "What do you think is happening in this photo?" followed by a series of questions that began with "Why?" The purpose according to the teachers was to help students engage in a deeper learning process using the photos as a stimulus. According to one teacher, the photos, helped students "to generate emotion, talk about personal experience, including such questions as how the gulf oil spill affected our sea life and seafood prices." The teacher further shared that 'The pictures brought emotion. We asked students to look at the photo without saying anything and then asked, 'what are you feeling'. This helped them to generate questions that then became a part of their investigation.

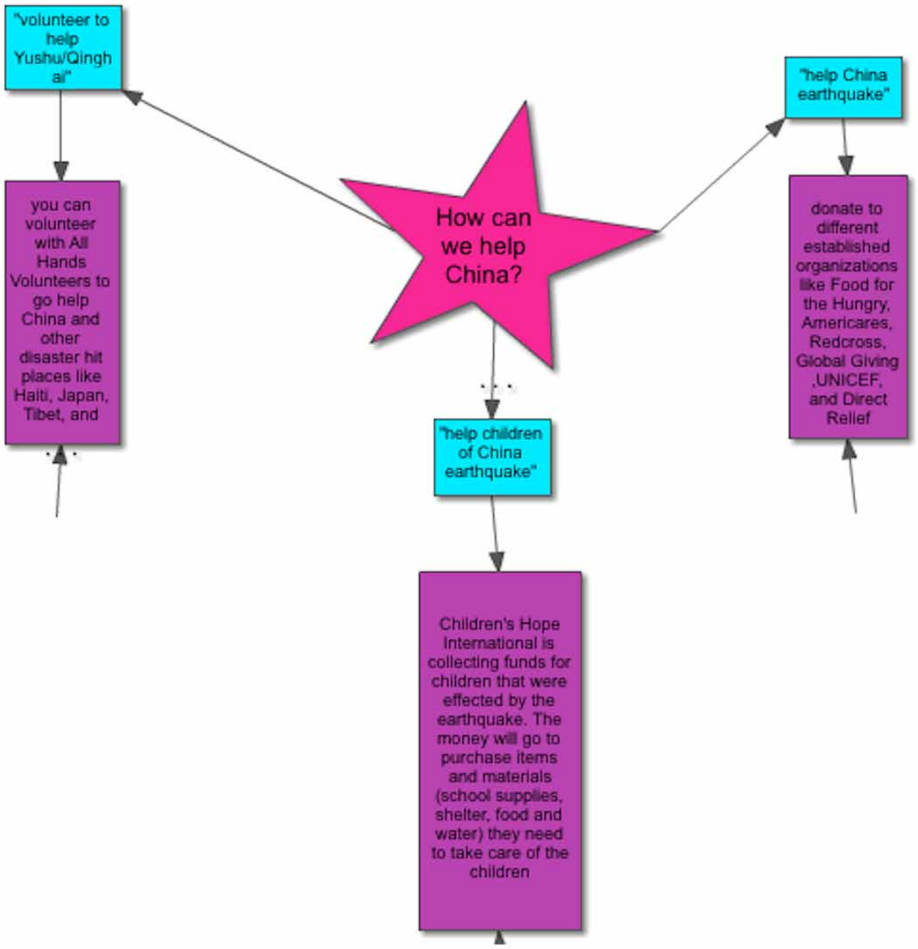
Following exploration of the photos, students collaborated in groups of three from each school working with concept maps to explore further the initial questions that had emerged from the photos. They received help from the teachers to generate a question that could help them start their inquiry. In the concept maps that were generated, there was evidence of three-dimensional thinking represented by the different types of questions asked that illustrate an understanding of the relationship between concepts. In the first concept map, the collaborating students asked the main question, "What happened to the sea animals during the oil spill?" Their inquiry included sub questions, such as "did the animals get cleaned after the oil spill? In which they explored information about the cleaning process. As well they learned that the particular timing of the oil spill had an impact on sea life in a larger sense, as many of them had begun the spawning and nesting period. According to the teacher, the photos helped the students to make different kinds of connections to additional questions so that their inquiry was not just fact based; it also included affect, which is linked to divergent thinking. They guided:, "as you type in the concept map, you enter data in different boxes. As the boxes develop, you see how questions become sub-sets of questions, and how concepts relate."

In one concept map in Figure 4, elements of affect are displayed in the questions, as well as deeper exploration of what can be done to help China in the cleanup. Rather than asking only fact-based questions, students were curious about how to engage in the issue, which is considered an important characteristic of critical thinking and creative learning.

In another concept map, presented in Figure 5, we see again evidence of the kinds of sub-questions that emerged in the student's inquiry that were generated from one major question: what happed to China's major cities. This question is reflective of an "essential question" which fosters divergent thinking. The question itself can be answered from a variety of points of view both fact-based and affect-based. The sub-questions that were generated during the inquiry indicate an awareness of the complexity of the event and its impact on china.

In the concept maps there is also evidence of collaboration. Students who worked in groups of three began with a common question and then generated a series of sub-questions, which they explored individually to begin with. Students collaborated on the concept map, filling in their information and then dialoging about its implications. During the interview with the technology teacher in one of the schools, they shared that the concept map was significant in stimulating collaboration: "When students researched

Figure 4. Concept map from a seventh grade team

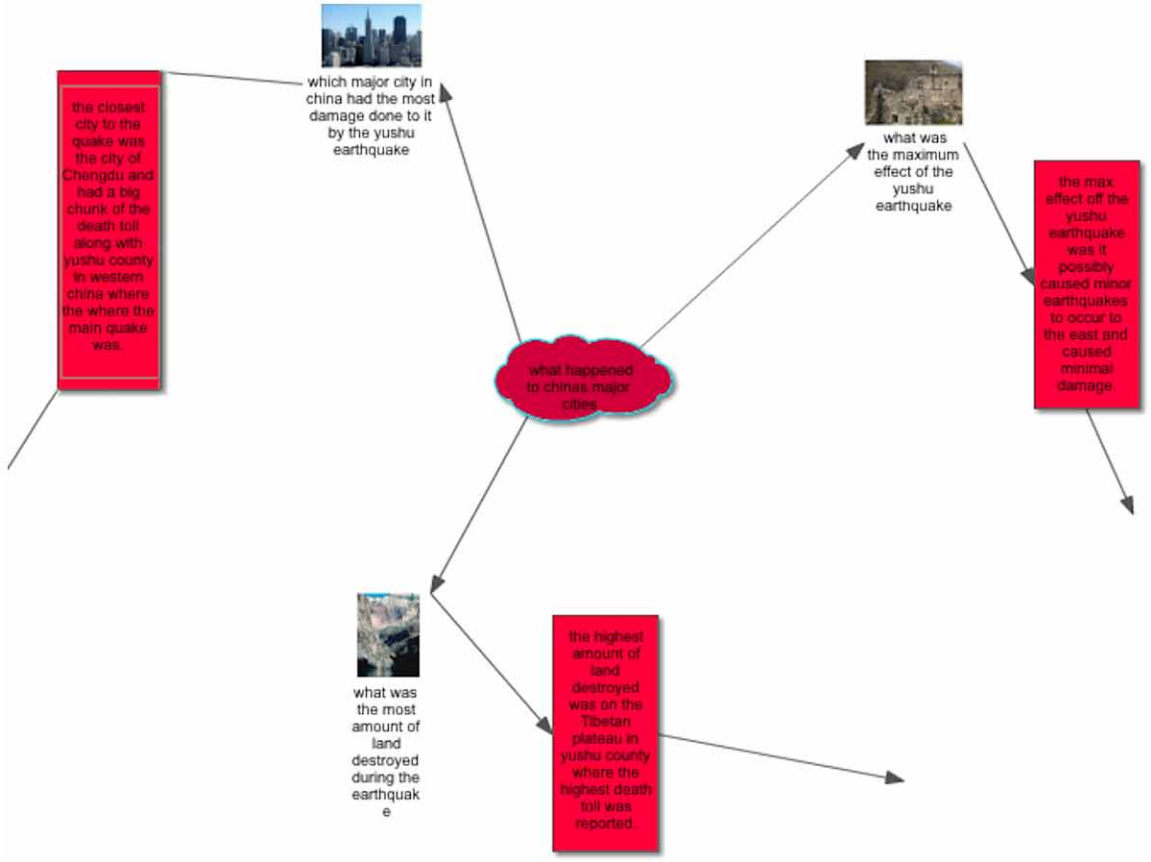


their questions, they could collaborate on one document in Webspiration (a concept mapping software). Students were asked to find a different photo to support their question. Then they uploaded them to the concept map. Then they had to research and enter their info. Ask questions about the picture and then research. They then saw that student A's question could relate to student B and C based on their pictures. We found that this stimulated students' curiosity and interest." What was not evident in second phases on the GPP project was cross-cultural collaboration. According to the teachers, the project was implemented too late during the spring term and did not allow time for cross-cultural sharing. However, according to teachers, the photos helped students develop a sense of curiosity about the respective countries and sense of empathy for the experience of both natural disasters for its citizens.

VoiceThread

In another class, students began to study the photos as a stimulus for dialogue. Instead of concept mapping, they used VoiceThread as the medium for communication, both to present their knowledge of the Gulf Oil Spill and Yushu Earthquake, as well as to present their experiment with how to clean up an

Figure 5. Concept map from a seventh grade team



oil spill using a simulated project model. In the first VoiceThread as depicted in Figure 6, two students presented information about the Gulf Oil Spill. A transcription of their postings showed that students incorporated facts they presented in narrative form. They used imagery in their words to paint a picture of the human element, rather than just reporting facts. For example, one student shared, "When the gulf oil spill happened they were a mile underground and there were eleven workers onboard who died because of the explosion and that's because there were a few glitches with the machine." Another student shared the following, "The gulf oil spill was terrible. It killed a lot of marine life. Mostly sea turtles, but it spread for a 100 miles and it also killed a lot of people." Together, these two different storylines embedded within the same VoiceThread represented collaboration around information about the event. One student focused on the explosion, its cause and impact on workers, while another focused on the impact on marine life. The two different questions, in collaboration with one another illustrate three-dimensional learning that connects facts with emotion and skills for working with visual imagery and digital media.

In the second voice thread, depicted in Figure 7, students shared the simulation they made to learn how to clean oil. They simulated an actual ocean using a variety of materials that functioned similarly to elements found in an ocean. Embedded in the VoiceThread are the voices of two different presenters.

In an interview with teachers, they shared their observations of students working with VoiceThread and compared this to text-based exchange on Moodle. Students were more engaged with each other

Figure 6. VoiceThread from an elementary school team

when working with the voice thread, and were more creative in their thinking: "when the students see photos they spur ideas, and the VT also stimulated new ideas listening to one another talk about the global events." The teachers also perceived other benefits to voice thread and working with visual images. According to them, "some students are more comfortable talking and have difficulty writing. For them, the options in VoiceThread help them to present their thoughts. Working with images they can also illustrate their ideas differently. In Moodle, it requires that students read everything in order to participate in a dialogue. That takes more time and another kind of skill that not all students are comfortable with."

Analysis

What can we learn from the above findings to help teachers think differently about the use of digital media to engage students in discovery, collaboration and 21st century skill development? Analysis of the findings show that students appeared to be more engaged, inquiry-driven and collaborative when working visually with concept maps and VoiceThread as compared to text-based dominated exchange. Understanding potential reasons for this can be found in other studies about the power of image for stimulating creativity (Bamford, 2009; Eisner 2002), and the interactive nature of learning that takes place with a transformative pedagogical practice (Mezirow, 1997; Sorensen, 2002; Snyder, 2007). In the text-based Moodle environment, which was teacher-driven, students displayed an interest in sharing their thoughts and ideas, however, they did not appear to engage in collaborative or shared learning. Their exchanges were based predominantly on sharing what they do or think and asking of their global partners what they thought. Salmon (2000) would suggest, in this text-based dominated platform the need to build a culture of learning that engages students in higher order thinking over time. She suggests that the text-based model requires a facilitator to help students move from engagement to involvement.

Figure 7. VoiceThread from an elementary school team demonstrating the oil clean up simulation

In contrast, the content of the VoiceThreads reflected dialogic inquiry that was evidence of what Pink (2005) refers to as storytelling and empathy, and an understanding of the parts in relation to the whole. In the GOSP project, students worked in groups to select photos from the photo data bank that were then used to spawn questions for collaborative discovery. What was interesting in listening to the postings and reading their text was the narrative nature of their communication. There were elements of story, including scenic description and emotion as well as facts about the oil spill. Unlike the text-based communication in Moodle, the messages in the VoiceThread had a more dynamic dimension as well as storytelling model that are akin to critical thinking, reflective learning, and divergent thinking. The work with VoiceThread also highlighted how students worked following the digital workflow model as they first used the photos to investigate answers to questions that they identified. With the information they began to create a collaborative story that was built by the variety of postings, told often in narrative form. In so doing, they developed a dialogic dimension in their learning through which student's individual knowledge, curiosity and understanding about the Gulf Oil Spill and Yushu earthquake was deepened and contribute to a collaborative knowledge transformation.

There was also evidence from the analysis that the role of the teacher and the pedagogical approach were significant for fostering divergent thinking and collaborative learning. In the GOSP project, in which concept maps and voice thread was used, teachers worked with questions to help probe students

to explore and reflect on ideas and information. The use of photos transformed the concept map into a dynamic collaborative exploratory. By taking time to select photos and explore the potential significance of them, students arrived at deeper questions for their collaborative inquiry. This process reflected transformative learning (Burden & Atkinson, 2008; Mezirow, 1997) depicted in the digital workflow model: investigate, create, share, and evaluate (Snyder et al., 2010).

Solutions and Recommendations

Asking questions stimulates curiosity and the desire to discover. The types of questions we ask have profound implications for the type of learning that can ensue (Erikson 2007; Wilson, 1997). Children in their early years reflect a natural, innate behavior, for divergent thinking and curiosity that somehow reduces with the years. It is often suggested that the left-brain dominated, prove it to me, model of schooling and educational politics has killed this wonder (Eisner, 2002; Silverman, 2004). Educators like Dewey and Vygotsky remind us of the need to keep the wonder alive by creating learning environments for youth that invite and stimulate curiosity and secure the notion that the process and experience of learning is just as important, if not more important than the outcome.

The standardized testing movement has challenged teachers to find ways to embrace discovery learning amidst the demands to prepare students for selected aptitudes that are tested on national and international tests. This paradoxical condition between proof of educational success and natural learning through discovery and social interaction has created a condition in which teachers themselves often do not take the risks to be creative. Their visions, albeit worthy, are often limited to the confines of the testing culture (Snyder et. al., 2008). This was evident in the Global Partnership Project in which carefully articulated lesson plans reflected the traditions of testing, in the form of stated objectives that sought proof of student knowledge acquisition. Despite the group context for learning, there was little to no evidence of teachers facilitating a dialogic, discovery based learning in Moodle that encouraged students to develop their sense of curiosity and investigation.

Dewey (1938; 1998) speaks of the importance of experience for learning and the need for teachers to create learning environments that invite curiosity, investigation and sharing. He states,

In a word, we live from birth to death in a world of persons and things, which in large measure is what it is because of what had been done and transmitted from previous human activity. When this fact is ignored, experience is treated as it if were something which goes on exclusively inside an individual's body and mind. It ought not be necessary to say that experience does not occur in a vacuum. There are sources outside an individual which give rise to experience. It is constantly fed from these springs. A primary responsibility of educators is that they not only be aware of the general principle of the shaping of actual experience by environing conditions, but that they also recognize in the concrete what surroundings are conducive to having experiences that lead to growth. (pp.34-35)

The context of the Global Partnership Project (GPP), one could argue, was well thought through from the start, with a base in contemporary research on learning and school development (Snyder, et al, 2010). The approach was holistic from a whole school perspective rather than classroom-based. The leadership and teaching staff planned together what was needed to foster learning in a cross-cultural context. Technology specialists were on hand to assist teachers with the development of Moodle and connections

in Skype and ooVoo. These measures are certainly commendable as research from this project phases indicated many positive outcomes for students and teachers regarding global awareness and the use of technology (Snyder, 2010). What was missing, I would contend, was an understanding of the need to create an environment that supported discovery and dialogue in order to fulfill the dream. The limitations could be understood from a variety of perspectives that emerged during the initial research, including language barrier, technological challenges, and schedule conflicts between countries which created a dynamic in which students did not have access to work together on a regular basis using face-to-face technologies. However, the analysis presented in this chapter suggests that perhaps something more fundamental was at play: the type of technology and the pedagogical model needed to invite student-driven participation and inquiry in order to stimulate creativity and divergent thinking

The GOSP pilot project, regardless of its introduction of concept mapping, visual images, and VoiceThreads, suffered from similar technological challenges as participating schools had difficulty accessing some of the software (despite prior testing of the tools). This limited the cross-cultural dimension of the learning space. Despite this, there is still evidence of a different kind of learning between and among students in local groups working with concept maps and VoiceThread, which is represented in the storytelling nature of their communication, as well as the reflective nature of their presentations.

There are two aspects, I suggest, that are important to consider from this analysis to understand what teachers can do differently to spawn divergent thinking with the use of digital media. The first is to consider the digital media that is chosen and the degree to which the interface invites discovery and sharing. The second is to understand the implications for teachers to create a learning environment that invites experience. The interface in Moodle was more linear and it was designed around individual postings, rather than group discussion threads. The dominant form of sharing was text-based, and didn't invite collaboration. Compare this with concept mapping and VoiceThreads in which the interface was both multi-modal, and the documents were shared among the students in each group inviting collaboration and dialogue around the content.

Another important factor is for teachers to understand how they can incorporate digital media to support discovery and experience. In the first project the curriculum framework was strict and evidence-based with an emphasis on sharing findings across cultures. In the second pilot project, the focus was on helping students explore two major events by reflecting on a set of photos from the Gulf Oil Spill and the Yushu Earthquake. The set-up of the learning activity from the teachers was experience-based both in exploring meaning behind photos, as well as experimenting with how to clean up an oil spill. In many of the dialogues students explored the meaning of the natural disasters for themselves, trying to understand, for example, what the students in the Yushu Earthquake must have experienced and what that would have been like for them, or the availability of seafood after so many marine life died in the Gulf Oil Spill. The more students explored their own questions together, the less they were interested in the teachers input. For the teachers, watching their students engage with eagerness stimulated new responses in their own teaching as facilitators of discovery and creativity.

FUTURE RESEARCH DIRECTIONS

This chapter has been developed in relation to a broader question spawned by the editors: "Can students improve their critical thinking, their understanding and production of arguments by being given practice

in mapping? ” The analysis was based on a comparison of the same schools over a two-year period that applied two different models and digital technology to support learning in a global context. The findings help to provide insights to answer the editors' question, suggesting there is strength in the use of concept mapping to stimulate divergent thinking, exploration and inquiry, as well as collaboration, which are linked to critical thinking and deep learning.

The chapter also pointed to gaps in the knowledge among educators about how to connect pedagogical models that support inquiry and social learning with digital media. One significant element that is supported by both brain-based learning and arts education is the need for teachers to work with multi-sensory learning and allow these tools and approaches to support a new kind of learning environment. Considering future directions of both research and practice, it seems necessary to begin connecting knowledge from different fields into a holistic understanding for teaching and learning. For example, the research on arts education tends to remain on the periphery of pedagogical practice, yet there is strong evidence to suggest the arts should be central to informing pedagogy. In research on technology and learning, there is a strong knowledge base developed about the strengths of media to support collaborative learning. And the theories of Dewey and Vygotsky related to social and experience-based learning have found a home in the practice of creation that is afforded by social collaborative technology such as concept mapping. Educational policies such as Framework for 21st century learning (2009) provide a natural context in which schools can begin to embrace the diversity of research to inform practice. Yet, the standardized test model of education seems to dominate. Perhaps this is the area that we need to be focusing on: how to rethink testing and accountability so that educators are supported by an environment in which they can offer students possibilities for developing 21st century skills that integrate knowledge and experience from a variety of disciplines including technology, the arts, communication, and social learning theory.

CONCLUSION

Helping teachers understand what they can do in their classrooms to spawn divergent thinking with the use of digital media has been the focus of this chapter. A review of research on future workforce skills for the 21st century presented in the beginning of this chapter suggests the need for continued exploration as too many schools continue to develop in an arena fixated on productivity and outcomes at the expense of preparing youth for a future workforce. Dewey's theory of learning is not new, but it is fundamental and paramount for today's educational agenda to help schools prepare youth with 21st century skills. The focus on experience and discovery is more than just social learning in which students work in groups. It is about creating possibilities for students to actively engage in a process of reflection, inquiry, investigation, sharing, and discovery to be prepared with skills to engage in storytelling, divergent thinking, empathy, and networking that are sought after by businesses. With the continued development of technology and digital media since Web 2.0, teachers have at their disposals a myriad of tools with which they can help spawn a stimulating and transformative learning environment for students. It requires, however, that teachers not only select software that supports such learning, but that they also match a learning model that opens doors for investigation, exploration, discovery and creation.

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KEY TERMS AND DEFINITIONS

Collaborative Learning: A concept that suggests learning occurs best when the participants themselves determine the focus of learning, the question to explore and the ways in which they will explore the focus of interest. Compared to cooperative learning in which a framework or structure is externally determined, collaborative learning engages participants in the creation of their own structures and determinants of learning.

Concept Mapping: A higher-order thinking tool that has been used as a graphic organizer to help reflect and represent relationships between concepts.

Creativity: Seeing relationships between unrelated ideas, objects, or concepts and combining them to make something new.

Digital Media: Used to indicate a variety of software programs that are used to communicate and represent information. The media can be visual and or auditory.

Transformative Pedagogy: A philosophical orientation to learning in which students engage in shaping the curriculum through their own questions and curiosity. The role of the teacher is to facilitate conditions for students to arrive at their own answers, rather than to provide the students with answers. One of the main intentions is to transfer the learning from the classroom to the real world.

Visual Literacy: The ability to represent and interpret ideas using graphical models and pictures. In the context of learning it is related to right-brain higher order thinking skills and it leads to cognitive growth in observing, speculating and reasoning based on evidence.

Whole-Brain Learning: Pedagogical praxis that engages both left-brain logical, analytic reasoning with right-brain creativity and higher order thinking.

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Chapter 50
Digital Media in Uganda: Where Regulation and Freedom of Expression Contradictions Are Sharpest

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ABSTRACT

This chapter is an analysis of the law in the face of the growing digital media in Uganda. It begins with a summary of Uganda's digital media terrain which helps the chapter to raise an argument of numbers in relation to relevance and external pressure, as forces behind digital media regulation. The background introduces the gist of the chapter, which is the regulation of Uganda's media in the digital age. A recent court case in Uganda, in which a local singer was sentenced to one year in jail along with her video producer, who was convicted for producing a pornographic music video that was distributed online, inspires this chapter. Didi Mugisha pleaded guilty and became the first victim of the Anti-Pornography Act, which was signed into law in 2014. Beyond that court drama and the international fame it garnered are some serious concerns. First is the relationship between the bulk of Uganda's media laws and the existing producer/consumer digital platforms, and secondly are the broad implications the current state of affairs of that and similar laws has on the freedom of expression.

INTRODUCTION

The chapter therefore reviews the above landmark case in Uganda's digital content production and the Anti-Pornography Act (2014), which was used to charge the two artistes, to present the contradictions that are apparent between the application of the digital technology, which is premised on the freedom of expression argument, and the protection of other freedoms and rights. The Neo-liberal understanding of globalization technology and the Neo-Marxist counter-views are used to ground the analysis into global scholarship. Furthermore, international and regional instruments which protect free expression and their stand on both the limitations and the regulation of the same freedom are used to strengthen the argument.

Indecent and pornographic clauses are not new in Uganda's media law history. In fact government takes a pragmatic view on the issue, arguing that media should exercise their freedom with responsibility.

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In 2004 for example, an FM radio station, Radio Simba, was fined $1,000 by the Broadcasting Council and ordered to make a public apology (BBC, 2004) for hosting homosexuals on a show, contrary to the Penal Code Act. Debates about freedom of expression and laws among traditional media have been around for quite some time. But the way media laws are designed in the face of digital media, how they relate with freedom of expression and the implications of that regulation for new media, has received little attention.

The other crucial issue that the chapter addresses, apart from attempting to cover the above gap, is whether or not media literacy extends to digital content producers. Article 19 of the Universal Declaration of Human Rights, assumes 'equal access to channels of communication' (Nassanga, 2009). After getting access, people should actively utilise the resource of information. Media literacy, or the "ability of individuals to analyze and evaluate media critically and to express themselves, producing social communication in a variety of forms"(Nassanga, 2009), has been advanced as an idea for media consumers mostly. What about the producers, especially the digital content producers, who may also act as the distributers? Using that background, issues of digital media literacy for local entertainment content producers, who are mesmerized by the free digital distribution channels, are highlighted in this chapter as well.

THE DIGITAL MEDIA FORM

The "digital revolution" is made important by the fact that it uses the web as a centre stage for voice, picture and text media that previously were mutually exclusive (Verweij, 2009, p. 75). That kind of convergence has been hailed for its production capacity that is massive, for its interactivity, for defying distance over time, and for its individualization of producers and consumers (McQuail, 2010). In the pre-digital era, the video described above would have to be through a major state/private TV/film company regulated by government. The new dawn of digital media has ushered in the "convergence of citizenship and journalism" (Berger, 2011, p. 708) and created possibilities for alternative content production such as the ones used to produce the music video that this chapter analyses.The advances in mobile phones are pushing the internet possibilities further by introducing a smartphone (Weiss, 2013) which has lessened the regular visits to internet cafes. Nevertheless, issues of the digital divide cannot be neglected when discussing the digital revolution especially in Africa, a region that remains the world's under-penetrated with subscriber growth standing at 12% (GSMA, 2015).

Regardless, "mobiles have been the platform for a uniquely massive and multidimensional enhancement of capabilities in developing countries" (Smith, Spence, & Rashid, 2011, p. 77) and "people turn to their mobile phones to get news and information and to be entertained" (Wei, 2008, p. 37). In Uganda specifically, there are 17 million people now having access to mobile phones (UCC, 2015). The number of people using smart phones in Uganda is not yet recorded but studies done on ICT and media in rural areas indicate that 1.6 percent use the phone to access the internet for various purposes (Semujju, 2013; 2016). The African internet picture is picking up too with one in five people using the internet (ITU, 2015). In Uganda, there are 6 million people with access to the internet (UCC, 2015) of the total population of 35 million people (UBOS, 2015). Mobile phones have been instrumental in promoting Uganda's digital revolution. In relation to this chapter, whether or not the current laws provide for content that is produced (and consumed) online using gadgets like the mobile phone, computer, and others, is crucial.

LOCATING THE PROBLEM IN THEORY: GLOBALISATION THEORIES

The internet is a global technology, one that is responsible for speeding up the process of globalisation in the area of media content, regulation and form. This creates necessity for this chapter to apply theories of globalisation to explain various understandings of digital media regulation. Regulation in the digital age can be theoretically explained using the globalisation theories of neo-liberalism, neo-Marxism and traditionalists theories (Servaes and Lie, 2003; Banda, 2006).

The neo-liberals include the content producers and consumers who see the internet as an invention that will help them to circumnavigate the authoritarian rule that puts undemocratic inscriptions on the enjoyment of fundamental rights. Due to the creation of "consumer-citizens" (Lemmens, 2015) or "prosumers" meaning producers who are also consumers (Rennie, 2007), the internet is a liberation tool against despotism or any despotic form of rule or, in this case, countries' communication commissions that go from regulation to control, draconian laws that criminalise the enjoyment of fundamental freedom (like the Anti-Pornography Act) and other government mechanisms. The technical aspects of digitalization and multimedia help to promote the pervasive and ubiquitous nature of the neoliberal interests (Kaul, 2011). However, despite the promise of globalisation to bypass the local political will, media policy-making is still influenced by national and political factors (Ndlela, 2007). In more progressive economies, content platforms like YouTube can be blocked as the 2009 case in China was (Antony and Thomas, 2010). As for the video that is discussed in Uganda's case, since the conviction of Mugisha and the imprisonment of Kansiime, the song that got them into trouble, is still on line. In the traditional media sense, if there was someone convicted, the radio or TV would be ordered to remove the content or risk being switched off. This happened to four radio stations in 2009 which were switched off-air for, as the government noted, 'hosting opposition' (Lumu, 2010).

On the other hand, the argument by the neo-Marxists is an argument of access at its least but inherent in it are the various economic, political and other interests (Banda, 2006). Issues like the digital divide come into play here. Out of the 35 million people in the country, although it is not known how many watched the video within the boundaries of Uganda, the video has 18,819 views. Even if one assumes that all these were Ugandans, it is not enough to say that the internet facilitates information access to Ugandans. The neo-Marxists therefore see no reason to be excited since the new media are just continuing to facilitate information access to people who can already afford to have information. On top of that, only those who understand computer knowledge and those who have a stable internet connection (or those who can pay for one) will be the only people to upload (or to comment on) information. In the end, they control both production and consumption processes and rather than liberating people, they enslave them (Verbeek, 2015; Lemmens, 2015). The digital revolution in addition, either introduces a new set of owners like the search engine giants or consolidates power to the previous owners like Rupert Murdoch who owns MySpace (Beckett, 2010). The majority are held hostage by those few people who happen to be those who have financial and literacy power. It is their information that millions and millions of people are consuming, which reinforces their domination.

The Traditionalists worry about the potential of "the new" or of globalisation to alter the status quo and disrupt the power of established order (Servaes and Lie, 2003; Banda, 2006). We would theoretically put the ideas behind the Anti-Pornography Act under the arguments raised by the traditionalists. The law could have been raised by people who thought it was necessary to preserve the cultural heritage or norms that relate to some music genre. Traditionally for example, among the Baganda, one of the 52 tribes in Uganda, when a couple bears twins, there should be a function thereafter where attendees hull

obscenities to the couple while the couple fires back. In fact, the couple is expected to shout the most explicit of all the words. Normally, the function takes place in the absence of children and at night. Between random shouting of obscenities, there are pornographic songs that have even more vulgar lyrics, passed on from generation to another. It is the way things are done traditionally. The digital media, like the internet, gets this tradition out in the open without regard for children or the rules of engagement. Additionally, the traditionalists worry about the globalisation of culture (Kraidy, 2002), especially at their own cultures' expense. While the traditionalists may enjoy trans-border data flow, they worry about other influences of globalisation like cultural imperialism (Jan, 2009). However, instead of undermining cultures, globalisation technology and economics create ways for new media setting to emerge, although weak cultures might be eroded in the process (Wang, 2008).

UGANDA

To be able to contextualise the arguments presented in the coming part, the background of the country talked about in the chapter is important. Uganda is located in East Africa. It is the twenty-first poorest country globally (Global Finance, 2013), a factor that is crucial in understanding the realities talked about in this chapter. The World Bank (2014) notes that Uganda is a low-income country (LIC) with a gross domestic product (GDP) per capita of US$506 and an economy growing at the rate of 5.2 percent. While agriculture employs 66 percent of the working population, jobs advertised in the public service decreased from 80 percent in 2010 to 49 percent in 2011(UBOS, 2015). That put employment in civil service to 275,149 jobs in 2011.The country's population stands at 35.4 million people (UBOS, 2015). Forty nine percent of that population is below 14 years of age. Although life expectancy is 53 years, the infant mortality rate is 76 per 1,000 live births. The maternal mortality ratio stands at 438 deaths per 100,000 births (Ministry of Health Maternal and Perinatal Death Review Uganda, 2013). The literacy levels on the other hand stand at 79 percent for men and 66 percent for women (UBOS, 2015).

THE MEDIA LEGAL REGIME

Uganda has a constitution that was made in 1995. It provides for freedom of expression and freedom of the press in article 29 which states that

Every person shall have the right to-

1. Freedom of speech and expression, which shall include freedom of the press and other media.

The constitutional guarantee above is supported by two international agreements on freedom of expression: the Universal Declaration of Human Rights (UDHR) article 19, and the International Covenant on Civil and Political Rights (ICCPR) article 10. On top of these, several regional covenants like the Johannesburg Principles, the African Commission on Human and People's Rights, and others, reemphasise the need for free expression.

Regardless of such a group of guarantees, freedom of expression is not absolute and so there is a legitimate (constitutional) limitation to the freedom. Article 43 (1) states that:

… no person shall prejudice the fundamental or other human rights and freedoms of others or the public interest.

The limitation cannot block free expression unless under 'demonstrably justifiable' circumstances. This has been a challenge to the Ugandan government in relation to freedom of association where the police's blocking of demonstrations sparks off violence.

But to safeguard freedom of expression, the constitution, article 43(c) has a limitation on the above limitation which regulates how article 43 should work. The other article that is important in the constitution is article 2 which states that "the constitution is the supreme law of Uganda and shall have binding force on all authorities and persons throughout Uganda." Since there are laws outside the constitution that affect freedom of expression, article 2 helps to regulate their impact on freedom of expression. Some of the limitations are found in the two principle laws that govern the press and broadcasting sectors. For example, the Press and Journalist Act (1995), limits people from practicing journalism (Section 15) by demanding a university degree from reporters and editors. This section violates Article 29 above which grants free expression for all, if you consider the fact that media are just a conduit of expression. The Press and Journalist Act, which regulates print, was condemned right before it was signed into law, in 1992, when journalists met in a conference in Kampala and declared it (then bill) "ill conceived, superfluous, dictatorial, draconian, obnoxious, and that it curtailed freedom of expression" (Okello, 2009). There is also the Uganda Communications Commission Act (2013) designed for broadcasting and new media. However, the criminal provisions for media are found in several laws some of which include: the Penal Code Act (1950), the Anti-Terrorism Act (2002) and the Anti-Pornography Act (2014), which concerns this paper.

The Penal Code Act for example still maintains Section 37 (Publication of Information Prejudicial to National Security), Section 51 (Inciting Violence) and Section 100 (Contempt of Court). The Anti-Terrorism Act (2002) on the other hand was intended to spy on people the Government suspects of terrorism by tapping into their phone calls. Journalists have sometimes been accused of collaboration in that regard like former *Monitor* news editor Wanyama Wangah, and Andrew Mwenda, a journalist, who survived a jail sentence or death penalty under that law. While it blocks coverage of conflict and conflict resolutions, it also hampers media from covering stories of the opposition (Okello, 2009). The current digital revolution makes it necessary for the regulators to create laws for the digital life. Among such laws that were made with online content in mind is the Anti-Pornography Act (2014).

THE ANTI-PORNOGRAPHY ACT

The Anti-Pornography Act defines pornography as "*any representation, through publication, exhibition, cinematography, indecent show, information technology or by whatever means, of a person engaged in real or stimulated explicit sexual activities or any representation of the sexual parts of a person for primarily sexual excitement*". Additionally, the Act mentions the internet as a possible distribution channel of pornographic material. Among the ideas noted in this chapter will be whether by publishing pornographic material online, the content producers fit within the realm of freedom of expression or they are just ignorant of the current legal and policy trends relating to the platforms that they use.The gist of this law is the section that prohibits and another that states the consequences of the prohibited action. Section13 (1)states: *"A person shall not produce, traffic in, publish, broadcast, procure, import, export,*

sell or abet any form of pornography." Section 13 (2)notes: *"A person who produces or participates in the production of, or traffics in, publishes, broadcasts, procures, imports, exports or in any way abets pornography*, *contrary to subsection (1) commits an offence and is liable, on conviction, to a fine not exceeding five hundred currency points or imprisonment not exceeding ten years or both."*

The first part of the Act interprets the terms used. The Act states that *"Internet-content-developer" means a person, individual or corporate, who produces and uploads or causes to be uploaded on the internet, any matter.* The Act also notes that "traffic" means to deal in or cause or permit or aid the provision or circulation of pornographic matter by way of trade or publishing or entertainment or programming or unrestricted internet access or any access or any other means or purpose. Section 17 too mentions "internet service providers".

THE LANDMARK CASE

On October 30, 2014, Jemimah Kansiime aka Panadol W'abasajja (stage name literally translating into Men's painkiller) and her manager Didi March Muchwa Mugisha, were arrested in Kampala and taken to court. The first defendant, Kansiime is a local singer while the second defendant, Mugisha, is an audio and video producer. The prosecution alleged that the two defendants trafficked and abetted pornography by making a pornographic music video called *Nkulinze* (Am waiting for you) and posting it on the internet, contrary to the anti-pornography law (Wesaka, 2014). If convicted, Kansiime faced 10 years in jail while Mugisha would go for four years. Mugisha pleaded guilty and apologised for his involvement, noting that he did not know that he was committing a crime. He was fined 10 currency points ($75) and released that day. Kansiime did not plead guilty and was remanded to prison pending another trial the following month. By entering a guilty plea, Mugisha was the first person to be convicted under the law that had been signed the same year.

There are two major implications of the above case on Uganda's media law scene: It implicitly exposes the relationship between the country's media laws and content producers while at the same time, it has implications on freedom of expression as guaranteed by the constitution. This chapter is concerned with whether or not the limitation on freedom of expression found in the above law (especially section 13) is consistent with article 43, which is the legitimate (constitutional) limitation on freedom of expression. The conditions set by the legitimate limitation on freedom of expression (article 43) are that "*…no person shall prejudice the fundamental or other human rights and freedoms of others or the public interest.*"

Posting a pornographic video does not prejudice the fundamental or other human rights. If anything, the act contributes to ways in which citizens can "seek, receive and impart" information, as protected by article 29 of the Ugandan constitution. However, it is in public interest to make sure that morals of different cultures are protected, alongside the protection of minors from accessing illicit sexual content (Edick, 1998), as the intention has been for countries that make laws to regulate indecent content (Saul, 2015). But inherent in the above good intentions is the freedom to enjoy or to produce content as a constitutional right. The above law protects children and family values at the expense of that constitutional right and this is done by banning the production and distribution of content which is the same as banning content itself.

The constitution (article 43c) still guides that public interest should not be used to allow *"Any limitation of the enjoyment of the rights and freedoms prescribed by this chapter beyond what is acceptable and demonstrably justifiable in a free and democratic society"*. There are two other problems created by

article 43 (c) that the Anti-Pornography Act does not answer. One is of what is acceptable and what is not. The other is of whether or not the limitation in the act is not beyond what is "demonstrably justifiable". Putting a ban on content is to go "beyond what is acceptable" in relation to the principles of "free and democratic" life. It limits both the freedoms of personal and public expression (Sturges, 2006) and gives credence to the fact that most of the nation-states that created bills of rights after the end of the cold war with influence from liberalism have laws that are "mere window dressing" instead of protecting the rights they claim to protect (Keith, 2002, p. 112).

When the constitution was made, TVs, radios and newspapers dominated the media arena and any information through them would reach to millions. There was pornographic content then with measures to make sure that it did not make it on TV or radio at a time when children were supposed to be awake. Apart from culture and beliefs helping to create self-censorship in media where content with nudity lost support among certain age groups, such content was broadcast at a certain time of the night when children were in bed, for example after 10pm (Baliboola, 2015). Additionally, warnings were given before that content, which was mostly in western movies, was aired. Regardless, the TV station still chose a movie with less explicit sexual content or blacked out some scenes that were deemed to be excessively sexual as the conditions for licensing were (Otto, 2013). This is how the balance was reached between the fundamental right of expression and the protection of minors and morals.

For a law to be truly helpful, the conditions set in article 43 and 43c have to be met. But, we must also consider the view that the constitution was created to regulate freedom of expression as it was understood in 1995. More than 25 years later, a lot has changed, especially with the emergence of the internet. These new changes and challenges have to be met without foregoing the fundamental freedoms. The internet is a multimedia (Lehman-Wilzig and Cohen-Avigdor, 2004) global network of computers (Dominick, 1996). In such a complex global system that promotes global lifestyles, only a network as complex as the internet can help us claim our global positions (Qvortrup, 2006). Undemocratic interference in content distribution means denying Ugandans freedom of expression in the global village.

In other jurisdictions, for example in Europe and America, restrictions tend to allow a certain level of enjoyment based on an understanding that opportunities and risks go hand in hand (Livingstone, 2011). In the United States, pornography or obscenity as the court held in *Roth v. UnitedStates* (1957) is not a right protected by the law. However, the enjoyment is still provided for. In relation to pornography online, the 1996 Communications Decency Act stipulates that content distributers online should protect minors by " requiring use of a verified credit card, debit account, adult access code, or adult personal identification number" (Edick, 1998, p. 447). Under those restrictions, children who access the internet should never have access to indecent material. In the UK, the 2014 amendment of the Communications Act specifies certain actions within pornographic material that should never be acceptable for children's consumption like "strangulation, facesitting and fisting" (Saul, 2014), on top of including a rating sign on content that should not be watched by persons under 18 years.

OTHER CRITICAL ISSUES ARISING FROM THE CASE

The landmark case above also raises issues of media literacy on the side of the audience and the producers of media content in Uganda. Mugisha told the court that he did not know he was breaking the law, and yet the Penal Code Act (section 166), which was repealed by the coming of the new law, prohibited trafficking obscene publications. The Penal Code Act had been active way before Mugisha started his

music journey. Being a music producer, he ought to know the law that regulates what he does. In an interview done for this chapter, Mugisha actually admitted that he advised the singer to make the video. He did not think even for a second that he would end up having trouble with the law. He also argued that "in a country that is still bound by cultural norms, the acceptability of certain things nude is still low compared to the West and this influences our ways of life, including laws" (D.M. Mugisha, personal communication, February 2, 2016).

The singer too was oblivious of the fact that she would be taken to court and even remanded for a video of herself dancing nude. According to Mugisha, the singer, Kansiime, is a sex worker and a friend, who too did not know about the legal implications of the video. Mugisha tended to mean by that statement that most sex workers in Uganda are girls who did not get a lot of education and even if some of them did get an education, without a special attention to the law, they would never know such details. What the court did not know (perhaps) is that Kansiime had not been singing for a long time. In fact Mugisha noted in the interview that Kansiime was not known in Uganda before the video. She was not a fulltime singer before the song in question. Mugisha, on the other hand, was a household name in Uganda's music production for having started off artists who are now superstars in the country, including one Eddy Kenzo, who recently won an American BET award.

Most importantly, the law criminalises speech and expression to an extent that artistes' creativity can be limited, which is a form of self-censorship. This is in addition to losing one's licence as Mugisha lost his. He survived going to jail, paid a fine but has no work because of the revocation of his licence. The law should have been designed in a way that someone pays a fine instead of both a fine and a prison as it states currently. Most importantly, speech and expression transgressions should be treated as a civil matter.

The media are known for their educational, informational and entertainment functions. The law provides for educational and informational purposes but does not do the same for entertainment. What about the adults who may want to watch pornography for entertainment? Should there be a special curved-off virtual space where such explicit content is enjoyed? What qualities should such a place have? Or most importantly, how could the law provide for such space? These questions are answered by the examples from the UK and US above where specific extremes are banned but not content in its entirety and provisions are made to limit children from accessing such content since the internet is a global medium. Internet service providers should make sure that they put the above procedures in place to comply with the law. Currently, by not providing for all those options, the law implies that watching a music video that is pornographic for entertainment is completely illegal.

CONCLUSION

This chapter made an analysis of Uganda's media laws in the digital era and revisited the Anti-Pornography Act that was enacted in 2014. The Chapter questioned the law's ability to respect freedom of expression, a right that is guaranteed by the Ugandan constitution, using some clauses that prohibit the distribution of pornography. In addition, the landmark case, in which the law was first applied where a music video producer and a singer were charged, is cited. The chapter concluded that by protecting both morality and the minors, the law takes away the right to free expression and this makes the law inconsistent with the legitimate limitation of freedom of expression. The chapter used examples of regulation of indecent material in other jurisdictions like the UK and the US to suggest that the best law could focus on prohibiting the excesses of adult content and also specify exactly the circumstances under which an

adult person seeking such adult content for entertainment can access or make the same content. Some of the major challenges pointed at include lack of digital media literacy by the relevant stakeholders in Uganda, especially the content producers, and the fact that the current law against pornography creates self-censorship, something that stifles creativity.

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Chapter 51
The Benefits of New Online (Digital) Technologies on Business:
Understanding the Impact of Digital on Different Aspects of the Business

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ABSTRACT

This chapter explores how digital technologies are impacting the businesses – challenging the industry leaders while enabling entrepreneurs to do so. The overall findings have been bucketed under three broad sections – Customer Experience, Process Optimization, and Business Innovation. The Customer Experience section captures the way companies are using the data from digital technologies to enhance the way they interact with the customers. The section on Process Optimization highlights the significant improvements achieved by using digital technologies for existing business processes. Business Innovation captures the transformation power of digital, through new business models, business areas, and data monetization.

INTRODUCTION

Digital technologies have deeply impacted the way we live, deal, shop, travel, socialize, interact, choose, purchase and make other important decisions. They have enabled a large number of entrepreneurs to solve real world problems and in most of the cases – in real time. A majority of startups today have a digital gene giving them the flexibility of having an agile business model, which can be tweaked as per the requirements and needs of the market. For example, Uber operates as an aggregator in some regions but provides ride sharing facilities in others, to avoid legal hassles. It also provides services such as cargo delivery along with pick up and drop facility in some cities. In parallel, existing and established companies are investing in digital, either to optimize the existing business models or to create new ones

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by lapping up the opportunities provided by the digital citizens of the world. To give an example from the travel industry, established car manufacturers like Ford are trying to establish themselves in peer to peer car sharing service industry, in some regions to battle stiff competition from purely digital startups like Uber and Lyft. Other than the new business models, digital also impacts the way companies reach out to their customers, understand what their customers are saying and what their needs are. Using digital platforms, companies can empower their employees to collaborate in real time, reach out to colleagues in different parts of the world and break the silos, which prevent innovation. Digitalized processes also mean increased efficiency, new data points for optimized calibration and most importantly – increased profitability. As Gartner predicts, by 2018, digital business will require 50% fewer business process workers and 500% more key digital business jobs, compared with traditional models.

Also, once thriving industry leaders such as Blockbuster, Kodak and Borders that couldn't adapt to the digital shift by providing any alternatives to the market, no longer exist.

Every business speaks about being digital or going digital; however, very few convey what they actually mean by it. Is it about the digital marketing and online presence, is it just the use of social media to reach out to customers or is it about using cloud or about applying the science of analytics to understand their customers better – the definition is wide open. That exactly explains how it positively impacts multiple aspects of business, internally as well as externally.

Digital is less of a 'thing' and more 'a way of doing things'. It is the strategy that drives digital, not the technology. Digital is orchestrated through technologies like social media, analytics, cloud and big data. It is demonstrated in the ease of usage, connectedness of customer and business resources, multi-channel experience, end-to-end integration, facilitation of storage for dissemination of data and information; and policies such as BYOD (Bring Your Own Device) which have led to consumerization of IT. Gartner defines consumerization as, "the specific impact that consumer-originated technologies can have on enterprises. It reflects how enterprises will be affected by, and can take advantage of, new technologies and models that originate and develop in the consumer space, rather than in the enterprise IT sector." Digital technologies are reaching the maturity stage with introduction of wearables, virtual reality, drones, video analytics and connected devices.

Digital helps companies understand their customer in ways not known earlier, in proper context of information and location, to provide a delightful experience, at different touch-points on every single occasion. It enables companies to engage their employees and empower them with the right tools to connect on a platform where they can provide quicker solutions by going breaking the silos. Digital also allows the company to keep their business models agile, have a faster go to market strategy, reach out to larger customer base and at the same time, have real time feedback. It helps companies hear what their customers are saying across multiple platforms about their existing brands, react and take measures to keep a check on their sentiments, or to nurture a new brand with which customers can relate to. It helps companies to generate revenues from new streams, supported by digital technologies

Need for Digital

An average employee uses much more advanced digital tools and applications at home than in office. Population in technologically mature markets like UK and US have lead the digital adoption with mobile penetration as high as 138% and 112% respectively, while Germany leads globally with 141% share. Similarly, mobile penetration in emerging markets has grown 321% compared to 46% in developed

countries in 2002. Globally, the number of smartphones is expected to increase from 2 billion in 2014 to almost 5 billion in 2019. In today's time, a smartphone has more computational power than what a computer had just a few years back. This has increased the consumption on mobile devices. Out of 890 million daily active users, 745 million access Facebook from mobile. Similarly, Twitter just crossed 302 million Average Monthly Active Users (MAUs) for the first quarter of 2015, up 18% year-over-year and compared to 288 million in the previous quarter and approximately 80% of total users logged in through mobile. Google searches on mobile devices now outnumber those on personal computers in 10 countries, including America and Japan.

The need for digital is further expected to increase as Millennials have started joining the work force. Millennials, as demography are those who were born between 1980 and 2000. They are also known as digital natives, given their ease at leveraging digital technologies for personal as well as professional use. Millennials represent the largest demographic group in history and by 2025; they are expected to comprise almost 75% of the workforce that is expected to have a tremendous impact on the entire business landscape. Their affinity for technology means they prefer to interact and work for those companies, which offer maximum convenience through the use of digital technologies. They want the information to be available to them with complete ease, as and when required by them.

This has made companies change the way they function and they have started adopting digital technologies such as cloud, social media and internet of things. According to forecasts by Forrester, cloud computing will increase from approximately $41 billion this year to more than $240 billion in 2020. Gartner reports that there would be 25 billion things connected over internet, by 2020, clocking in close to $2 trillion of economic benefit globally. All of these will have a great impact on the economy by transforming many enterprises into digital businesses and facilitating new business models, improving efficiency and new sources of revenue.

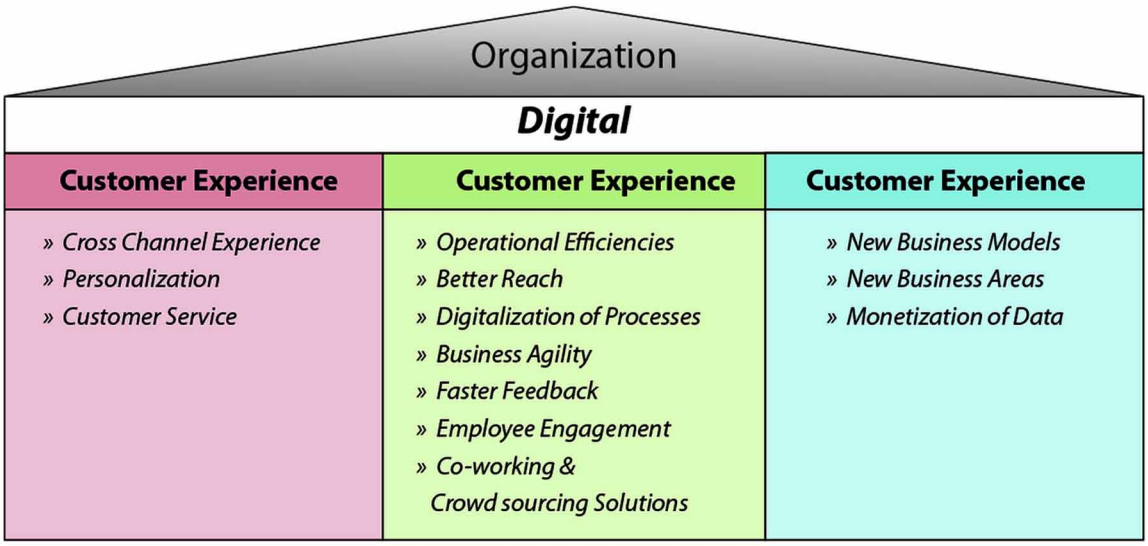
And digital also means profit. An in depth research undertaken by Capgemini Consulting along with MIT Center for Digital Business in 2012, surveying over 400 major global companies worldwide, reveals that digital leaders outperform industry competitors on multiple financial metrics. They generate, on average, 9% more revenues through their existing assets; outperform their peers by 26% in terms of profitability; and achieve significantly higher (12%) market valuations.

Impact of Digital

By and large, majority of practitioners equate social with digital. While social is an important subset of digital, digital goes much beyond that. Most of the large scale companies were already working with standard technologies as per their business requirements such as ERP, CRM, PLM and CAD systems. However, with the introduction of digital tools, the way companies were working has changed drastically as it has connected machines, employees and customers together through big data, analytics, social media, mobility and cloud. While initially these technologies were being used to support the existing systems within the company, the digital tools are now driving business forward, creating new opportunities and revenue models. Briefly, there are three aspects to how digital impacts businesses – Customer Experience, Process Optimization and Business Innovation.

Companies which are digitally mature are focused on integrating their different digital initiatives to transform their business, while the less mature ones are focusing on solving discrete business problems using individual technologies.

Figure 1. Impact of digital on business



Customer Experience

Digital has changed the way companies deal with customers. From the demand side, the customer expectations have witnessed a sea change. Customers now expect personalized experience at all the touch points – offline as well as online. They expect companies to be aware of their likes, dislikes and preferences. With rise in emerging technologies customers now expect services to be available on demand, at the pull of the customer, while being more relevant and responsive. Similarly, customers are now active users of social media and mobile penetration has been huge. Buying decisions are made on the move and the customer journey has evolved to become complex as customers keep use a mix of mobile, social media and store before completing a purchase. There has been a 'mobile mind shift' in customers and they now expect to get what they want in their immediate context and moments of need.

In most of the industries, the competition has been so intense, that it has reduced the scope for traditional product and service advantages. With rapid technological evolution and innovation, the products across segments have moved towards commoditization, making customer experience the new battlefield. In the digital age, innovation in customer experience thus becomes the most strategically important aspect for value creation and is proving to be the only truly durable competitive advantage. According to Gartner, by 2016, 89% of companies expect to compete mostly on the basis of customer experience and by 2017, 50% of consumer product investments will be redirected to customer experience innovations.

Cross Channel Experience

Digital has lead to complex customer journeys with customers using multiple channels to connect with the companies. Engagement on digital channels like social media, web and mobile means companies need to be forever listening and be available for the customers. Digital technologies have empowered customers to compare prices, specifications and features on the go, before making the purchase decision. This has resulted into customers using mobile devices within the store to make the final decision and

often moving out of the funnel before reaching the purchase stage. Initially when there were store-only retailers and pure ecommerce players, many retailers suffered from the concept of 'showrooming' – where customers would research about the product online, walk in to the stores for checking it out physically and then end the purchase journey by ordering it online at a discounted price. As ecommerce players adopted the mobile first strategy, the 'showrooming' actually increased significantly as customers would check the product in the store and directly order it online from ecommerce players, even while being at the store itself.

Burberry uses multiple digital channels to ensure a perfectly orchestrated cross channel experience for all its customers. Using digital channels, Burberry brings its brands to life within the store premises. Sales personnel within the stores are equipped with iPads, which provides customers access to the entire global collection, irrespective of their availability in the store. On the other hand, 60% of its customers complete the purchase journey online but prefer collecting their products offline, from the stores.

Burberry also uses digital technologies to enhance the multimedia experience within the stores. Whenever a customer approaches a clothing item, the RFID system gets activated which shows the details about the clothing item on the display. Customers can also place their products on RFID platforms which project the same products on the large display. Mirrors double as audio-visual displays that show footage from run-way shows while the fitting rooms have screens which show specific product information such as a bag's stitching detail or how a skirt was worn on the catwalk. Thus the overall experience, across offline and online channels, remains seamless, creating a memorable experience for customers while increasing satisfaction and minimizing annoyances.

Similarly, pure ecommerce players are looking at ways to provide a platform where customers can physically experience the products to counter the growing phenomenon of 'reverse showrooming'. 'Reverse showrooming', also known as 'webrooming' is when customers browse, compare and finally choose the product online, but complete the purchase offline, in a store. The reasons for completing the purchase journey offline can be varied – from better customer service, to immediate ownership of the product, assurance of receiving a genuine product or even the level of trust in the local shopkeeper. Also, for most of the customers, there's no substitute for being able to see, touch and test a product in person before buying it.

However, many companies, especially retailers, have invested in uniform cross channel experience. As customers have started using multiple channels for shopping, the more channels they find a particular brand, the more they develop a familiarity with the product or service associated with the company and, ultimately, a loyalty towards the brand. It has positively contributed towards the revenues by ensuring brand loyalty and has helped companies to leverage 'showrooming' and 'webrooming' in their favor. Companies use data from customer's web presence and online behavior to personalize the experience offline, in the store. Similarly, companies are leveraging customer preferences disclosed and mapped in the stores to send relevant mailers, offers and newsletters to the customers – online, on social platforms as well on the mobile.

Digitalization is also enabling manufacturers to establish a more direct link with the consumers and manufacturers have already started leveraging it. They have also started using online marketing and advertising, in compared to their earlier traditional ways of reaching the customers. Significant numbers of manufacturers have started selling online, especially higher-margin products in high-growth markets. This has helped them with increased profitability (by recovering some of the margin given up to retailers) and has also empowered them to get valuable new insights as they engage in more direct relationships with their customers than they have ever had before.

Personalization

Personalization is a process that creates a relevant, individualized interaction between two parties designed to enhance the experience of the recipient. It uses insight based on the recipient's personal data, as well as behavioral data about the actions of similar individuals, to deliver an experience that meets specific needs and preferences. – Gartner (n. d.)

Industrialization enabled companies to manufacture at scale, thereby reducing costs, while allowing them to maintain high standards in quality. Henry Ford took the industry by storm using mass production for his Fords Motor Company using assembly line method for producing just one car – in one single color, black. Over a period of time, they got displaced in the market by General Motors which understood and celebrated the existence of different customer segments which had different expectations from the same product – car. More number of companies started realizing the importance of segmentation and they tried categorizing customers using different parameters. With evolution of computers and databases, companies were able to reach out to customers directly and store structured information about them. Similarly, more processing power empowered companies to generate better insights using data mining, artificial intelligence and clustering analysis.

With the advent of digital technologies, the customer touch points increased significantly, giving companies an opportunity to have a more holistic view of the customer. Mobile and digital channels not only provide details such as real time location, in app behavior, on site preferences, but also empower companies to understand the relevance, context and customer sentiment at given point in time along with their purchase intention and aspirations. The segmentation has thus evolved from the simple geographic segmentation to the more advanced and technology dependent behavior-based segmentation (Oliviera-Brochado & Martins, 2008). Integration of structured data from enterprise systems and CRM along with the unstructured data from digital channels is helping companies create better personas of their potential customers.

Caesars Entertainment, one of the world's largest gaming and entertainment companies, has personalized the entire experience – right from booking till the actual stay in the hotel. Company starts with collating customer details from the vast amounts of transactional, demographic and gameplay data through its loyalty program for creating a detailed profile for each of the customers. It also provides the customers with mobile check in facilities and uses their mobile data for sending location based offers. The mobile app of the company helps customers to track their loyalty points and to check where they can use those points. The app is also the first point of contact for any concierge and room services, which helps the company in understanding individual behavior to personalize the experience accordingly. Even the wait staff uses mobile app for ordering drinks to reduce the time for reaching the counter. As company uses multiple data points, it is well aware about customer's experience even at the table and it tries to personalize the experience accordingly – so a player with big losses gets freebies such as food and extra night accommodation—that can ease the pain of the losing, without affecting the gaming for anyone else.

All these can lead to more sales per customer, higher retention and greater profitability. It has also helped companies to identify where the next marketing investment should be made and while ensuring higher return on investment by implementing behavior-based segmentation and personalization (Tsai & Chiu, 2004). According to Gartner (n. d.), by 2018, organizations that have fully invested in all types

of personalization will outsell companies that have not by more than 30%. Companies are leveraging this data to envision new products and services, and ways to bundle and price them in different markets and categories. Almost 20% of durable goods "e-tailers" are expected to use 3D printing for creating personalized product offerings by the year 2017.

Large organizations which value the growth of their employees are exploring data generated from digital training channels to personalize the learning through programs which are paced according to individual's capabilities to grasp and use the knowledge imparted through such programs. With digital technology being available for instructional data and tools for analyzing, such data points that help understand immediate and larger context are increasing the adoption of personalized and adaptive learning.

Customer Service

Customer service involves engaging with customers for a variety of reasons – it could be before purchase to answer any queries and concerns, it can also be for handling post purchase issues and eventually for up sell based on the existing purchase. For any of which reasons, customer service is generally expected to be pain-free, proactive at minimum and preemptive at best. Company needs to value the customer's time spent during the engagement and needs to ensure maximum productivity. For customer focused companies, customer service has been one of the key pillars on which the brand has been built over a period of time through exceptional service record.

BMW launched ConnectedDrive technology that serves as an in-car navigation system with mobile components. It also offers a wide range of intelligent services and apps that provide customers with all the relevant information and entertainment during their journey. BMW car come with SIM card and basic telematic features along with facilities such as BMW Teleservices, BMW Breakdown Call, TeleService Battery Guard and Intelligent Emergency Call (Motoring, 2014)

BMW Teleservices keeps the driver and the preferred dealer informed of the car's condition – and notifies them if there's any need for a service. Driver can use BMW Breakdown Call using the iDrive menu and relay the vehicle's functional state and location to a technician for roadside assistance. The system will also provide vehicle's driver with further information to connect with technician. TeleService Battery Guard automatically updates the vehicle's owner of unexpected deterioration of the battery, sending the information by text or email, according to the preference selected in the iDrive menu. Intelligent Emergency Call contacts a call centre in the event of a crash and provides details of the severity and circumstances of the crash. Customers can also book other optional services and applications such as Concierge Services, Internet or Real Time Traffic Information. The car is connected to Google and can be used to locate best restaurants in town along with recommendations from BMW Online (Motoring, 2014).

The digital technologies have redefined the times to be called the age of the customer. With everything expected to be at the pull of the customer, companies don't decide how customer centric they are, but the customers do. The social, mobile and big data have changed the customer expectations from companies they have to deal with. Also, providing good customer service is a win-win situation for both - the customers as well as the company. Great customer service makes customer more loyal and loyal customers are less likely to switch companies as they will prefer considering purchase from the same company. As the company's efforts to establish loyalty increases, customers are also more likely to recommend the company to friends and colleagues, thus establishing advocacy for the brand. In digital age, customers expect their questions to be answered in real time, with painless and minimum service interactions, ir-

respective of their position in the purchase journey and across different channels. They get frustrated if they have to struggle for accessing customer services and they even drop off the purchase journey if the experience is unsatisfactory at any stage.

By 2020, the number of connected devices is expected to cross 50 billion. The kind of customer information companies will have will be unmatched and so will be the expectations of the customers. Companies will be in a position to be in forever listening mode of the connected devices. This will help them notify customers in advance, preemptively diagnose and fix small issues with minimal human intervention. The emerging digital technologies will thus change the face of customer service resulting into faster resolution at lower costs and extremely personalized engagements. It will also help companies to plan accordingly and anticipate future service requirements of their customers.

Process Optimization

While digital is largely associated with digital transformation and disruption, digital technologies are also being used to optimize the existing business processes. By leveraging digital technologies, companies are able to benchmark the repetitive processes against the standards or industry leaders and map the deviation, if any. It has even empowered companies to rectify the processes on the go with real time feedback. This has increased the overall operation efficiencies of the long established processes.

Some companies entirely transforming their existing business process to rethink it in terms of final output. This allows companies to break away from the business strategies that have been deemed redundant in the digital age. However, not all companies have the necessary mandate or will to change from the scratch. A lot many companies are using digital to enhance and optimize the prevailing business models by replacing some modules with digital technologies. Breaking larger processes in to small independent ones, which can be digitized without disrupting the overall system, is helping companies to increase efficiency. It has enabled companies to have faster access to information, which on processing in correct context, helps them to access accurate insights, almost in real time. It the companies are leveraging digital technologies like cloud; it also empowers them to have agile business models in place.

Operational Efficiencies

The kind of data provided by digital technologies is humungous and depending on the capabilities companies can use it to improve operational efficiencies of different business units. While some companies would like to focus on the supply chain aspect, others would be more interesting in looking how their marketing campaign is being received by different segments of the customers. For example, the financial organizations use data to reduce risk, improve fraud detection and to ensure complete compliance. Companies working with employees operating out of different locations, in different time zones are successfully leveraging digital technologies to run the processes in a more efficient manner, with a direct impact on the business outcomes – making it more profitable and customer friendly.

ABB Process Automation Service (USA) used different spreadsheets to manage approximately 300 field service engineers (FEs) managed through regional coordinators. The spreadsheets were used to aggregate data to streamline and improve processes which led to inefficient resource utilization. Therefore, the company invested in a new cloud based technology platform to run the service application. A service dispatch board was created to provide a consolidated view of all regional service requests. The

software allows the company to assign FEs based on skill set, availability, and geographic proximity. It also allows the customers choose FEs from a more distant region by paying an additional fee, depending on urgency. As a result of this, these services have become more responsive and have delivered improved uptime. The productivity applied by field engineers increased from 70-80% to a whopping 120%, post the deployment of cloud based application. The digital upgrade has also resulted in an improvement of customer satisfaction ratings from 79% to 84%. (Capgemini Consulting, 2014)

Better Reach

As digital captures every single interaction with customers, it helps companies to understand their customers better. Given the rate of adoption of digital technologies, customers are present at different channels, round the clock and are engaging with other customers and companies. As the number of digital technologies being used by customer increases, it gives companies new avenues to reach out to customers. The data generated from these touch points also helps companies to understand their target customers and tailor the communication accordingly, which helps in creating engaging conversation instead of blink-and-you-miss traditional channels.

Nike introduced Nike+ product range in 2006, consisting of a sports watch, a wrist band and a mobile phone running app. The products track wearer's location and their activity level throughout the day. The data is collected on a central platform that the athletes use to make training schedules, track sports achievements and share them with friends across multiple digital platforms. This service enables Nike to achieve strong customer engagement with all its existing customers. Over and above this, the digital platform also helps Nike to reach the customers in a direct manner for advertising its products while gathering valuable data about how customers use their products.

Companies are also using the digital reach for different business reasons. Industrial companies use the digital channels to convey the technological advancements and innovation to the end customers as well to inspire potential employees. Hotels and restaurants use different digital mediums such as Instagram and Vine to share pictures of new décor and dishes. Those employed in entertainment industry leverage these channels to share behind the stage scenes to create a special bonding with the users and these days it is also used to interact in real time through platforms like Google Hangout, Twitter and Facebook. Digital also makes it faster. Cloud enables companies to have a faster time-to-market at a pace, which could not be achieved using traditional data center, empowering companies to deliver results in a short span of time.

Digitalization of Processes

Digitalization of processes is one of the initial steps when companies set out for digital transformation. In such initiatives, companies start with introducing digital technologies to their existing business processes and workflows to replace manual and physical efforts, such as introducing mobile application instead of paper-pen entry work to capture data in digital form. This tremendously increases the velocity of business process and enables quicker decision making. While digitalization being about huge benefits to the organization, it is not transformational in nature as it simply improves the existing process, by and large following the same structure of implementation and governance.

The aviation industry commonly uses milling process to manufacture complex aviation parts. But milling produces large amounts of waste in the form of swarf. This makes prototyping complex, consuming more time for retailing and produces large amount of waste. Leveraging the new digital technologies GE adopted rapid prototyping approach using 3D printing for these parts. Instead of machining parts from solid billets of metal, only the material needed to shape that specific part is used. (Capgemini Consulting, 2014)

Digitalizing processes not only replaced paper and manual processes with software and digital technologies, but also allows businesses to automatically collect accurate data that can be analyzed to better understand process performance, cost drivers and causes of risk, if any. Further, it also enables companies to deliver real-time reports and dashboards on digital-process performance, empowering managers to address problems before they become critical in nature. According to a report released by McKinsey & Company in 2014, digitalizing information-intensive processes can help save costs by up to 90% and improve turnaround times by several orders of magnitude. It also helps companies in improving their bottom lines while delighting customers with faster, accurate and predictive processes.

Business Agility

Legacy systems, which earlier helped the companies to evolve as they became huge enterprises, have often posed a challenge to agile business strategy. Established process often followed top down approach with decisions taking forever to percolate to the ground where the real action takes place. With the expansion of businesses, companies got department oriented which created organizations working in multiple silos, further slowing down the strategic decision making process. While such a setup ensures cost benefits and business efficiency, demands of the customers have changed and they now expect agility and real time capabilities from companies they deal with.

Uber being a purely digital company is one of the most agile companies in the market. Its ecosystem consists of the back end system, which leverages big data and analytics, a driver willing to work as a partner using mobile application and the end customer that pays for these services. The technology helps Uber to modify its business model on the go – so in some countries it uses the ride sharing model while in others it offers carpooling services. This model helps Uber to provide other services such as UberCARGO for moving cargo in the city and UberRUSH, a document delivery service. Uber also uses analytics to understand the demand in a particular region and increases the price through its surge pricing program, where it offers higher fees to drivers to attract them in these particular areas, all in real time.

Digital technologies when integrated with the existing enterprise systems provide companies with a much needed agility to handle the new age connected customers. Deep social listening with advanced analytics and cloud-based infrastructure enable fast paced deployment of new products and services. They also offer the ability to quickly learn from and fix mistakes. The explosion in smartphones, tablets, wearable devices with internet-connected objects and mobile apps means that a company should have the ability to interact personally, directly and in real time with consumers and business partners. Companies need to move with great speed to meet evolving customer needs, adapt to market and deal with dynamic regulatory changes. Companies are investing in processes which are unstable in nature and can be adapted dynamically with changing customer demands. They are moving away from stable processes which are based on typical legacy systems having limited information about the customer to unstable and ever evolving ones which capture customer information on the go and adapt.

Faster Feedback

Before the advent of internet, companies would launch product and services, which would have a long curve of adoption. The cycle to gain some ground level feedback about the offering would therefore be much longer. In case of factory based production, companies would have to complete one cycle of quality check before flagging off mass production. With digital technologies, companies have redefined their feedback processes – in terms of manufacturing as well as customer feedback.

The digital processes create continuous cycle of improvement fed by continuous feedback during the manufacturing process. The entire process cycle fetches data from multitudes of sensors that monitor every move and feed those observations directly into predefined and tested models. As the feedback is in real time, the model itself can rectify the glitch or there is scope for manual intervention to make real time adjustments in the manufacturing process. Such digital processes also enable mass personalization of products as the interventions can be made in real time to customize products on the go.

BMW's prototype cars produce an average of 15,000 data points from the engine and transmission down to the suspension and brakes. Using big data analytics, BMW Group can detect and even fix vulnerabilities that show up during the manufacturing process. In absence of digital technologies, it would have taken months to analyze reach the actual root cause of the defect, if any. However, with digital, the entire process of error detection to correction can now happen in just days. Based on the data collected during the test drives and other processes, BMW can find faults and fix them before new cars go into full production. BMW Group is thus able to enhance customer satisfaction by producing higher quality cars through digital technologies as the feedback is quick and data can be mapped to the source easily (Motoring, 2014).

Digital process can also be leveraged to sense the feedback from the customers and make adjustments in the current manufacturing cycle without much effort. If the products are enabled with internet or if the customers are speaking about the product on digital channels, companies can leverage such data to do real time listening, analyze the cause and try to fix up in the next production batch itself. This helps companies to fail fast and reiterate at much faster rate. Some retailers have actually replaced the price marking with digital boards as it helps them fluctuate the pricing of the products in real time – based on the insights from the sales generated in the store at that very point of time. In a traditional ERP or CRM based system it would be difficult to leverage such real time feedback unless the systems are able to speak with the new digital technologies (Motoring, 2014).

Employee Engagement

Digital technologies have changed the way employees work in office. The concept of on duty hours and off duty hours has been impacted as digital allows employees do some of their personal work online during office hours and vice versa. Employees end up carrying doing thing – work or entertainment while being in office and often complete the task assigned to them from home. Depending on the maturity level of bring your own device (BYOD) policy in the office, employees have been provided with enough flexibilities to choose a device as per their own liking and consideration. While some companies limit this option to phones, some even allow employees to choose their work stations (computer and laptop). Social media has also helped to establish an employee-to-employee relationship, which often goes beyond the work.

Companies are now leveraging all these aspects to engage employees, which studies have proved, have a direct impact on productivity, efficiency and attrition rate of the company. The digital technologies have now empowered companies with data to design, asses and redesign their engagement activities in continuum. Some companies are using off the shelf digital tools such as Yammer and Chatter for providing a platform for employees to connect and share knowledge with each other, while some companies are investing in bespoke mobile applications which are hardwired according to the needs and functioning of the company.

The Cheesecake Factory, a well-known national chain of restaurants, gamified its operational training, to change training from a typical "operational training" process to a Disney-like gaming portal. Instead of notes and presentations, employees had to post videos of their experiences in solving common restaurant problems in dedicated digital platform called as Video Café. Other employees accessing this content had options to comment and rate it along with sharing their videos or blogs. The contributors with highest ratings are celebrated on a "leaderboard" and are presented with "slices" (for example, of cheesecake) for their contributions to the team (Engaming, 2012).

It also uses a mobile application to ensure that the employees know all the ingredients of their burgers. The Cheesecake factory launched a mobile app where employees actually "build the burger" on their iPhones, instead of practicing it offline. They have to increase the speed as they play further and after that a new burger recipe is introduced. Playing the game for quite a few times ensures that the employees remember all the important aspect about creating a perfect burger for their customers (Engaming, 2012).

Using gamification and analytics, companies are mapping the performance of individual employees against fixed parameters, while benchmarking them against colleagues to choose the leading players. These players are then awarded with points or rewards based on the company policy, which inspires other colleagues to join in as the engagement continues further. Companies are even using engagement activities to improve the health of their employees by tracking their calories and activity details using fitness bands which keep sending the data to the company. Such companies are utilizing the data to make informed decisions which help them save on insurance.

Co-Working, Collaboration, and Crowdsourcing Solutions

Digital tools have not only enabled companies to connect with their customers better, they also strengthened the intra company networks of employees like never before. Large of companies have invested in such digital tools which enables employees to connect with each other beyond the email. Cloud based collaboration tools have provided the connectivity on the go. They have eased communication and thus given a huge impetus to collaboration. This has helped companies to increase resource efficiency even for widely distributed teams.

Citi launched Citi Mobile Challenge to foster digital and mobile innovation in banking. Citi Mobile Challenge is a next-generation accelerator that combines a virtual hackathon with an incubator, a worldwide network of FinTech experts and Citi's unparalleled global sponsors and clients to discover solutions across more than 100 markets. It invites developers from around the world to help build innovative solutions based on the Citi digital platform. Citi opens up a variety of APIs from the bank and other leading financial and technology companies to help developers create real-world innovations that could function with existing Citi technology. This helps Citi to reach beyond its own employees, crowd sourcing innovation from the global community of developers on its digital platforms. (PwC, 2015)

In 2014, Citi brought 60 finalists to Silicon Valley, New York City and Miami to present their ideas to a panel of judges who could decide whether these were innovations that could benefit its clients. The finalists competed for an opportunity to take their idea to production, a share of $100,000 and other services to help get some of their ideas off the ground. Citi is currently working on several top innovations from this competition to launch pilot solutions for consumer and business clients in various markets. (PwC, 2015)

Companywide collaboration has sped up innovation and development processes as the digital tools are being used to support idea generation. Bringing multiple stake holders from different geographies on one single platform, virtually together, has further reduced the turnaround time of an idea to get implemented in the organization.

Business Innovation

As more number of companies are embracing digital technologies and deepening the engagement with the customers, they are generating piles of data which is often left unused. However, few companies understand the importance of this data and are investing in technologies which will help them innovate and to create new sources of revenues. While some companies are using data to create new business models, which are premium because of the nature of information they carry, others are trying to monetize this trove of data by either selling it in the raw format or by processing it to deliver in on demand – as a service. Entrepreneurs are leveraging digital technological advancements to create platforms where users can share and offer underutilized resources in creative ways. Most of such companies are growing rapidly across the globe, entering new markets, without having to invest in any resources other than technology. Being asset-light makes these companies agile and they are able to transform the business strategy as per the needs and demands of the market.

New Business Models

Digital technologies have helped connect people in ways which were not thought of earlier. Companies have created dedicated platforms where users having a common need, can directly get in touch with other users and can share, barter, buy or loan products and services, without having to deal with any middlemen in the entire process. Such platforms have paved the way for the new sharing economy, also known as peer to peer economy, which encourages collaborative consumption. The sharing economy is an emerging economic-technological phenomenon that is fueled by developments in digital technology, growing consumer awareness, proliferation of collaborative web communities as well as social commerce/sharing (Botsman & Rogers, 2010; Kaplan & Haenlein, 2010; Wang & Zhang, 2012). The potential sustainability benefits associated with such sharing economies are thus interesting from an organizational and environmental perspective, particularly in the context of the increasing urbanization many countries experience today.

According to MetroMile, 70% of American car owners overpay for insurance because they drive much less than rest who actually drive more. The insurance is then designed in a manner that those who drive less often end up paying the same amount as those who drive much more, creating a steady balance for the insurance companies. With digital, companies can now access data directly from the vehicles – be it the distance covered in the car or the way it was driven, using details about the fuel consumed. Me-

troMile has thus started distributing a Metronome device that plugs onto the dashboard of the car and capture such detailed information in real time. These details are also available to the customers on their mobile through a dedicated app which information such as miles per gallon, time spent behind the wheel and other weekly statistics. MetroMile uses this data to provide a personalized deductible and liability options along with the pay by mile alternative (Constantine, 2014).

The kind of data being available to companies is helping them to define new business models as well. With internet of things, companies are able to analyze the performance of anything and everything, which has internet enabled on it. From cars to patients, from tennis racket to sports car, all objects which transmit data on regular basis can be optimized to perform better or prevented from failure by timely intervention. These scenarios have encouraged existing companies and entrepreneurs alike, to establish business models which would have not been possible without digital technologies. As per the predictions from Gartner, by 2017, a significant and disruptive digital business will be launched that was conceived by a computer algorithm.

New Business Areas

Companies which adopted digital technologies early on, started accumulating data in large quantities, which when processed right, provides insights about costs, profits, operations, supply chain and even the end customer behavior. The early adopters are leveraging data to disrupt the markets and are threatening the traditional value propositions of their respective industries. Similarly, such companies are challenging the competitors in adjacent industries as well, while they are being themselves getting threatened by the digitally agile startups.

GE resolved to expand its business into the software and analytics domain in 2011 and since then it has developed and introduced nearly 40 software products under its "Predictivity" brand. It started embedding sensors to all the machines for capturing their performance data. The data is then analyzed for providing real time information which helps in improving machine efficiency. It also helps clients to prevent downtime and enables them to effectively schedule preventive maintenance. The company has also introduced a wide range of big data products which predictive software products, a Hadoop-based big data software for ingesting and managing industrial data. GE has partnered with Amazon Web Services to share industrial data in public cloud.

GE expects the revenues from 'Predictivity' solutions to reach $5 billion by 2017.

Companies are redefining their value propositions and unique selling points, based on the new data. For example, an automobile company which records detailed data of the connected car for providing efficient customer service will know the driving habit and risk attached with the driver more than anyone else. Such an automobile company is thus, in a much better position to offer personalized and robust insurance offerings than traditional insurance companies. Similarly, social media companies, with magnitude of data about the customers, is much better equipped to provide feedback about the newly launched product or service than a dedicated market research company. Digital companies which not only capture such diversified data, but also have the processing power, are challenging the traditional players in horizontal industries.

Monetization of Data

For data rich digital companies, data is the new product, which they either directly sell to other organizations or process it and sell it as a service. As data reflects the customer preferences, patterns and behaviors, a company from one industry can benefit from using data of another company from a different industry altogether. This kind of data actually allows companies to understand customers from a more holistic point of view. For example, data from telecom companies is helpful for retailers to deliver real time location based marketing. Similarly, data collected from automobile companies can help insurance companies bundle their packages in a more personalized manner where every customer pays according to his driving habits.

Vodafone Netherland wanted to monetize the mobile data it had of its customers. However, Dutch Telecom law restricts telecom companies from using customer-generated personal data for non-revenue assurance purposes, since the personal data is also stored in non-anonymized form within the same company. So Vodafone partnered with Mezuro and started supplying crowd analytics to the public sector. Mobile phone data is sold by Vodafone in anonymized and aggregated form to Mezuro. Mezuro further accesses data from companies specializing in camera-based person counting systems (ViNotion) in order to provide high-level estimates of crowd density, mobility and footfall. With the combined network and video-count data, Mezuro is able answer questions related to city marketing, event safety and traffic density. Because Vodafone provides network data around the clock, Mezuro can offer its customers trend analyses, such as the effects of weather or changing shopping hours on footfall in a city district. Thus, mobile network data is used for crowd analytics without endangering the privacy of Vodafone's own customers, while it earns a share of Mezuro's revenues billed by processing the data further for the end clients.

FUTURE TRENDS

Digital technologies have the capability to revolutionize the way industries have been operating, but companies are finding it challenging to leverage it completely. While some companies have successfully implemented digital for driving down costs, improve efficiency, very few have used it to create new revenue streams and business models. Companies will need a deep shift, more than technological; it has to be strategically and culturally driven for being digital in truest sense. Since 2000, 52% of the companies in the Fortune 500 have either gone bankrupt, been acquired, ceased to exist, or dropped out of the Fortune 500. With data being the new oil, or gold, as some thought leaders call it to be, companies with such data will be the new leaders across different industries. Companies which are aware and accept the new data based economy will adapt and continue to flourish.

According to Forbes, by 2018, 35% of IT resources will be spent to support the creation of new digital revenue streams and by 2020 almost 50% of IT budgets will be tied to digital transformation initiatives. Digital will also transform the way companies chose their IT partners to implement strategies in action. Bank of America, for example, is working to leverage Facebook's Open Compute project, which applies the principles of open source software to hardware, and is expected to have a major tech overhaul by 2018. Standard IT organizations are expected to spend 30% of its budget on risk, security and compliance by 2017 while allocating 10% of IT staff to these functions.

Companies are working on innovation centres where they can attempt and fail faster to in order to understand the impact of emerging technologies on different aspects of the business. These centres, working as startups within the organization, are working closely with entrepreneurs and venture capitalists to bank upon the next wave of digital technologies. Another example can be of Bitcoin, a type of digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, operating independently of a central bank, which is now being accepted for transactions by larger corporations such as Target and Amazon. Companies, such as Tesla, are also a sneak view of how digital transformation could be manifested in hardware, on the roads. Not only the cars from Tesla have been truly digital in nature, they have also upped the customer experience expectations, and with its frequent software upgrades, it has revolutionized the way cars would be treated in the future.

Artificial intelligence is also expected to drive the wave of digital transformation. After Apple's Siri and Microsoft's Cortana, even Facebook is leveraging artificial intelligence and has launched virtual assistant, M. This wave of digital transformation initiatives will shift focus from gathering and mining data to creating new models and algorithms that augment existing work activities and support consumers when they shop, trade, and make decisions in real time. Similarly, government agencies will also be more open to leverage such technologies either by adoption or through strategic partnerships with startups to improve the efficiency of governance. Altamonte Springs, just outside of Orlando, has adopted Uber as its public transport and partially subsidized fares, paying 20% of the total fare, starting or ending within the city. It also provides a twenty 25% waiver for rides to and from the local railway station.

However, according to research by Arthur D. Little, eight out of ten companies are lagging behind when it comes to digitalization. Most of the leading companies are being reactive, rather than proactive, with lack of knowledge and sense of urgency, being the biggest obstacles. While every industry is trying to respond to the digital disruption, automotive industry seems to be leading the pack followed by telecom and media industry. The energy and utilities industry comes a close third, but the travel & transport along with EPC & manufacturing industry appear to be the slowest in chasing up with digitalization. Overall, Accenture estimates that digital technologies in the world's top 10 economies can add a combined $1.36 trillion to their GDP in 2020 – more and more companies are digitalizing their operations.

As more companies embrace digital transformation, across different industries, the future looks exciting!

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Chapter 52
Impact of Interactive Multimedia in E-Learning Technologies:
Role of Multimedia in E-Learning

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ABSTRACT

Multimedia-based technologies have significant impact on our daily life learning activities as they have shifted the education from teacher centered to learner centered. E-learning provides opportunities to people to take course online and provide a virtual classroom environment on the web through teacher learner interactions, course material distribution based on interactive multimedia. Interactive multimedia offers learners different forms of media to match their learning style, provides personalization of adaptive content delivery which enhanced learners learning effectiveness. In this chapter, we have discussed how information quality can be improved by multimedia based authoring tools and approaches, also identified the negative and positive effects of using interactive multimedia for learners in E-learning. Finally, focus was given on current E-learning multimedia technologies, their research challenges and future trends on social networking based technologies.

INTRODUCTION

E-learning is one of the important fields of research in education. The purpose of E-learning is to automate education. Various authors agreed on different definition for E-learning. (Ghaleb, 2006) defined an E-learning as a means of education that incorporate self-motivation, communication, efficiency, and technology. (Rosenberg, 2000) defined an E-learning as use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance. It is concerned with use of computer and advance technology to support learning and transfer knowledge to learners by guiding them from basic to advanced concepts in particular domain, as it allows learner to learn anytime, anywhere through

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various process including web based learning, computer based learning, virtual classrooms and digital collaboration. E-learning is suited to distance based and flexible learning, but also suited in conventional based learning where blended learning plays a major role. In higher educational institutes there is a need to create Virtual Learning Environment (VLE) which combined strategic and tactical planning with management information system to create a managed learning environment with help of consistent user interface as a standard throughout the organization. With the rapid deployment of growing number of universities, as well as newer online-only colleges, have begun to offer a select set of academic degree and certificate programs via the Internet at a wide range of levels and in a wide range of disciplines. Most of the orientation sessions require student to attend classroom sessions or many are delivered completely online. Most of the educational institutes offer online student portal services such as online counseling, advising, online purchasing of text books, e-distance learning, e-newspaper for student through various multimedia modes such as telephonic system, caller Id, video conferencing etc.

E-learning technologies are designed to support learning by encompassing a range of media, tools and environments. With an invention of web based and E-learning technologies the education methodology has been shifted from traditional classroom teaching to virtual or blended learning. Multimedia technologies facilitate the presentation of adaptive learning materials in different forms. These enrichments are effective in delivering personalized learning material, effective learning content to learners based on their preferences, skills and learning characteristics. An important characteristic of E-learning is to provide interactivity with help of interactive multimedia. Interactive multimedia facilitates collaborative creation through project-based learning that provides opportunities for authentic collaboration (Mishra & Ramesh, 2005). Lot of media types like collaborative networking technologies, game-based learning has been developed to enhance learner learning effectiveness and experience.

Knowledge management (KM) and E-learning are recognized as self-contained disciplines as they deals with knowledge capture, sharing, application and generation; contribute to building a continuous E-learning culture and can be decomposed into various learning objects. The major goal of E-learning and knowledge management is to promote learning and knowledge transfer. There are several theoretical approaches for connecting both disciplines. They are described in literature as KM and E-learning integration models (Maier 2016; Schmidt 2005; Islam and Kunifiji 2011; Woelk and Agrawal 2002; Sivakumar 2006; Mason 2013; Ungaretti and Webb 2011). To develop practically applicable integration solution for specific organization it is necessary to understand these integration approaches.

PROBLEM STATEMENT

How to promote learning and transfer of knowledge to different e-learning systems with interactive usage of different multimedia based applications.

OBJECTIVES OF STUDY

The objectives or aims of this chapter is

- To analyze current practices and latest trends in E-learning industry regarding the use of interactive &emerging multimedia technologies as a learning tool.

- To establish relationship between knowledge management and E-learning with respect to various integration models.
- To analyses how the quality of E-learning can be improved by effective multimedia learning tools.
- To identify the positive and negative effects of using interactive multimedia in E-learning as they relate to both learners and developers.

LITERATURE REVIEW

Semantic web is used in E-learning systems for different purposes such as: to control the acquired knowledge of learner, to generate learning path sequence, to developing course material on basis of e-resource content available on web and storing and retrieving the learning material. Various types of interactive e-learning system have been developed on basis of interactive multimedia. The effectiveness of Intelligent Tutoring System (ITS) and Adaptive Hypermedia System (AHS) for multimedia content delivery analyzed by adaptive learning.

Learners ability can be characterized on basis of learners Visual, Auditory or Kinesthetic ability to absorb and process the information. Visual learning is based on gathering information from visual media i.e. charts, diagrams, maps, slides etc. Auditory learning comprise of listening lectures, discussions etc. and kinesthetic is based on practical experience. Activity theory is applicable to E-learning and interactive multimedia which states that learners use interactive multimedia as tool to interact with the world to achieve their goals in work place (Benson & Whitworth, 2007).

Interactive multimedia promotes motivation, which accelerates learning and provides manipulative experiences which are unavailable in regular classroom environment (Aldrich, 2005; Jackson, 2007).

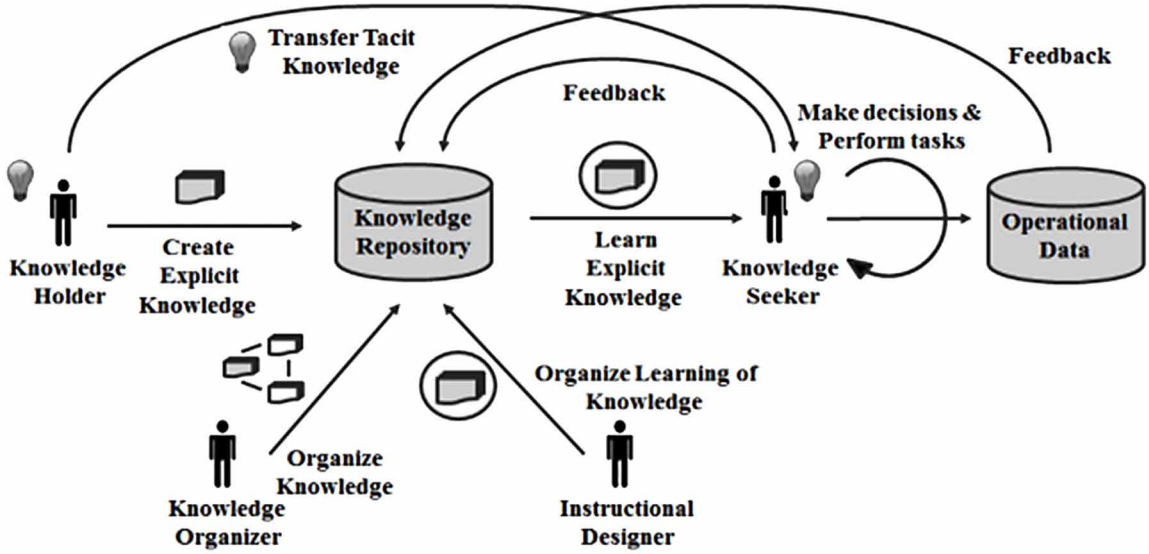
A platform called eMUSE has been developed based on social media and integrated learning environment for collaborative learning which integrates learner tracking functionality, visualization feature and evaluation system support (Popescu, 2012).

There are various approaches to train learners like game based, digital-modeling based learning. Some researchers investigates how lower level students get trained and learned by modeling skills in mathematics through a multiplayer based online game (Araya et al., 2013). A system called DigiMina developed for self and peer assessment of instructors digital competencies based on performance indicators (Poldeja et al., 2012). Interactive multimedia identified path sequences for different activities of learners based on GUI and supports a hybrid recommendation system to recommend learning items based on discovery or filtering and identification of common learning sequence approach during the learning process.

In order to establish the relationship between knowledge management and E-learning some integration models has been suggested by various researchers.

Woelk's and Agarwal's (2013) model helps to understand the E-learning and KM technology integration capabilities with the aim to capture, organize, and deliver traditional courses and large bodies of knowledge. Knowledge management can be analyzed for understanding the role of knowledge management life cycle and the knowledge flow in the organization. Model is based on Nonaka and Takenuchi SECI model (1995) of knowledge conversion with four phases - socialization, externalization, combination and internalization 16. Two more phases are added to SECI model - cognition and feedback. For each of the knowledge management phase e-learning technologies are providing their own improvements. Knowledge management phases with e-Learning enhancements are shown in Figure 1. Knowledge Holder can create explicit knowledge and store it in a knowledge repository or transfer his tacit knowledge to

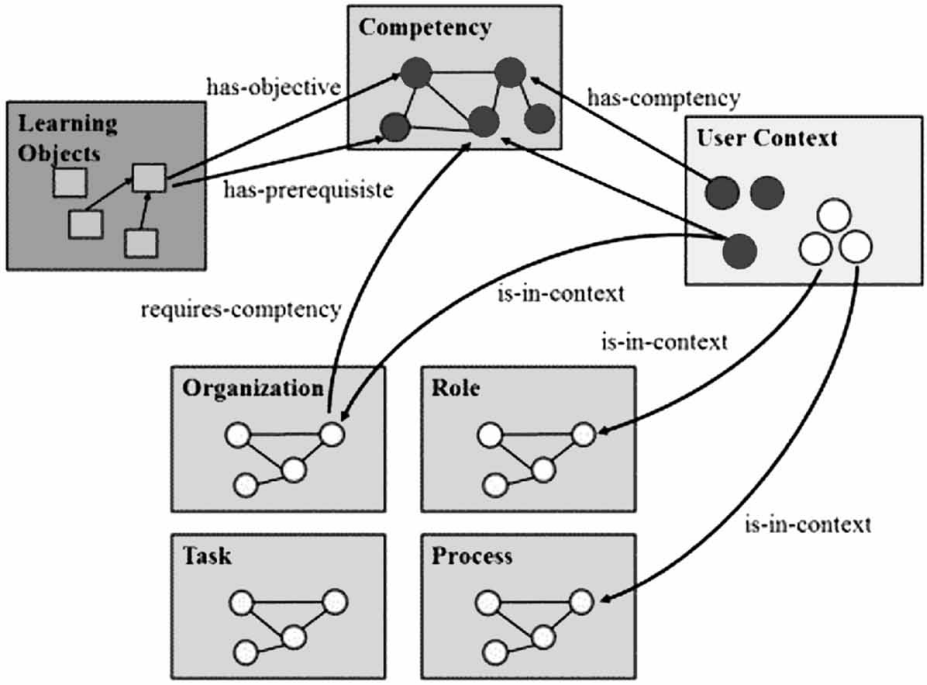
Figure 1. Knowledge management with E-learning enhancements



Knowledge Seeker through socialization. The Knowledge Organizer and Instructional Designer are persons or software programs. The Knowledge Organizer is responsible for linking knowledge bodies or other improvements. The Instructional Designer is responsible for preparing knowledge for learning needs by adding assessments and assignments. The Knowledge Seeker gains the explicit knowledge by selecting them from knowledge repository. The Knowledge Seeker uses his knowledge to make decisions and perform tasks. Work performance of knowledge seeker can be measured and returned to knowledge repository as feedback.

Schmidt (2005) believes that both knowledge management and e-learning solves a fundamental problem – encourages learning in organization. However, for the solution of the problem two different paradigms are used that lead to two different types of system use. Reason of the isolation is explained by the lack of attention to the context of employees involved in learning. For practical usage, the employee's context can be described by the personal (current competencies, objectives, desired interactivity), organization (department, role, business processes) and technical specifications (operating system, applications, bandwidth). Learning objects are bind with the user's context using competences from competency catalog (see Figure 2). Competences and individual context are linked directly (as the existing competences and future planned) and indirectly (by linking the organization contextual elements with the competency requirements). Learning objects are described by their objectives (which are described as competencies that are acquired as a result of successful training) and prerequisites (which describe the competencies needed for successful learning). This model demonstrates KM and E-learning integration by using user/learner context as connecting platform. Both KM and E-learning are seen as equally important disciplines. Model has been implemented in some prototype environments and shows relatively high user acceptance. Evaluation of this model shows that this blend of e-learning and knowledge management functionality can help to improve workplace learning. For practical implementation, organization must support general user context management services to deal with user context acquisition and management tasks.

Figure 2. Relationship between Context and Learning resources



The main interest of Sivakumar (2006) research is the dissemination of knowledge in the organization and how this may be improved with specially adapted e-learning system. For different types of knowledge (tacit and explicit) dissemination it is necessary to choose the appropriate technology, the pedagogical method, the type of communication, interaction and learning styles. E-learning environment development in organization must comply with the three aspects of the design - a technical solution, communication and interaction between the organization and design of training. For each of these aspects certain pedagogical approaches and learning styles need to be selected in accordance with organization's needs and knowledge types. In order to effectively meet the needs of geographically distributed employees, e-learning system providers should provide support for all four Nonaka and Takenuchi SECI model knowledge conversion phases. They also need to adjust the e-course content, teaching methods, architecture and training delivery methods used in their systems. In accordance of this model, integrated e-learning system design framework for knowledge dissemination in the organization must: Promote close interaction between staff, using synchronous and asynchronous communication; Incorporate pedagogical approaches that encourage active, collaborative, self-paced e-learning for explicit-tacit (explicit) knowledge conversion; Implement effective online mentoring forms for tacit-tacit (explicit) knowledge conversion; Integrate existing employee communication channels to organize practitioners, experts and mentors communications.

Maier un Schmidt (2013) propose integration of E-learning and KM on the basis of a process that explicitly aims at designing the transitions of knowledge along varying degrees of maturity. The authors indicated the following barriers to the successful integration of E-learning and KM: Different fundamental approaches. E-learning is rooted in psychology, didactic and pedagogy, emphasizing importance of structured and personal guidance. In turn, knowledge management focuses on the organization's memory

or knowledge base, where individual's knowledge must be transferred and made explicit; Fragmented ICT environment. Organizations use a wide range of systems to improve the knowledge and learning processes. Employees are working in fragmented environment and each system provides only a certain part of the learning and knowledge processes; Fragmented organizational structure. Knowledge and learning processes are distributed among the organization's departments, such as human resources, e-learning, knowledge, innovation, and quality control departments. However, disciplines are using knowledge bodies with different levels of maturity. Maier and Schmidt offered the use of knowledge maturation process as a conceptual framework for organizations to undertake necessary integration processes. Knowledge maturation process is presented as a conceptual model to analyze and explain the disruptions in the organization-individual knowledge flow.

Mason (2013) proposed InterCog sense-making model (ISMM) for analysis and understanding common areas of e-learning and knowledge management. The model can be used to create a strategic approach for planning, development, implementation and use of e-learning standards. This may be achieved by describing e-learning and knowledge management common "problem area" with very general and simple concepts. The main emphasis is placed on interrelationship of learning, knowledge and thinking.

In accordance with personalized learning model proposed by Irfan & Shaikh (2008) e-learning can take place via either explicit or tacit knowledge. Islam & Kunifuji (2011) offers to increase efficiency of e-learning systems by supplementing personalized learning model with knowledge management knowledge conversion methods to convert tacit knowledge to explicit. This approach is described as a theoretical model for knowledge management adoption for e-learning system. Term "adoption" here is understood as the application of certain techniques, i.e. conversion tacit knowledge into explicit knowledge. In the KM an E-learning adoption model knowledge creation, acquisition, evaluation and feedback are displayed as tacit knowledge with corresponding conversion to explicit knowledge. On the other part, knowledge organization, storage, dissemination and retrieval is shown as explicit knowledge, which can be converted to tacit knowledge.

Ungaretti and Tillberg-Webb (2011) suppose that knowledge management and e-learning are important components of learning allowing integration of both disciplines. Learning may be common ground where KM and EL distinct theoretical approaches can be combined and complement each other. For this goal Dynamic learning system (DLS) model is proposed by combining three components – knowledge management, e-learning and assurance of learning

(AoL). Assurance of learning is described as systemic, intentional process that identifies desired learning and provides a process to measure its achievement and the improvement of both the learning and the process to attain it. AoL is also known as learning outcomes assessment, assessment, the outcomes assessment movement, assessing student learning, assurance of learning. Assurance relates to systemic and multidimensional nature of process – it is not limited to assessment of learning results. Dynamic learning system model is composed from common elements of knowledge management, e-learning and assurance of learning value chains, divided into four groups/ phases: Institutional-level analysis and goal setting; Individual/ group-level needs analysis; Knowledge/ learning design and distribution and Knowledge/ learning increase measurements and analysis.

Each of these three disciplines has their primary goals. KM is focused on organization-level knowledge formed by individuals. EL main aspect is individual learners while considering impact on whole organization. Assurance of learning is focused on achieving certain business goals aligning this with data management, externalization of tacit knowledge, individual learning with explicit knowledge, etc. Together they allow the organization to develop a systemic approach to knowledge and learning. Important

part of DLS is evaluation that measures impact to organization produced by KM and EL. In this phase, learning outcomes are analyzed in the level of learning program or organization. Results may suggest improvements for learning system. In that way closed organization's development circle is formed. Main targets of KM systems are on what tacit and explicit knowledge is and how it will be managed: created, organized, shared, preserved, gathered, captured, etc.

Various researchers have identified different models for KM and E-learning integration in the analysed literature as shown in Figure 3.

Analysis of these models showed usage of both approaches – integration (both disciplines are seen as equal) and adoption (approaches and techniques when one discipline is used to enhance other). Adoption approach was used in both directions – EL techniques may be applied in KM and KM approaches may be used to enhance e-learning. Integration approach is looking for common ground of knowledge management and e-learning. Several authors identified learning as a common ground, however they proposed to use additional component (like context, knowledge maturity level and assurance of learning) for integration of KM and EL. Dynamic learning system model is best example to base integration on learning as common ground. However, assurance of learning is approach specific to academic environment and it may be problematic to implement it in business environment.

ANALYSIS OF SEMANTIC WEB AND ITS KNOWLEDGE BASED SERVICES

The semantic web is the future generation of web comprises of set of language and standards. It is the extension of the current web, in which information is given well-defined meaning, better enabling computer and people to work in cooperation. The basic aim of semantic web is to create a layer on web that enables automatic processing of dynamic web content so that data can be shared and processed by

Figure 3. Comparison of KM and E-learning integrated models

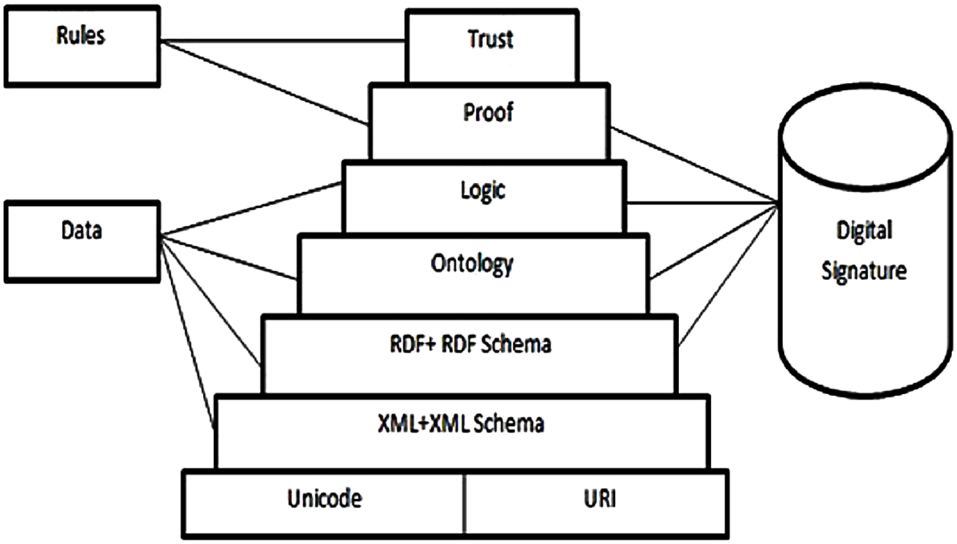
Nr.	Author	Integration model	Practically applied	Description
1.	Woelk, Agarwal	KM and EL technology integration model	Partly	Theoretical model; KM enhanced with EL technologies; Applied to some real world scenarios; Lack applicability support.
2.	Schmidt	KM and EL integration using context-aware corporate learning	Yes	Practical model; KM and EL integration based on user context; Implemented in prototype environment; Need applicability support for generic user context management functionality.
3.	Sivakumar	An integrated EL system-design framework for knowledge dissemination	No	Theoretical model; EL system development based on knowledge type conversion; Lack importance and criticality assessments for system design factors. Need further elaboration and validation.
4.	Maier, Schmidt	Knowledge maturing conceptual process model for integrating EL and KM	No	Theoretical model; KM and EL integration based on knowledge maturity process; Need further applicability support, elaboration and validation.
5.	Mason	InterCog sense-making model	No	Theoretical model; KM and EL integration by adding dimension of knowing; Need applicability support.
6.	Islam, Kunifuji	KM and EL adoption model	No	Theoretical model; Adopt KM approaches to EL to enhance EL performance; Need applicability support, verification and testing.
7.	Ungaretti, Tillberg-Webb	Dynamic learnings system model	No	Theoretical model; KM and EL integration by adding assurance of learning; Need applicability support, elaboration and validation.

both humans and software. Semantic web technology will facilitate the intelligent search, structural and semantic definition of documents, query answering instead of information retrieval and provide customize view to documents via ontology mappings with help of its customized architecture.

Architecture of Semantic Web

The semantic web architecture comprised of seven layers. It has been developed step by step with each step building a layer on top of others. A layer in layered semantic web architecture as shown in Figure 4 follows the principle of downward compatibility and upward partial understanding. The first layer is URI (Uniform Resource Identifier) and Unicode, the URI is uniquely identifier used to identify the resources. Unicode is standard of encoding international character set and allows all human centric languages to be used on the web. The second layer includes XML (Extensible Mark-up Language) that can be used to write structured web documents with user defined vocabulary. An XML document contains element that can be nested and may have attribute and content. The next layer is composed of RDF (Resource Description Framework) to describe the resource and RDF Schema (RDF-S). The next layer is Ontology vocabulary representing more powerful ontology languages for domain knowledge representation and relationship between web objects. The logic layer represents the further enhancement of ontology languages to allow the writing of application specific declarative languages. The actual deductive process as well as representation of proofs in web language from lower layer and proof validation is involved in next layer. From use of digital signatures and other kind of recommended knowledge or rating of trusted agent and certification agencies, the trust layer is emerged. SWRL (Semantic Web Rule Language) is an extension of OWL that supports Horn rules. It is combination of both OWL-DL and OWL-Lite in which OWL-DL descriptions are used in both head and body of rule.

Figure 4. Description about Semantic web Architecture



Functions of Web Services for Knowledge Management

Web services are a kind of framework for creating services for users over the World Wide Web. Web Services consists of three functions: publishing, finding and binding. The service provider describes all the details necessary to interact with service, provide message format that based on standards and formal XML notations with help of Web Service Description Language (WSDL). Then provider publishes the web service with a service registry using a standard called Universal Description Discovery and Integration (UDDI). The semantic web adds annotations to web service description to facilitate operations like service discovery, publishing, selection, composition, invocation, monitoring and ontology management (Cabral, Domingue, 2004). Different types of operations utilize different functionalities of web services.

Semantic web services are self-sufficient, reliable, supports software reusability which can be used to fulfill a particular task.

Service discovery locates appropriate web services needed to fulfill a given request. Service features include inputs and outputs of the service and also the precondition for running the service and effects of running the service on world. Precondition and input features should be satisfied before service invocation and effect and output features will be satisfied after service invocation. Semantic service discovery can be performed in different ways depending on the service description language, means of service selection and coordination between separate entities. UDDI is a mechanism for recording and discovering web services. It permits how services interact with each other. A web service discovery process can be carried out in three ways; first step is the advertisement on the web, Services by developers, in second step web service is requested by user through some repository, the final step is to select and invocation of retrieved web services. Discovery of Web service mainly depends on how user requirements can be interpreted and how they are matched with available services. Discovery enables flexible matchmaking between service descriptor and requests by using descriptor logics which preferred DAML and OIL languages. Peer to Peer systems support decentralized discovery in which web services are indexed based on the keywords being described. Discovery framework covers the entire task from service mediation, selection and considered as best matchmaker to service invocation.

Service publishing will allow agents or application to discover services based on its goals and capabilities. Service selection is required if there is more than one service matching the request. Non-functional attributes like cost or quality can be used for choosing a service. In agent type of interaction a negotiation process can be started between a requester and provider but for them the service must themselves be knowledge based. Selection of services is based on quality of services, adaptation of context, matchmaking, ontology prediction and agent system. Various types of filtering and different models with specific languages like XSLT, DAML-S and SOAP preferred by several authors to achieve QoS and related parameters. Client requests for service which is selected by service selectors from a repository of services where different web services are stored. After getting feedback from client, repository of non-functional parameters analyzed with desired web services and stored them back in Service repository for better and efficient selection of services. A response arrived to the service requester to invoke client if desired query feedback is solved on the basis of QoS.

Service composition is required when a single service is not able to produce the desired result for user, so this operation composes atomic services to create a new composite service to fulfill the desired needs. Service composition life cycle involves following phases to improve end to end service composition. It includes specification, planning, validation, discovery, execution and monitoring. Service provider proposes web services to use; service requester consumes information or service offered by a service

provider. The translator converts or translates the outward language used by participants, and internal languages used by service generator. If more than one plan found validated validates and evaluates all plans and proposes the best plan for execution. The execution engine executes the plan and returns the result of the service provider. The necessity of composition is to provide validated web service to use on the basis of service specifications mentioned by them. Different web engines are required to execute user requests. Only the translator predicts the internal service specifications and provides to the user as the result in xml or rdf formats.

The purpose of service invocation is to validate the input against the ontology type and invoke the service on basis of required parameters. Service matchmaking takes the form of matching appropriate web services based on syntax and semantic matching. In syntactic matching textual comparison or presence of keyword in the text is matched with known information, whereas in semantic matching relationship between the elements is matched with structured data. Use scenarios like prototyping and composition matchmaking allow searching for services on demand. Various matchmaking approaches like SHADE and FIPA operate over logic based structured text language like open-math and XML. Various matching algorithms are adopted in the context of semantic web services like syntax and ontological match, an algebraic equivalence match, value substitution match and decomposition.

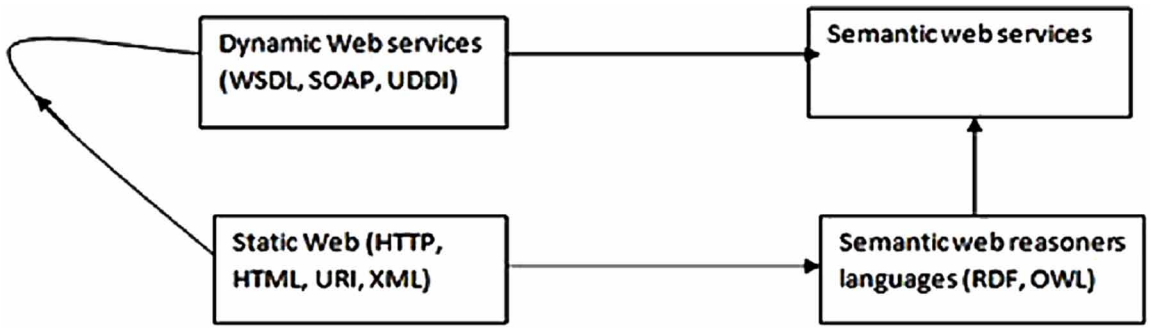
Service monitoring assists during the execution of composite task and give feedback in form of alert to composition agents so that they will adapt to new situation if changes are required The advantage of such monitoring is it can give feedback to the execution or composition agents and they will be able to adapt to the new situation if changes are required.

Ontology management guarantee that semantic web descriptions are created accessed and reused within the semantic web. Ontology describes in the knowledge representation about a specific domain. Relationship among classes and objects is used for semantic composition of services inOntology domain.

MULTIMEDIA AND ITS KNOWLEDGE MANAGEMENT FOR E-LEARNING SYSTEMS

Multimedia is powerful tool for making presentations, slides, charts, maps etc. in the field of E-learning. To enhance the educational experience, and deliver the learning material to learners based on sequence of learner's response and request, multimedia applications are used. Multimedia can provide an enhanced or augmented learning experience at low cost per unit through exploration, discovery and experience.

Figure 5. Realization of semantic web services with web



With multimedia the communication between instructor and learner can be done in more effective manner and enable the instructor to represent the information in various media like sound, videos, animations, text and images. Multimedia learning tools enable learners to represent information using several different media. Hypermedia based adaptive systems allows learners to organize information in meaningful ways which involves theme based activities, open book assignments, etc. With an invention of multimedia based learning authoring tools learners are motivated to create quality product by taking strong decisions and execution skills.

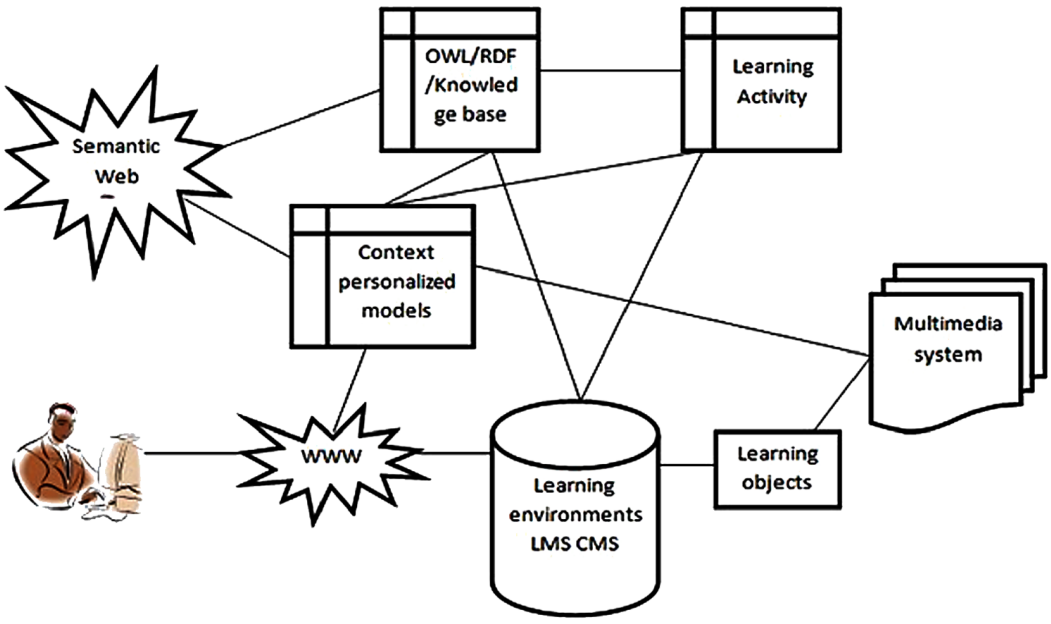
As shown in Figure 6 Multimedia based e-learning system where users interact with semantic web with help of personalized models which correlated with knowledge base and ontology structures. Different types of learning activities are associated with management systems like LMS, CMS etc. which relates individual learning objects to multimedia systems. These systems engaged learning activities according to context of individual needs and preferences.

Advantages and Disadvantages of E-learning

E-learning has various distinct advantages over other learning or conventional approaches like Personality, Flexibility, Interoperability, Collaboration, Source sharing, Reusability, Cost and time effectiveness and performance evaluation.

- **Personality:** The most important feature of E-learning is personalization as it allows selection of learning material according to knowledge level of learner, preferences, skills and according to their needs provide intended learning material to them.
- **Flexibility:** Variety of learning materials which can be shared and provide add on to developer as ability to add, remove and update the learning material content at any time.

Figure 6. Multimedia based e-learning system



- **Interoperability:** Variety of learning standards allows building new contents with different learning style and can be used as platform independent by various users.
- **Collaboration:** Learner's collaborate together in a group or individual according to their convenience through e-mail, chats, and forums to discuss learning standards and intractability.
- **Source Sharing:** Learning resource or material content available on the web has to share knowledge with peers. Various learners are engaged to demonstrate their concept understanding with peers to reflect their thinking processes.
- **Reusability:** The learning content based on different learning styles can be used without redesign, reconstruction in multiple applications and platforms. Similar concepts can be restructured and reused with adaptive methodology.
- **Cost and Time Effectiveness:** The E-learning tools, methods are much time effective and less costlier than traditional learning. It allows learner to learn anytime, anywhere with any modes.
- **Performance Evaluation:** E-learning has measurable assessments which can be used to evaluate learner's acquired knowledge and performance upon completion of course.

The feeling of isolation experienced by distance learning students is also often cited, although discussion forums and other computer-based communication can in fact help ameliorate this and in particular can often encourage students to meet face-to-face, although meeting face-to-face is often not possible due to the disarray of student's physical locality. Discussion groups can also be formed on-line. Human interaction, faculty-to-student as well as student-to-student, should be encouraged in any form.

E-learning tends to work better for the student when the topic matter consists of self-learned items. When much group collaboration is required, E-learning can cause lag times in collaborative feedback if the students are not disciplined. For example, some student's may only check their online agenda once a week, or even less, making it impossible to achieve goals. Web and software development can be expensive as can systems specifically geared for E-learning. The development of adaptive materials is also much more time-consuming than that of non-adaptive ones.

Multimedia and Knowledge Based E-learning Tools

Now a day, many commercialized and personalized multimedia based E-learning tools available in education sector. These tools can provide training and educating a large number of learners with diverse cultural background and provide sufficient amount of learning content to them based on their knowledge level, preferences, skills and their desired needs. There are varieties of E-learning tools like MOODLE, Blackboard, CMS, WebCT, Udutu and Dokeos etc. available in market for delivering and managing online learning content.

A Course Management System (CMS) is a web based system with back end support feature of database. It assists instructors in obtaining resources on web for learners and to facilitate the management of course activities and tasks. There are mainly three strengths of web based course management system i.e. accessibility of course resources to students, proper time to time communication between instructor and learner and reduction of paper usage by enabling online learning systems. The strength of CMS is a security and privacy. CMS system enabled student access controlled to activities and tasks. It protects the instructor intellectual properties. Student privacy and copyright material has been protected from hackers and crackers. The intended course content is released and updated on timely basis with help of CMS.

Moodle is a web based learning management system used in education, training and knowledge management. It helps instructor and learners as a tool to provide in creation of quality teaching and learning. Moodle stands for modular object oriented dynamic learning environment. It is easy to install, configure and reuse. It can be installed on many servers and work in different execution platforms without any requires modifications. Moodle supports user authentication in which instructors and students are allowed to log into system with help of username and password to provide security protection mechanism. It has facility to conduct surveys and supports built in template format for questionnaire. Different type of questions has been asked by system to assess the knowledge level of learners at different level of interest. Apart from all these, there are varieties of advantages of the communication in Moodle.

Moodle avoids regularly reminding and repeating learners during lectures. It has been used to provide immediate response to learner queries and issues and solve them with help of messages. It encourages learners to give sufficient time to courses outside the classroom. Very helpful in saving time spent on writing questions which are of long length. The most advantageous thing about Moodle is Just in time delivery of lectures and downloading of course content has been on demand as required by learners. Open house discussion on course topic has been facilitated easily with help of Moodle.

Blackboard is a hybrid kind of instructor tool. It can be used by instructors throughout the lecture sessions to discuss important ideas and brief on main points. It can be useful tool to help learners to visualize their key aspects and learning features of chapters but if like conventional learning in a classroom teaching, if instructor attempt to teach large group them it will be failure to do so. Blackboard comprised of lot of tools like tests, surveys, assignments, software considerations as technical usage, control over quiz and assessment pattern, grading, reporting and alternative form of assessments. There are numerous advantages of blackboard learning system like integrating assessments with teaching material, the learning content has been available on demand basis, it is mainly used to select randomized questions from list of allotted questions. There are several disadvantages of blackboard like it is not desired for testing of all skills and activities of learner regarding the course topic which they studied. Some IT skills need to be incorporated to support fundamental mechanism of blackboard. The biggest hurdle is time require to design questions which is more costly and input requirement is large compared to other learning systems. As per security aspects, it is more vulnerable to security attacks compared to Moodle and other systems. In comparison to functionality, blackboard is far better than Moodle as it permits greater flexibility in designing the course curriculum for regular terms and maintain the study schedule as per learner requirement to continue the education course in successive manner.

Dokeos 2.0 is a web learning based application which is used to manage online courses. It is mainly SCORM compliant, reliable, light weighted and secured application. It supports different kinds of learning and collaboration activities. Instructors can easily create, manage and publish their course content over the web.

ROLE OF ITS AND KNOWLEDGE MANAGEMENT IN E-LEARNING

An Intelligent Tutoring System (ITS) is a computer system which provides personalized learning content to students based on their performance, needs and background knowledge. ITS may be defined as computer based instructional system with models of instruction content that specify learning strategies i.e. what to teach and how to teach. ITS is web based learning system which are used to teach wide range of topics based on personalized learning.

Knowledge management and training are integral and closely associated parts within a single framework. Knowledge management allows effective control and management of the corporate memory – the knowledge that is within the organization. As a result of corporate knowledge, a virtual classroom evolves, which in addition to the classic "live training program" makes a dialog / interaction possible despite "distance learning." For example the interaction of virtual teams and how they can process information together. Especially the exchange of experience and interaction in form of chats, discussion forums is one of the most efficient ways

of informal training. On the other hand corporate memory that has been collected, managed, organized and has been made accessible to everyone within the company through a KM program, could work proactively pushing knowledge and new information to interested parties (alerting) so that they could better accomplish their job. The training is provided through 4 different media: User Guides (available on knowledge management community of practice), FAQ documents, CBTs and Digital Library.

Computer Based Learning

Computer based learning is commonly abbreviated as CBL, which refers to the use of computer as a key component of the educational course systems. While this can refer to the use of computers in a classroom, the term more broadly refers to a structured environment in which computers are used for teaching purposes. The concept is generally seen as being distinct from the use of computers in ways where learning is at least a peripheral element of the experience (e.g. computer games and web browsing). Common types of Computer Based Learning include CBTs, asynchronous online discussions, or synchronous interactions.

Computer Based Training

Computer-based training (CBT) services are where a student learns by executing special training programs on a computer relating to their occupation. CBT is especially effective for training people to use computer applications because the CBT program can be integrated with the applications so that students can practice using the application as they learn.

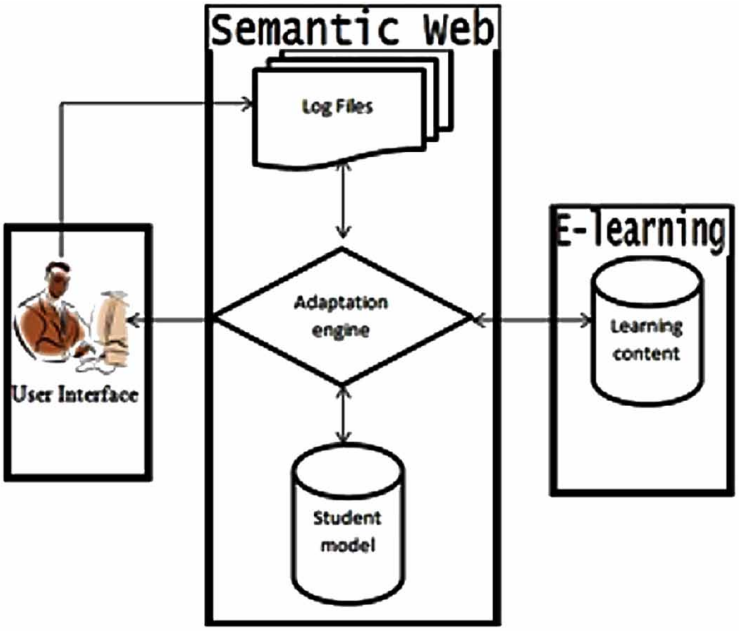
Variety of modules has been integrated into ITS to enable the flexible and efficient delivery of learning materials. They have evaluated the learner on the basis of their skills and requirement of knowledge needs and preferences. Variety of applications has been integrated with ITS to provide flexible, interoperable, secure, plagiarism free environment to support more number of learning web based solutions.

The ITS consist of user interface, the learning content, student model and adaptation engine.

The functionality of ITS can be expressed as:

The user interface delivers the learning content to the student and accepts the students' responses to the questions posed by the ITS. Based on the nature of the ITS, the learning content can be delivered as text, voice, simulation or interactive games. The user interface can be a mobile device (PDA, Mobile, and Laptop) or a desktop. The students' interaction with the ITS, such as response to questions, number of attempts and time taken for various activities (responding, reading and others) is captured in the log file. The log file used to create student model. The learning content of the ITS is stored in a database as topics. The topics are divided into learning units to enable the teaching of a specific concept or a fact. Misconceptions and common wrong answers of each learning unit are stored in the database.

Figure 7. ITS architecture



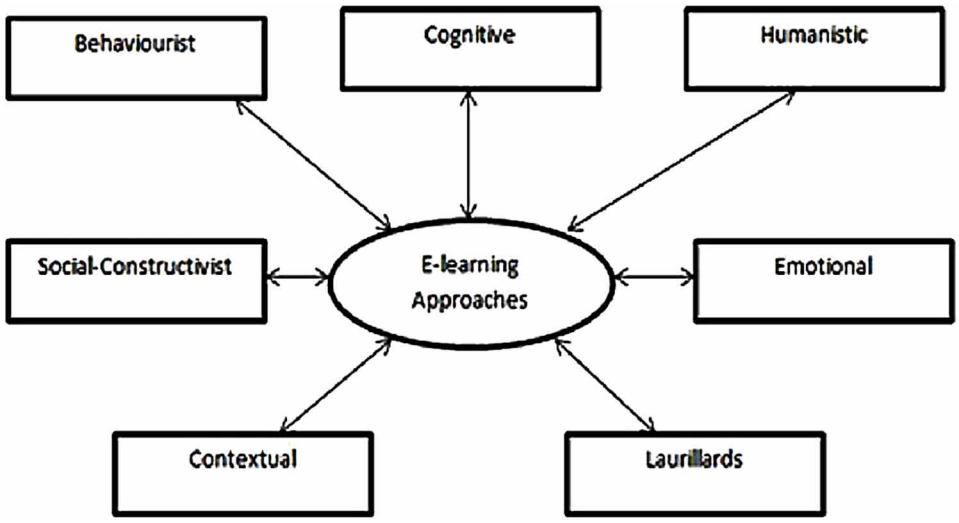
The learning units can be explanations, examples, hints, quizzes, questions and they can be used to teach, demonstrate or test the students. The student model contains general information about student their skills, goals, background knowledge, plans, learning styles and characteristics.

The adaptation engine is an algorithm to select (adapt) the learning content based on the student's input from the user interface (response to the question) and the information from the student model. In ITS, if a student registers for the first time, general information like age, gender and background are collected and stored in the student model. Based on the student's request, the learning content that matches the student's profile is provided in the user interface. The student then interacts with the ITS by solving problems, or playing games or by other ways of interaction. The student's interaction with the ITS is stored in the log file, which is analyzed to identify the student's performance and preferences and is stored in the student model. The adaption engine in ITS tailors the learning content based on the student's request and the data from his/her profile. For example, if the ITS detects that the student has a misconception on a learning unit, the ITS can suggest that the student redo the current learning unit, or redo the previous learning unit or resolve the misconception using remedial content.

Pedagogical Approaches for E-Learning

Learning theory or methodology based upon accepted theories as to how people learn (Aimeur & Frasson, 1996). Not every person learns the material in same way according to given situation, so lot of variants of theories are required to cover specific types of individuals and learning situations. To create such type of E-learning content various pedagogical approaches are need to be evaluated. Simple pedagogical approach can create content easily but lacks flexibility, productivity and purpose behind creation. Complex approaches provide better learning experiences for learners but they require extra

Figure 8. Shows E-learning approaches



effort and time to build system. To incorporate these features there is a need to use various pedagogical approaches for E-learning which includes behaviourist perspective, cognitivist perspective, emotional perspective, contextual perspective, laurillards conversational approach, humanistic approach and social-constructivist approach.

E-Learning Problems

Most of the author focused on various e-learning problems classified as learning path generation (LPG), object recommendation (OR), personalization of content (POC), Context learning problem (CLP), Information retrieval (IR), Domain Ontology construction (DOC), Classification of learning styles (CLS).

LPG focused on providing sequence of learning object materials to learners (Helic et al., 2005). OR system advised learner to choose most desired learning object (Wang et al., 2007). POC specifies what learning objects are needed for course established for specific learner requiring a specific subject. CLS is performed on the basis of learner's interest, background knowledge, mental level, skills and preferences (Li and Park, 2007). CLP describes the availability of learning materials from difference courses for different learner at the same time. IR is activity of obtaining intended course from collection of different courses as per need of learner (Chang, 2002). DOC provides best possible information to learner on basis of hypertext structure.

EMERGING MULTIMEDIA TECHNOLOGIES FOR E-LEARNING

Multimedia technologies are used to enhance content visualization, collaborative network technologies and user interaction with help of digital media. The integration of multimedia is key role in present E-learning technologies. Multimedia based technologies induces dynamic course content delivery anytime

anywhere, improves learner learning effectiveness and experience based on learning content. Variety of media in form of audio, videos, animation etc. supports E-learning whose purpose is to provide channels for delivery of various forms of learning content.

Now a day communication technologies, social networking, Gaming and virtual learning act as a medium for E-learning. In case of communication technologies electronic gadgets like mobile devices, PDA, laptop etc. provides more convenient way for instructor and learner to interact and collaborate with each other.

Communication technology based media facilitates accessibility, interactivity, adaptive, permanent and situation based learning. The hybridization of communication devices with help of ubiquitous and pervasive computing enrich E-learning environment where learner can use his gadget anywhere for their personalized learning environments. Based on collaborative tools, assessment of learner has been done and if learner can correctly answer the questions they receive further information about course.

Social networking plays a major role in E-learning. It uses internet and mobile networks as communication medium for maintaining social groups and communities like Facebook, Twitter, and Instagram where information sharing and interaction among learner takes place. With growth of such online communities learners are engaged to discuss, formulate and share information based on their experiences. Use of social media strengthens the collaboration and interaction among learner easily with help of multimedia learning tools.

Third important medium called game based learning motivates students to learn new skills with help of gaming and visual effects. This kind of learning is supported by different computing technologies like Human Computer Interaction (HCI), Ubiquitous and Pervasive computing etc. The intent is to turn learning process into visual oriented, entertainment driven, and interacted one which facilitate students to gain insights of learning. There are various criteria's for evaluating the quality in E-learning like explicit pedagogical design principles appropriate to learner types, need and context must be clear and high level of interactivity.

Multimedia Content

Student learning performance and effectiveness can be improved by providing appropriate learning content to them. Multimedia content available in different forms like audio, video, images and animations. Various web based E-learning systems like Moodle, Blackboard, Dokeos conduct online quizzes, test assessment, distribution of learning content to students. Based on pre and post-test analysis, it was observed that learners self-efficacy, personalized learning ability, interactivity and multimodal instructions are dominating factor to learning effectiveness. To enable interactivity video based learning has been formalized which generate learning content in multimodal forms helping students to visualize concept easily. Virtual learning provides graphical simulation environments with dynamic learning content to students. Multimedia instruction requires communication standards to formulate and produce learning content. Different types of authoring tools are available to construct multimedia information based learning content. SCORM and IMS is popular standard for content authorization, student assessment and schedule learning content delivery to students. Various kind of learning path sequences has been provided to students based on their skills and background experience which motivates them to enhance their learning effectiveness.

Positive Significance of Multimedia on Learners

Interactive multimedia provides several benefits for learners enable them to use multimedia based information content in form of audio, video, images and animations. Interactive multimedia enhance motivation, which accelerates learning power of learners; enables knowledge transfer through retention and provides manipulative experiences unavailable in normal classroom environment (Aldrich, 2005; Jackson, 2007). Effective learning occurs when learner interacts with multimedia content and on basis of activity feedback which they performed to improve their skills. E-learning needs to encourage learner motivation by providing depth learning experience to them and enable knowledge transfer among efficient learners. E-learning is blind to racial, cultural and sexual differences as it offers no more or less learning support to any individual. It promotes disinhibition which enables learners to express themselves openly. It promotes the interaction of shy people because they are more comfort when they have space and time. The accessibility of E-learning content has biggest impact on learners so they can access learning at their own convenience.

Negative Significance of Multimedia on Learners

Interactive multimedia has negative implications on the learners which include the problems resulting from self-guidance, diminished media richness and issues regarding technology compatibility. Variations on learner preferences like lack of self-directed learning, unclear objectives may result in a hesitancy and reluctance to learn among them. Due to instructional systems, E-learning may be time consuming for learners and sometimes due to lack of experience beginners take poor decision to proceed with given information. Media richness associated with face to face communication diminishes when communication goes electronically. It can be resolved by using multimedia content as adding visual to text. If learner gets distracted due to information available on the web or in online environment then desired animated software enhance their interactive skills and provide fun learning environment for others. Lots of technical issues are involved in interactive multimedia as lots of software are required to play multimedia files and computer capabilities affect online speed in web that prevent learners from accessing multimedia efficiently.

Multimedia Based Educational Programs

In education sector, variety of educational programs have been developed and implemented to identify the problems or trouble those are faced by learner and provide better and optimal solutions for them. The combination of multimedia content and distinguished methodologies are used to solve out such issues which academic society is facing now a days. There are various multimedia based educational programs run by several nations to spread awareness among learners and their guardians to improve the literacy rate which can be achieved only when we deliver or impart right education at right time. Here, we have discussed various educational programs like HEADS UP, WIT, ACALPA, KAD and TiM.

HEADS UP stands for Health education and discovering science while unlocking potential. The main purpose of this program is to aware Non-Asian minority students of schools and the goal is to develop their interest in health sciences and motivate them to choose medical science as their career goal options. Various multimedia based technology used in such programs like various lectures and history of

scientist from medical health sector, different graphical and animated activities to increase awareness among learners, implant and usage of customized web resources, feedback taken from instructor on the resources available for students.

WIT stands for William Instructional Technology. This program spread awareness among summer interns working on government funded project. The goal of this program is to develop high quality multimedia application based project, which helps instructor to teach course contents to learners according to their needs. The multimedia technology used in this program will be to print publications for advertising WIT as per need, different types of standalone presentations and share individuals experiences with each other, organize digital workshops for the learners to customize their work during training.

ACALPA stands for Affective Computer Aided Learning Platform for Children with Autism. This program is applicable for students who suffered from Autism. The main goal is to examine the educational procedure for students who have autism and can motivate other students of same level. Various multimedia technologies used in program like different usage of sensing techniques with help of color, words helps user interest during game playing. Specific synthesized speech will be delivered in native language of person who suffered from autism. Varieties of animated visual motion are being expressed for identification of student reaction. To achieve personalization, individual instructions are being delivered to different students at different levels.

KAD represents Kino-Ani-Drama and animation therapy. The intention of this program is to provide better improvised learning for blind children or those having several visual impairments. The major purpose is to design, develop and to adapt simulated computer based games for visually and physically challenged children. Variety of multimedia technologies like boom sound interface for playing through several narrated stories which children feels interactive and interesting, usage of virtual keyboard need to be enhanced and different game playing instruments like maker, joy stick, cards have been used to control the sound interface for small children.

CONCLUSION

In this chapter we have made discussion of relationship between Knowledge management and E-learning with respect to various integration and adoption models, semantic web technologies and E-learning approaches pertaining to different multimedia systems. It contains information on understanding the fundamental concepts of E-learning. The development of knowledge management (KM) and E-learning (EL) naturally brings both disciplines closer and encourages integration. There are several models that offer possible ways of such integration. Model analysis shows several integration ways and approaches, however, these models are not implemented in production environment and lack necessary technical specification and application support. As result of specific organizational goals and needs models employ different adaption and integration approaches. The more general approach is to base integration on common ground, which was identified as learning.

Similarly, availability of multimedia based technologies on web enable distance-independent learning, low cost video telephone service, improved customer relationships through e-commerce and allows new gaming entertainment. We have analyzed current practices and latest trends in E-learning industry regarding the use of interactive & emerging multimedia technologies as a learning tool in form of social learning, emphasize on instruction authoring, game based learning, to integrate multimedia type with

database system and its query language and to incorporate reality as learning content. Finally, we have discussed different E-learning approaches and their positive and negative effects of using interactive multimedia in E-learning as they relate to both learners and developers.

FUTURE RESEARCH DIRECTIONS

Based on numerous studies, we visualize a lot of research directions in developing and incorporating multimedia technologies for E-learning. Interactive multimedia has impact towards social learning, emphasize on instruction authoring, game based learning, to integrate multimedia type with database system and its query language and to incorporate reality as learning content.

Conventional E-learning systems delivers learning content material i.e. static or based on predefined knowledge set but not on basis of dynamic and adaptive content. Social learning changes learning paradigm from traditional to online community based system where learners can interact with people with similar common interest. It facilitates learning processes by sharing opinions in discussion forums, writing blogs, and article conversion from text to speech or audio with help of predefined converters. Various social networking platforms like Dokeos, Udutu, Moodle, Elgg, blackboard etc. have been designed for online education. Social networking allows experts of different domain to interact with each other with help of multimedia aids.

A major research area in social learning is to improve interaction among learners. There is a need to identify desired methods which fulfill learner request on basis of learning activities like sharing ideas, comments, content sharing, and post videos in social learning environments. As learning content comprise of various multimedia forms like text, audio, videos etc. there is a need to develop automatic methods for content searching, discovery and delivery of learning content in social networking based learning environment. Student characteristics and their behavior also played a major role in E-learning. By identifying learner characteristics E-learning system can better address their individual needs to improve learning effectiveness and classifies on basis of their knowledge level.

Learning facilitates learners to gain deeper insights in certain knowledge and acquire different skills on basis of learning approaches. Conventional multimedia E-learning systems allow learners to represent knowledge based information through various senses like cognitive, humanistic, emotional but these systems unable to integrate physical context of learners. To achieve the same context or situation and reality based learning come into role. Context aware learning uses sensors which can sense and react based on personalized context or environment. It enables community based learning by wearing wrist gadget and captures personal thoughts, locations, body temperature and feelings of learners. Reality based learning enable vision of augmented reality where learners able to visualize information from both real and virtual world. There is a need to improve accuracy and performance of real world object recognition and design interaction techniques to manipulate real and virtual world objects. Another research challenge in E-learning system is to collect interactive response from learner which includes multimodal information and determines way to analyze and interpret the response which is collected.

Game based learning is another research focus which facilitates game designers and educational professionals to work together. Variety of gaming tools is available to develop such systems. An important research issue is the constructional learning design which carried out easily in game based learning environment. This issue requires collaborative and team based learning. It provides learner a way to use

such gaming based environment based on training information they receive. Game playing has improved learner way of learning and helps them out to be restrained.

Constructing multimedia instruction imposes extra burden on instructors as instructions are complex and takes time to produce. Despite of all such facts, challenge is to produce multimedia learning content as an important research objective. The implementation of producing learning material for learners based on their learning style makes adaptive multimedia instruction authoring difficult. Learner has to choose best possible learning path using path sequencing techniques. Instructors can monitor student learning details based on multimedia based content. Based on learner feedback it allows instructors to review instructions and improve the quality of authoring process. There must be production of unified form of abstractions to learning content constructed by different kind of media and ensure that abstraction produced are pedagogically meaningful.

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KEY TERMS AND DEFINITIONS

ITS: It is computer software designed to simulate a instructor behaviour and learning guidance. It provides customized instruction or feedback to learners without intervention of instructor.

RDF: RDF stands for resource description format. It is a standardized model for data interchange on web. It mainly provides interoperability between applications that exchange machine understandable information on web.

SCORM: It stands for sharable content object reference model. It is designed to meet technical standards like durability, interoperability, accessibility and content validity of systems.

Semantic Web: It is an idea of World Wide Web community to make web more intelligent and adaptive to human needs based on their intuitions.

Web Services: These are client and server based an application which provides a standard means of interoperating between software applications running on variety of platforms and applications.

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Chapter 53
Interactive Media Steer in Educational Television Programs

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ABSTRACT

Most distance education institutions still use traditional media such radio, television, printed materials to provide and support education. The educational materials are designed according to the students' individual necessities. So, students can maintain their own learning. The most important property of digital media is interactivity. Traditional media provide interactivity with the support of digital media. To provide a transparent learning and teaching activity in cyber space can be accomplish with interactive opportunities to all learners. In this case the most effective environment should have open access to everyone, easy to follow, unlimited information access. These specialties can be seen in web-based environments. In these days we can eliminate the noninteractive structure of traditional media with the support of web based environments. With the development of Web 2.0 technology, social media applications have gained great popularity in recent years. This chapter will explain, the contribution of Web 2.0 on television in distance education systems.

INTRODUCTION

In spite of developments in information and communication technologies, the instructional television is used in distance education already. Because the television is common traditional media environment which appeals to wide audience and which has in every household as mass medium.

Television takes part in the media environments by the reason of existing the communication which doesn't hold the interaction and which is unilateral. Even if there are interactive television applications developing with technological convergence, utilization in order to provide the training doesn't grow up completely yet.

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Distance education activities contain education and support services in which tutorial and student don't exist together and in which take part the different time and place applications. So the point arrived at distance education in the world, it prefered interactive media in which has been placed individualization to forefront. Despite this disposition, the instructional television situated in traditional media category is subsisted.

To being in use of television already while there are applications of interactive technologies which are popular between users shows that it maintains it's importance for audience. Even if it was prefered by audience, joining digital collaborations to maintain the presence as teaching environment prefered by students in training events confronted as inevitable reality.

It becomes popular quite between users the social media with expanding of the web 2.0 technologies in recent years. Social media guidances given during the television broadcasts also beget interactive chat environments in which audience can share opinions about watched program, can take part in discussions. Hereby it was prompted the guidances for environments in that audience can compare notes about program by breaking the structure of television which enables to simplex communication. The result of this digital collaboration can be seen as an interactive opportunity presented for watchers of television.

Presentation of digital collaboration opportunities that we can describe as interactive environment guidances with the intent of instruction presentation or support in instructional television applications to distance learners are quite important service. With digital collaboration to be provided, students with guidances given at the time of lesson's presentation can access to detailed support about content through social media environment. It will be stated in this study for what purpose and how to use this model of distance education institutions which uses the television as dominant educational environment. However it should be emphasised on the television training programs, web 2.0 technology and interactive media guidances before configuring the model.

DISTANCE EDUCATION AND COMMUNICATION TECHNOLOGIES

In fact the Distance education concept is not a new concept. Concept was used primarily in 1892 catalogue of Wisconsin University (Verduin & Clark, 1994: 7). First use of concept in the form of "Maintain the teaching-learning relationship of student and teacher separately from each other" was heard while had a conversation between Moore and Börje who is Swedish pedagogue. First beginning of the distance education was performed with letter. Later on it was used different communication and information technologies in teaching presentation parallelly to emerging technologies.

Definition of the concept was changed by the time as well as technologies used in teaching presentation. Because it has been formed the distance education perception in which placed the teaching methods and techniques, student expectations and requirements, individual needs in changing conditions to forefront. In this regard, the distance education concept has been possessed wider definition. Distance education is defined as system in which the communication provided with technology and student gets education independently from time and place.

As it is understood through its definition, distance education defines the activity in which continued the teaching activities with communication technolgies' support. Therefore distance education institutions carry on the activities as institutions providing the ideal education opportunity for students by following the developments in communication technologies. Diffusion of individual-centered instruc-

tional approach, understanding of interaction's importance in education caused to arising the wider use perception of communication technologies in teaching domain.

In recent years the use of digital technologies become widespread rather quickly in the community. Distance education institutions also don't ignore the contributions of digital technologies for teaching activities. However television and printed material based instructional media located in traditional media category subsists already. Especially distance education based on book and television has great advantages in terms of teaching presentation for audience. For this reason these technologies located in traditional media category can be prefered already in teaching activities. It can be provided more ideal learning environments in accordance with education requirements of the age for distance learners by crossing the several lines of television and printed materials with coalescence between traditional media and digital media in recent years.

INSTRUCTIONAL TELEVISION

Television is between mass communication most commonly used. Television which located in traditional media category and defined as household technology takes part in media category consumed at most by audience. As per Mohanty (1986:85) Instructional Television (ITV) is mass media which has interest and motivation arouse power for children and adults (Akhter, 2011:189). If television is used for community education, then it is instructional television. ITV programs also define programs prepared for training courses. The television is convincing and influential tool for enormous mass of humanity (Akhter, 2011:189).

It should define the limitations and possibilities clearly in mass communication of television media. It should be configured the ITV activities in the direction of facilities defined in this way. We can put television features located in traditional media category in order as shown in Table 1.

The possibilites and limitations of television features given in Table 1 by classifying. The limitations can be thought as an obstacle for consumption of television when considered the features of digital media environments nowadays. However in spite of it has very much disadvantages in the face of digital media, it subsists presently as popular media environment in many parts of the world. It prefered as communication media which persuades person at most with presented program and channel varieties

Table 1. Television features

Possibilities	Limitations
Television provides relayed messages for wide audience which are spread and froma distance physically from eachother	Television is traditional media which allows one-way communication.
Television is electronic media which can relay mobile video and audio messages at once by its structure	The interaction on TV as traditional media is limited with only channel variety. Accordingly it is low as minute amount.
Transmitted messages on televison can receive at the same time a great number of audience which positioned dispersedly	Because of interaction absence the audience is defined as passive audience.
It's information distribution is faster than other traditional media	Because of there is one-way communication and there isn't interaction on TV, the feedback is so low.
User-friendly technology	Television is situated as household technology by its structure.
It is easy to access to the content	

inspite of mentioning about passive audience, which motivates and has display and sound quality at high level. Because of these features it stays popular as educational media used at present by distance education institutions and their students. It can be exceeded the features determined in limitation category as the result of collaboration between traditional media with digital media at the present time. Because instructional television applications possessed more individual, interactive and immediate feedback opportunity with digital media collaboration. Thus it has been paved the way for turning into active audience by breaking the passive position of audience and it has been provided dual communication medium for distance learners.

Instructional television programs show similarity with production and coverage of television program. It has been mentioned small differences in process before production of programs to be prepared for instructional television. Because the television also has taken place among main components of training activities in addition to printed or written course materials in distance education institutions. It performed pre-production process by considering the training material prepared as written and printed in training program which will be prepared accordingly.

The first thing to be done in program which will be prepared for instructional television is determination of important issue, conception and sections required to be presented, clarified, visualized or animated on television within the course involved in printed materials. Producer, editor and scenarist determine this process together. Following it will be designated instructor or presenters who will host training programs. Afterwards it will be completed necessary preparations for pre-shooting. (Demiray and others, 2002:5)

After shooting performed in accordance with determined points, it will be set post production stage. In this stage the program will be made ready for broadcast by editing the program and adding the visual and audio effects. The program prepared for instructional television can be produced in two different ways. They are: Live Broadcast and Prec.(Pre-recorded) Broadcast.

Live Broadcast defines producing the television program in an instant production (John, 1967, 517). There is simultaneity in programs to be broadcasted live. In studio or in setting intended as studio performed shootings made. In these shootings where discussed the use of camera more than one, the visual transitions and program integrity will be provided with vision mixer's support. After completion of pre-production process in programs to be broadcasted live like in all other productions, the shootings will be performed in extent of determined projection and it is given to broadcast instantly. The biggest advantage of such kind of broadcasts is giving feed back with getting through, e-mail possibilities provided for audience. Live broadcasts are used too much in instructional television applications in order to give lecture. Live broadcasts are set up in the manner rendering the support service for students mostly. For instance as well as exam preparation programs, programs which can kept informed about system operation. Students can connect to performed live broadcasts by using the support communication technology as telephone, e-mail and can ask the questions which they wonder. The importance of live broadcasts is pretty great in instructional television applications. Because it made possible receiving feedback of student with interaction opportunity provided, even if it is limited. However despite this opportunity the number of students is limited who will interact in limited period of the program. And this is doesn't seen as sufficient opportunity for distance education institutions which has enormous student audience.

Prec. defines realization of television programs' production process with broadcast process at different times. In programs broadcasted from prec, the shootings are performed in accordance with criteria determined at pre-production stage of program id est. at pre-development stage. It will be gone to post production stage with obtained video and audio as the result of shootings performed either in studio or

outdoor with use of one or more than one cameras. Obtained video and audio informations will be edited in the manner that visual and semantic wholeness will be provided. It will be added required effects with with animations and program will be made. Completed program will be given to broadcast in order to communicate for target audience in appropriate day and time. Because of there is different timeliness in production and broadcast of prec program, the audience is in more passive position. It is not possible to mention about interaction. Feedback is received from only ratings or reactions after broadcast. Therefore it can't be mentioned the direct feedback. Indirect feedback can be seen in the form of reflections within society. Training programs devoted to lectures by distance education institutions are broadcasted from pre-recorded broadcasts mostly. Accordingly it hasn't been satisfied the need of interaction and feedback which are important factors for distance education. Nevertheless it has not given up a prec because of visual-auditory power of television and communication prevalence for target audience.

Programs to be produced on instructional television remain incapable in two-way communication and interaction dimension regardless whichever broadcast technology is used. At the present time when becomes widespread the use of digital media and applications, it can be exceeded the limitations with instructional television applications located in traditional media category. The digital collaboration with one-way non interactive structure of traditional media training can be broken with digital media's support. Especially with mobile devices it can be gained access to contents of digital media without time and place limit, can be shared information and thought and received the feedback. In this regard the use of mobile devices is prefered further. Mobile devices contain main features as portability, functionality, multimedia convergence, accessibility, personal ownership, social interactivity, context sensitivity, spatial awareness, connectivity and personalization (Cook, 2010,1-2). Teaching process' promotion of distance learners can be possible with digital collaboration between mobile devices and television.

WEB 2.0 TECHNOLOGY AND SOCIAL MEDIA

Under widespread of social media concept underlies the development of web 2.0 technology. Web 2.0 concept states coming together of methodologies, technologies and platforms which represent the new progresses in the development of web (Akar, 2010:11) There has been a rapid change in the understanding of technological advancements which provides emergence of web 2.0 technology with user's information retrieval. For this reason it can be said that web 2.0 technology is not only technological change, therewithal it is web environment which is open for participation, interaction and implementation. In consequence there are many possibilities provided for user with features whihc possessed by web 2.0 applications. With this new technology, the web users have been transfered to more active position by eluding from passive position. The users are not in case of let off with a reading the content located in web environment anymore. Because the users with web 2.0 technology can spread their contents by creating them over the web which has a great number of users to whole world. In this way user can use web services with this new application for information sharing as well, not only for information access. All of these services are presented for user with different applications which presented by technology. We can put these applications in order as shown in Table 2 (Constantinides & Fountain, 2008:233).

Five main applications of web 2.0 technology give wealthy opportunities for users. Kaldoudi, Konstantinidis and Bamidis (2010) state that web 2.0 applications have 7 main component. (Yuzer, 2014:88). They are displayed in Figure 1.

Table 2. Web2.0 applications

Blogs
Social Network
Media networking site
Forum/bulletin boards
Content Aggregators

Figure 1. Web 2.0 components

- **Participation:** Defines participating of social media users to internet environment as much as they like, receiving feedback from everyone and sharing thoughts with everyone freely.
- **Collaboration and Sharing:** Defines propagating and distributing of users located in a social media platform obtained content with other users.
- **Clarity:** Defines the gaining access of social media users to content which they want without time and place limitation. Shared and propagated information is mass, not individual. Shared information open for rating and comments.
- **Reuse:** States ability to use shared content in social media by other users exactly or re-usability of them by commenting and handling.
- **Personalization:** Can determine contents which followed by social media users in accordance with individual requests, necessity and expectations. Hereby they can perform information access and sharing upon their requests in social media monitoring. Social media users can provide information access and sharing by tagging the content which they want to follow.

- **Promptness:** Means digital speed of the age. It performs information access and sharing within very short periods. Users can access to an information within seconds freely from time and place and can spread to other users.
- **Apomediation:** Defines the use of social media's some environments as a promotive tool. For sectors as educational, professional life the social media environment can be converted into structure which will support the activities. In this respect it can be configured as support medium for advertising, marketing, educational and even for other media.

Web 2.0 technology is used easily as support for instructional television broadcasts in support structure when taken into account the main components of technology, especially the apomediation. Accordingly the most appropriate environment between social media environments in which will be performed apomediation can be facebook and twitter. Because there are two-way communication flow where can be performed the instant audiovisual information sharing and access, where is possible direct and instant access with tagging.

Social Networking Sites: Facebook/Twitter

In words of Castells (2005) today's human being lives in the community where they will be in connection with each other in global or local dimensions. One of the formative of individual existence in this network society is social networking site (Toprak and others, 2009:25)

Social networking sites are interactive communication media in which users create one completely or partially public profile, in which they can exhibit people list with whom in relationship and they are can be in relationship with other users by observing, and which can be defined as the invention of the age adopted by millions of people in a short time (Varnalı, 2012:105). Between social networking sites Facebook and Twitter also are in demand mostly.

- **Twitter:** Is free of charge social networking site in which users can share messages based over 140 characters with each other and communicate mutually in this way (Akar, 2010:58) Twitter users determine the users whom they want to follow by identifying them in their accounts. Hereby, twitter user either individual or organizational structure can see instant information sharing of other users in own page. Also it is possible to answer to up-to-date information and sharing this information with another user for twitter user. There are three main components of Twitter: followings of User, followers of User and Tweets. Also there are e-mail service with ability to send a private message to other user as well as they can share openly to all followers of Twitter. We can put the main features which provide the popularity of Twitter between users in order as shown in Table 3.

Table 3. Twitter's features

It is easy to write a message and read it
It is easy to become acquainted with other people
They can receive automatically the message of following people with User selectable messages
The messages can be received in any internest-enabled device

- **Facebook:** Is virtual communication environment in which users create the profile by registering to social networking and by sharing the personal characteristic, photos, videos. In Facebook environment also it can be shared public messages for everyone as well as thee can be sent private messages to one user or user group directly. Facebook is virtual communication environment in which can be added only persons as friend and corporate pages can be followed. Individuals can give feedbacks and share own thoughts as can be received the up-to-date information sharings of following person and pages. In this respect the facebook is interactive virtual communication environment. They can have simultaneous conversation with persons as individually or in group listed with on line chatting property. There are so many features which support user interactions of Facebook. They are; (Toprak and others,2009:38); "Wall" where located sent messages, "Pokes" which enables for virtual pokings, "Photos" which allows to load the album and photos, "Status" where provides information access to place and actions of users.

Digital Collaboration between Television and Social Media

New Technologies renovate the traditional media and improve them on the contrary to destroy. For instance TV viewers can share opinions comments about content as real-time during the broadcast. This event can be defined as "viewertrait" (Anstead ve O'louglin, 2014:441). Viewertrait states digital collaboration in which applications belonging to traditional and digital media tools work together.

In recent days one example of this collaboration is experienced between television which is traditional media and social media. Almost in all programs broadcasted on television used often interactive environment guidances intended for social media. In this regard especially facebook and twitter guidances are one of the interactive environment guidances which prefered commonly. Interactive environment guidance on television covers applications in which audience situates in interaction as the result of collaboration between traditional media and digital media. For instance audience can connect to page about watched program with one hashtag defined in facebook/twitter guidance given on television program broadcats through constant or portable internet-enabled device. It can be accessed directly to up-to-date information, comments, and opinions of other audience with given hashtag.

Hashtag; is easy and effective way to access to wide range of people. In Twitter writing of one word after # sign shows the hashtag. Users can tweet between themselves with Hashtag. (Abanoz, 2012:77) Real-time social media conversations of users seen in the characteristic of reform for wide range of audiences.

In television programs it is used facebook guidances except twitter hashtags. Facebook platform as its structure is not active as twitter in real-tşme instant messaging. However it is possible to share instant comments by accessing to guided pages of audience. With synchronization between Facebook and twitter, twitter users has a chance to send messages to facebook which was shared. In this regard there can be seen advantages provided by both technological convergence and digital collaboration between different digital platforms and traditional media.

Support Provision of Social Media for ITV

We stated before that instructional television is used already in many countries prevalently. It is obvious that instructional television remains incapable in some points against the developing technology despite

it's plenty advantages. Structures in which students can interact and communicate on Itv broadcasts can be possible with support of interactive media guidances' use and digital technology.

It can be provided communication of both other students and curators of explained lesson with distance learners during the broadcast with social media hashtags to be given in training progams which were telecasted. In this regard, Facebook and Twitter which are social media platforms can be configured rendering the service for students differently.

Twitter is the platform that can render the service better to real-time messaging necessity. Therefore even if training program is live broadcast or prec, it is situated as a platform where students can communicate simultaneously with other srudents and instructors. On live broadcast itv programs, replying the sent messages from social media on television during the broadcats can be seen as an important service. Herewith program broadcast will be produced in accordance with requests and reviews from social media. Accordingly there is no need to subject matter expert to be there during live broadcast which manages the social media platform. Subject matter expert/ instructor involved in presentation of live broadcast will make statements simultaneously toward received messages. It is not possible to provide this service in the prec programs intrinsically. Student has abilities to comment and getting answer by asking questions about subject directly with twitter hashtag given about explained lessons on instructional television. Hereby one-way communcation structure of the traditional media with learning activity can be broken with a support media. At airing time of progrmas in interactive itv support program to be given with twitter, the subject matter expert which will reply the questions should be active and support the students during the broadcast. According to result of the study made intended for Tweeter use, it was proved that 50% of the sent tweets with # sent during the program broadcast. (Anstead and Loughlin, 2014:454) As for study made intended for influence of tweeter on learning reveals that tweets sent by users ease the learning and carry out better comprehension (Aydın, 2014:2).

The use of Facebook guidance on Itv as social media platform can be projected as student supportive service. Student can get answers by asking the questions to page administrator by adding the facebook guidance given for a lesson in own profile outside itv program broadcast and can benefit from the service by communicating with other members. In this way it can be provided interaction of distance learners with both subject matter expert and other students. Sharing of the video lesson telecasted will be benefit for the student from supportive service by listening them again independently from the certain place in a time of need later. In Facebook guidance it can be sustained simultaneous or different time conversation under the discussion headings about the subject. Hereby it can be positioned the facebook as important supportive service which will be given to student except the moment of teaching presentation. We can put the main criteria intended to use supportively of the facebook and twitter's traditional itv broadcasts in order as in Table 4.

Provided services in both of social media platforms even if it is facebook or twitter are quite important student supportive service for distance education activities presented with traditional media. In this respect the opportunities of social media platforms for students shouldn't be ignored.

FUTURE RESEARCH DIRECTIONS

When distance education is called, it has been reminded that an education activities, which are supported and carried on with technology. Also recent development on the era of digital media gives opportunities to take place in education environment everyday for a new application and innovations. In this study,

Table 4. ITV features of social media collaboration

Twitter		Facebook
Live Broadcast	**Prec.**	**Non-Teaching Moment**
No need to Twitter administrator	Required Twitter administrator. The subject matter expert is twitter administrator.	Required Facebook administrator. The subject matter expert will be designated as administrator
Program presenter/ subject matter expert involved in program follow the messages	Twitter administrator follow the messages	The subject matter expert follows messages
Program presenter/ subject matter expert reply the messages during broadcast	Replying of the messages will be carried out during broadcast on twitter	Replying of the messages will be carried out on non-broadcast
The interaction of learners with each other will be carried out on twitter	The interaction of learners with each other will be carried out on twitter	The interaction of learners with each other will be carried out on facebook
The interaction of student and instructor/ subject matter expert will be carried out through television	The interaction of student and instructor/ subject matter expert will be carried out through twitter	The interaction of student and instructor/ subject matter expert will be carried out through facebook
It will be provided supportive service during broadcast. Time is limited.	It will be provided supportive service during broadcast. Time is limited.	The supportive service will be configured as at the moment of broadcast and out it.
Shortcut of the interactive media guidance will be given during the broadcast.	Shortcut of the interactive media guidance will be given during the broadcast.	Shortcut of the interactive media guidance will be given during the broadcast.

an interactive content design, which can be served to students, was developed with using Web 2.0 technology. The developments of TV program production and broadcasting technology brings with its new opportunities and these opportunities mean that new applications for distance learners. IPTV application can developed for education environments with to become widespread of Internet based broadcasting practice. Interactivity is one of the most important concepts in the distance education activities. Because of this, it's required that students can manage their own needs and requirements on education activities with supporting of technology. All technologies in the category of digital media include interactivity components. In the context of the ITV activities era, the studies are requiring such as IP based broadcasting, the development of NVOD and VOD systems, the supporting of education contents with augmented reality. The adaptation of Web 2.0 philosophy on interactive digital TV (IDTV) also can brings great interactivity opportunities to distance learners in nowadays which widespread smart TV ownership. Because, Web 2.0 philosophy is gradually turning the current web into a cooperative space where knowledge sharing collaboration take a leading role in the new social networking sites (Redondo an others, 2011, 151-152)

Further research, which are suggested about distance learners supporting with digital media environments on ITV application are not limited those mentioned above. Distance learners' satisfaction levels and attitudes towards on new digital media environments are other subjects that need to be understood. Because, it can be supposed that the environments where convergence of technology are preferred preliminary when individuals' digital media usage are considered. Within this context, it is predicted that the environment, which have faster information access, suitable for mobile life and usage of more than one application within a digital media technology, will be preferred principally. It's undeniable reality that making design which gives freedom learner and access the interactive content any time and space. Learners' attitudes towards ITV applications and interactive environment redirection are included the

subjects which needed to be researched. The investigation of learners' ides about television capacity directed towards solutions of individual learning as being household technology.

The investigation aspects of digital media supports directed towards ITV applications and in this context, the researchers understanding about students' perceptions and attitudes will contribute to academic literature.

CONCLUSION

It is fact that digital media products don't destroy the traditional media, on the contrary it helps maintain the popularity by supporting it. Above all of these supports is seen possibly in educational field. Even if use of digital media in distance education applications is widespread, the dominant teaching tool is traditional media in our age already. Television and books don't lose thier popularity in this context. However in any case this traditional media used prevalently should get support from digital technology.

There aren't too much studies yet intended to use of social media as direct and supportive training environment in literature. Made studies concentrate on social media users, interactive media guidances from television programs and advertising. There can't be finded research results intended to use of social media in television training programs in this respect.

In recommendations given devoted to effective use of social media in television with training activities, it was demonstrated the small difference for live and prec broadcast progrmas. Apart from that the process is handled identically. Supportive service given on Facebook defines supportive services about non-teaching moment lessons not about direct training presentation. While Twitter service occurs actively during itv broadcast, facebook service covers also the time of non-teaching moment.

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Chapter 54
Lean and Digital:
A Case Study on Procurement and Supply Chain Professionals' Online Social Network

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ABSTRACT

This study focuses on "BuyerNetwork.net," an online social networking website which brings procurement and supply chain professionals together on a digital-sphere for the purposes of interacting on work related communications and gathering information about supply chain products, operations and industry specific updates. It is aimed to explain the concepts of digital entrepreneurship and lean startup concepts with a literature background and on a case study. In the proposed case study, BuyerNetwork.net's establishment process is examined.

INTRODUCTION

Entrepreneurship is the topic that occupies a prominent position on the research agendas of scholars from a variety of disciplines including anthropology, history, management, psychology, sociology and economics. It has been introduced by Jacques des Bruslons in 1723 on the French dictionary, *Dictionairre Universel de Commerce* (Navale, 2013) and the 'entrepreneurship' word derives from the French word 'entrprendre' (Kuratko, 2009). In about 1800, Jean-Baptiste Say, a French economist who was one of the first mentioned 'entrepreneur' word, has explained it as "a person who shifts economic resources out of an area of lower, into an area of higher productivity and greater yield" (Butler-Bowdon, 2010, p. 82). Over the years, many research studies have been conducted to understand the personality characteristics, abilities, capabilities of the entrepreneurs. One can see many studies which examine the relationship

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between entrepreneurship and many more related concepts such as culture, innovation, economy. Moreover, 'entrepreneurship literature' shows that it has many new categories such as eco-entrepreneurship, social entrepreneurship, woman entrepreneurship, digital entrepreneurship, lean entrepreneurship etc.

Weightless economy, digital transformation and many other new concepts emerged in the 21st century. Social media and social networking are two of these concepts which take place in the digitalization movement. Mainstream social networks such as Facebook, Instagram, LinkedIn are widely in use. Also, there is an emerging attention to vertical social networks which are specialized online communities built on shared interests, needs, events etc. BuyerNetwork.net is one of them which has been established in 2014 at Istanbul University Teknokent (Turkey) for innovative university practices by two scholars. There are procurement and supply chain professionals, entrepreneurs, scholars, researchers, students and NGOs in the BuyerNetwork.net ecosystem. It provides professional communications and connections; B2B opportunities and campaigns; and professional tools. It has more than 3300 members, 6 modules (performance measurement, commercial campaigns, goods and services, quality documents, references, marketplace, blogs and events modules), 3 user groups and 16 special functions.

The emerging digital economy has attracted much interest in recent years. Since internet and digitalization have changed almost everything including entrepreneurship, it brought new concepts such as digital entrepreneurship. Davidson and Vaast (2010, p. 2) explains that "digital entrepreneurs rely upon the characteristics of digital media and IT to pursue opportunities. In doing so, they exacerbate changes in the competitive landscape, as they attempt to seize the opportunities and thereby potentially further the creative destruction process of the digital economy". According to Hull (2007) digital entrepreneurship basically has three types which are mild, moderate and extreme digital entrepreneurship. In this study, BuyerNetwork.net is emphasized as 'extreme digital entrepreneurship' which the entire company is digital, going from production to customers. This explanation points a 'type of entrepreneurship' based on the digital-sphere.

The other concept which is explained in this study is lean startup. It offers innovative and profitable products and/or services while minimizing unnecessary over-costs to customers, suppliers and the environment. In this study, BuyerNetwork.net establishment process has been explained with this concept. While lean start-up method focus on how new entrepreneurial companies can develop new products and services for a large number of customers in a shorter period of time by minimizing costs (Tanev et al., 2015), digital entrepreneurship states the platform which entrepreneur(s) do business in. Lean startup concept deals with "how" by explaining the process of producing MVP(s) in an early stage company based on waste reduction thinking. Digital entrepreneurship defines "what" by putting a framework and stating the tools can be used such as social networking platforms, digital apps. Both concept stress the challenges, the risks and uncertainties the companies have to deal with. In many cases, the solution for the companies is to build relations and networks to minimize both complexity and uncertainty, as well as to optimize the use of external resources. The link between the two approaches can be found in their focus on entrepreneurship, since in both cases the entrepreneurs have to learn to operate in a complex and uncertain business ecosystem including customers (which is very important for lean startup concept), suppliers, R&D partners, competitors, etc. (Tanev et al., 2015).

Some previous studies examined the concepts both conceptually and empirically (Sambamurthy et al., 2003; Hull, 2007; Turban et al., 2008, Davidson &Vaast, 2010; Ashgari & Gedeon, 2010; Hafezieh et al., 2011, Esmaeeli, 2011, Tanev et al., 2015, Grohn et al., 2015). This chapter aims to bring these two concepts together with a single case study on BuyerNetwork.net. In doing so, lean start-up method can deeply be understood for establishing a digital company on a vertical social networking site.

LITERATURE REVIEW

Entrepreneurial activities had begun with the first age and still continues. It has varied in many different concepts with the new necessities such as being green, digital and lean etc. Thus, in this direction, for this study, digitalization, digital entrepreneurship and lean concepts are explained below.

Digitalization and Digital Entrepreneurship

In today's world, one word is so popular: Digitalization. But what exactly is digitalization? According to Business Dictionary, it is "the integration of digital technologies into everyday life by the digitization of everything that can be digitized" (online). The communication has been digitalized by social media, the design of production prototypes have been digitalized by digital tools etc. Weightless economy, dematerialization, digital transformation are the emergent subjects related to the topic recently. The Internet and digitalization have changed almost everything including entrepreneurship.

From traditional entrepreneurship models at the Industrial Age, to new entrepreneurship models at the Information Age; capability, learning and flexibility became the essential facets. According to Naisbitt (1994), technological revolution is the deriving power of the new economy. The global dynamic and ever-changing environment, with technological resources, brings continuous change, transformation and development. Rather than material goods, bits of information are processed (Negroponte, 1996), accelerating the shift away from the production of material goods and toward an economy based on the production and circulation of information and knowledge-based services (Davidson & Vaast, 2010).

Technological developments and innovations empowers individuals by challenging them to go further, harnessing new innovative ways of thinking, working and being creative. Thus, it can be said that entrepreneurial activities on digital-sphere increase among individuals who intend to engage in entrepreneurial activities day by day. More and more businesses are 'born digital'.

Sambamurthy et al. (2003, p. 242) define four factors which explain why one would start entrepreneurship in the digital-sphere:

1. Entrepreneurial action that refers to behaviours through which companies recognize and exploit market opportunities through novelty in resources, customers, markets, or combinations of resources, customers, and markets;
2. Agility which refers to the fit that could exist between the company's strategy, its structures and capabilities;
3. Digital options which refers to a set of IT-enabled capabilities in the form of digitized enterprise work processes and knowledge systems; and,
4. Capability of a company which refers to exploring marketplace and determining opportunities for action which is called as the entrepreneurial alertness.

According the Schumpeterian perspective on entrepreneurship, entrepreneurs render certain industries obsolete while creating new ones (Davidson & Vaast, 2010). Entrepreneurship activities on webs (in other words, web entrepreneurship companies) are ventures that do not only use IT to support their business processes, moreover, they use internet and associated technologies such as 'Web 2.0' to create and implement new business ideas (Spiegel et al., 2013). Since digital media (e.g. Web 2.0) and information technologies have generated new conditions for communication as well as new opportunities for

business models while also damaging long-standing, established industries; the concept is especially useful to understand digital entrepreneurship. Esmaeeli (2011) describes digital entrepreneurship as a subcategory of entrepreneurship. According to him, some or all of what would be physical in a traditional organization has been digitized. Thus, digital entrepreneurship implies entrepreneurship activities associated with some degree of digital goods or services, or with other forms of digital activities. Entrepreneurs competing in the digital environment face unique challenges and opportunities; ease of entry, production, and distribution, instantaneous responses from competitors and 'virtual commitment' from employees (Tanev et al., 2015). Thus, there is a growing need to understand deeply this type of entrepreneurship with related concepts.

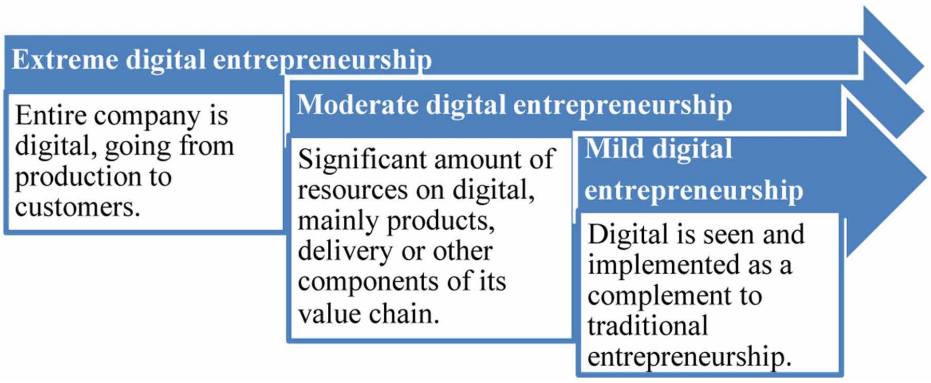
When explaining digital entrepreneurship, it is essential to develop a typology of digitalization of a company. According to some authors, digital entrepreneurship implies entrepreneurship, or new value creation, involving a new business model based on digital goods or services, digital distribution, digital workplace, digital market place, or some combination of these (Turban et al., 2008; Esmaeeli, 2011; Hafezieh et al., 2011). According to Esmaeeli (2011), the degree of business digitalization may be derived from; (1) the digital nature of a company's goods or services, (2) the digital distribution of goods or services, (3) the digital interactions with key external stakeholders within the value chain, and (4) the digital internal activities associated with a company's operations. Hull et al. (2007) also explain the degree of business digitalization by enhancing Esmaeli's framework to six items which are; (1) the degree of digital marketing undertaken by a firm, (2) a firm's digital selling, (3) the digital nature of a firm's goods or services, (4) the digital distribution of goods or services, (5) the digital interactions with key external stakeholders within the value chain, and (6) the digital internal activities associated with a firm's operation.

First one refers to digital goods or services such as videos, search engines, websites, portals, online advertising, digital media services etc. For example, Yandex Search Engine is the digital good of the Yandex Company. It is one of the largest internet companies in Europe, operating as Russia's most popular search engine and its most visited website (Mission, 1997-2017). Second one refers to the distribution of digital goods and services. The potential of digital distribution impacts a company's activities, markets and competitive abilities. For example, Rakuten Kobo Inc. sells digital goods and distributes them on a digital platform. Third one refers to activities of potential digital interactions with key external stakeholders within the value chain such as customer relationships, gathering feedback and information from customers and suppliers etc. It is very important for the companies, especially for marketing activities and strategy practices. Fourth one refers to a digital workplace that employees can work despite geographic distances. Such new ways of work are possible via video conferencing, intranets and other virtual tools. Fifth one refers to the use of digital resources to communicate and interact with stakeholders, including suppliers, industry associations, NGOs, and governmental agencies. Finally, sixth (the last) one refers to the digital operations which are based on digital modes of interactions within a company.

In recent years, more and more theoretical and empirical studies have been conducted on digital entrepreneurship and related topics, especially which have tried to examine the underlying mechanisms. In one of those studies, Hull et al. (2007) categorizes digital entrepreneurship into three types (see Figure 1):

1. Mild digital entrepreneurship which refers to a company's business model that is similar to "click and mortar"; both online and offline operations, which typically include a website and a physical store. In this category of digital entrepreneurship, digital is seen and implemented as a complement to traditional entrepreneurship.

Figure 1. Digital entrepreneurship categories

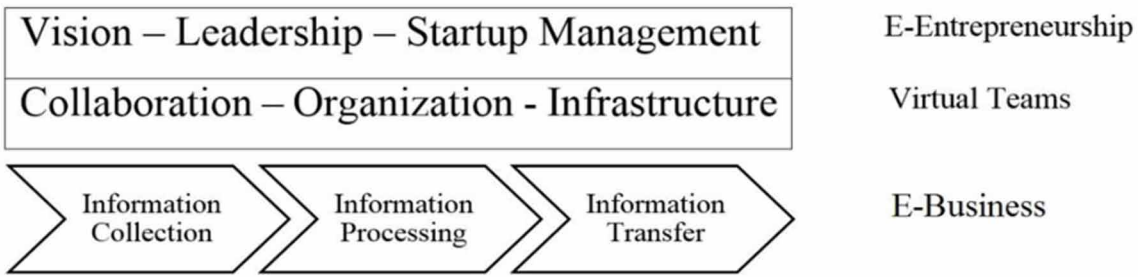


2. Moderate digital entrepreneurship which refers to a company that invests a significant amount of resources on digital, mainly products, delivery or other components of its value chain.
3. Extreme digital entrepreneurship which refers to an entire company that is digital, going from production to customers.

This study tries to explain 'extreme digital entrepreneurship'. On this concept, a modified version of the conceptual framework for *Completely Digital Entrepreneurship* (CDE) based on Kollmann's "E-Business Value Chain in the Net Economy" by Ashgari and Gedeon (2010) is presented (Figure 2).

Completely Digital Entrepreneurship (in this case "extreme digital entrepreneurship") means developing digital products and/or services and selling them over a digital channel. In the framework, there are three key factors which include some sub-factors: e-entrepreneurship, virtual teams and e-business. E-entrepreneurship includes vision, leadership and startup management. A startup company is an organization formed to search for a repeatable and scalable business model and startups are not smaller versions of larger companies; it is a temporary organization designed to search for a product/market fit and a business model (Blank & Dorf, 2012). In line with this definition, one can understand that startup management is highly different than a regular company management. In any organization, vision and leadership are the basics. These concepts provide founder(s)'s way of doing business, plans, desires, leading style etc., and they effect the whole company's both soft and hard elements. Collaboration, organization

Figure 2. The conceptual framework for Completely Digital Entrepreneurship (CDE)
Source: (Ashgari and Gedeon, 2010).



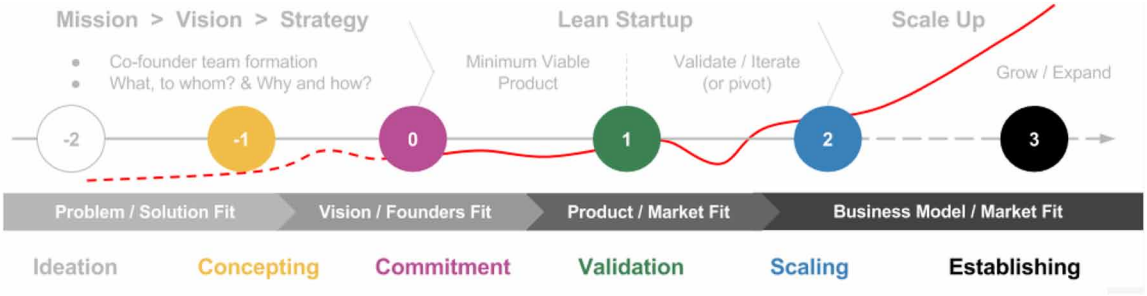
and infrastructure are the factors of virtual teams that refers to all aspects of managing human resources which allow team members to connect independent from physical existence in the same place. They can do business online and collaborate effectively. In the framework, information collecting, processing and transferring it refers to e-business. It includes internet based activities inside and outside of the company to maintain the process of services and product creation, procurement activities, external collaboration, marketing and financial management (Ashgari & Gedeon, 2010). By explaining this framework, the necessary components are defined and examined. For example, below mentioned examplary case company has followed these complete/extreme digital entrepreneurship internal processes. The vision and leadership of the founders of the company is a part of e-entrepreneurship thinking. Also, startup management is the key concept since it hasn't started as a regular traditional company which started with a 'preparation phase' before the establishment by grounding on the lean thinking. Collaboration, organization and infrastructure are stated in virtual teams which lies upon a "team understanding".

The 'Lean' and the 'Lean Startup' Concepts

Startups do not unfold in accordance with master plans. They are not smaller versions of large companies, instead, they are the ones that ultimately succeed, go quickly from failure to failure while adapting, iterating on, and improving their initial ideas as they continually learn from customers (Blank, 2013). Eric Ries, in his popular book *The Lean Start-Up*, explained 'the lean startup' term as a method for developing businesses and products. A lean startup is "a temporary organization designed to search for a repeatable and scalable business model" (Blank, 2013, p. 5). The lean method has three key principles: (1) instead of writing an intricate business plan, founders summarize their hypotheses in a framework called a business model; (2) lean startups ask potential users, purchasers, and partners for feedback on all elements of the business model, including product features, pricing, distribution channels, and affordable customer acquisition. They test to redesign offerings and make further small adjustments (iterations) or more substantive ones (pivots) to ideas that aren't working; (3) lean startups practice agile development, which eliminates wasted time and resources by developing the product iteratively and incrementally. It is, on the basis, a process by which startups create the minimum viable products (MVPs) they test (Blank, 2013). Basicly, a 'lean enterprise' will sustain with growth by aligning customer and employee satisfaction. The Lean Enterprise concept offers innovative and profitable products and/or services while minimizing unnecessary over-costs to customers, suppliers and environment.

In Figure 3, startup development phases can be seen. For the establishment of the project company, founder team should follow these phases. First phase, ideation refers to the entrepreneurial ambition and/or potential scalable product or service idea for a big enough target market. In other words, initial business idea on why and how it would create value is the ideation. As can be seen, 'the before foundation' process start with problem-solution fit and it should be certain and determined. Mission, vision and strategy will be shaped with co-founder team (or one person) that has been formed in this phase. Questions such as "what product(s)/service(s) will be produced? To whom? Why and how will it be produced?" are essential to be answered for this process. Also, vision-founders fit is important for the process to continue well. Second phase is the concepting which refers to define mission and vision with initial strategy and key milestones. Two or three entrepreneurial core co-founders with complementary skills and balanced ownership plan are needed. Third phase is commitment. Committed and balanced co-founding team with shared vision and attitude is the key factor in this step. They should be able to develop the product (minimum viable product-MVP) or service without dependency of uncommitted

Figure 3. Startup development phases
Source: (Startup Development Phases, 2017)



external resources or already have initial product or service in place. After commitment, validation comes as the forth phase. In this phase, iterating and validating assumptions until validated solution to demonstrate initial user growth and/or revenue Key Performance Indicators (KPIs) are identified. KPIs include attracting additional investment-based resources (money or sweat equity) for equity, revenue share or future revenue though. Product-market fit is really important in this phase. Fifth phase is scaling. In this phase, focus on growth showing KPIs based measurable growth in user, customer revenue growth and/or market traction in a big or fast growing target market are the key factors. The sixth (the final) phase, is establishing which the business model-market fit is important for the process. In this phase, the company achieves great growth that can be expected to continue. It easily attracts financial and human resources. Depending on vision, mission and commitment, it is expected that company will continue to grow. It often tries to continue 'like a startup'. Founders and/or investors make exit(s) or continue with the company in this phase (StartupCommons, 2015, online).

There are some differences between lean and traditional organizations (see Table 1). In the lean start-up organization establishment, the process begins with the search for a business model rather than execution a business model. As stated above, it is hypothesis-driven, not implementation driven. The new product process is not a typical step-by-step product management plan. It is a customer development process which includes testing hypotheses. It requires deep researching and testing practices because of the need of problem-solution fit. It requires agile development which means building up the product iteratively and incrementally. The organization members should be hired for their learning capacity, nimbleness, and speed rather than their experience and ability to execute. For the reporting system, metrics are important. In this manner, accounting-style reports should not be adopted. When facing a failure, expected actions will be fixing the failure by iterating on ideas and pivoting away from ones that don't work, rather than fixing the failure by firing executives. In data management, lean start-ups operate on good-enough data, not complete data which is essential for the speed when doing business.

METHODOLOGY

Research Background

Widely used online social networks (e.g. Facebook) can be called as mainstream social networking sites (SNSs). These platforms allow people to create a personal profile (Boyd & Ellison, 2007). A research

Table 1. The differences between lean and traditional organizations

	Lean	Traditional
Strategy	"Business Model" Hypothesis-driven	"Business Plan" Implementation-driven
New-Product Process	"Customer Development" Get out of the office and test hypotheses.	"Product Management" Prepare offering for market following a linear, step-by-step plan.
Engineering	"Agile Development" Build the product iteratively and incrementally.	"Agile or Waterfall Development" Build the product iteratively, or fully specify the product before building it.
Organization	"Customer and Agile Development Teams" Hire for learning, nimbleness, and speed.	"Departments by Function" Hire for experience and ability to execute.
Financial Reporting	"Metrics That Matter" Customer acquisition cost, lifetime customer value, churn, viralness.	"Accounting" Income statement, balance sheet, cash flow statement.
Failure	"Expected" Fix by iterating on ideas and pivoting away from ones that don't work.	"Exception" Fix by firing executives.
Speed	"Rapid" Operates on good-enough data.	"Measured" Operates on complete data.

Source: (Blank, 2013).

indicates that there are 3.42 billion internet users and 2.31 online social network users. According to the recent data, internet usage has been increased as %10 (332 million users) and social networking usage has been increased as same percent (%10 which is about 219 million users). Mobile usage for online social networking is about 1.97 billion users, which correspond to %27 (Kemp, 2016). In this manner, it can be said that about 46% of internet users are using online SNSs and connecting to other users via these platforms. Mobile devices allow internet and social media usage to be easier and faster then ever, thus, people are increasingly use these platforms almost every hour in a day by being on-line all day. Individuals and organizations which are doing business via internet can have many advantages such as gathering information, staying connected and doing business easier.

Platforms such as Facebook, Twitter, LinkedIn, Pinterest, Google+, YouTube, Tumblr, Instagram are mainstream social media platforms which are used widely. Besides these sites, there are vertical/niche SNSs which are used by a group of people. These SNSs aim that group of people for the specialization that they have. They are some kind of specialized online SNSs which serve basic features plus some other special features (see some examples of this platforms at Table 2).

It is possible to predict that vertical SNSs will increase by number in the near future. In this manner, entrepreneurs who work/want to work in the digital-sphere are aware of this opportunity and this kind of online clusters, especially for the groups which share same interests and have common background, special knowledge etc.

Purpose of the Study

Purpose of this study is to explain BuyerNetwork.net as a vertical online SNS which provides a platform for procurement and supply chain professionals and other participants by mentioning lean and digitalized

Table 2. Some examples of vertical social network sites

Vertical Social Networking Sites	Target Group	Explanation	Year of Establishment
Petsbook.com	Pet owners	This SNS is an online platform where pet owners can create a profile for their pets and connect to other pet owners.	2015
BuyerNetwork.net	Supply chain and procurement professionals and other participants such as academics	This Turkey based SNS is a platform which supply chain and procurement professionals and other participants such as academics can create a profile, connect each other, and share their professional knowledge.	2014
Gromsocial.com	Children	This SNS is an online platform where children can use only by having an allowence document of their parents.	2011
Doximity.com	Medical doctors	This USA based SNS is a platform which doctors can create a profile and connect each other.	2011
Edmodo.com	Teachers, Students and Parents	This SNS fill the gap between teachers, students and parents by providing a platform for school and home learning.	2008
Github.com	Software developers	This platform is used by software developers for exchange information about their professionalism.	2008
Rocketlawyer.com	Lawyers	This SNS is an online platform where lawyers come together and share their knowledge in online-sphere.	2008
Researchgate.net	Scientists	This platform is used by scientists for scientific research such as articles by providing membership and a personal profile.	2008
Spiceworks.com	IT professionals	This SNS is a platform where IT professionals come together and share their knowledge in online-sphere.	2006
Patientslikeme.com	Patients	This SNS provides a online networking platform for patients to exchange information about their illness.	2004

establishing processes. In this regard, it is aimed to contribute to the field by making it clear how can lean startup method be put into practice in digital startup companies.

Research Questions

In accordance of the purpose of this study, some research questions are mentioned below:

- What is BuyerNetwork.net and for what purposes and by whom it has been established?
- How has the establishment plan been made? How did the project idea come forward?
- How has lean entrepreneurship methodology been used for this project?
- Accepting BuyerNetwork.net as an examplary company, what are the advantages and disadvantages of lean entrepreneurship methodology for vertical social network sites?

Case study research method has been used for this study. This method is "an empirical inquiry about a contemporary phenomenon (e.g., a "case"), set within its real-world context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2014:43). It gives the researcher(s) the opportunity to harness in-depth knowledge and to examine the subject deeply. Yin (2014) mentions three different case study types for different usage purposes: exploratory, explanatory and descriptive case studies. While "exploratory designs seek to define research questions of a subsequent study or to

determine the feasibility of research procedures; explanatory designs seek to establish cause-and-effect relationships. Descriptive designs attempt to present a complete description of a phenomenon within its context" (Hancock & Algozzine, 2006:33). This study bases on descriptive case study method.

Research Design

All public and business-special documents and informations have been gathered directly from Buyer-Network.net establishment documents since it has been established by two of the authors of this study. Thus, all the information about the processes, decisions, strategies and how the entrepreneurship thought represent the lean method have been collected from primary resources. For the case study research, in regard to the questions have been mentioned above, analysis type(s), method(s) and source(s) can be seen at the Table 3.

Participant Observation, Interview Review and Document Review techniques are widely in use when doing a case study research. These useful techniques provide the researcher(s) to participate in the process of the research by direct observations. In this manner, findings of this study are build upon the data results of these techniques.

Findings

BuyerNetwork.net is a procurement professional-oriented online vertical social network site (also supply chain managers can be members of this platform) which has been established by two scholars at Istanbul University Teknokent (Turkey) for innovative university practices. It provides an online platform for;

- Procurement and supply chain managers to connect for professional communications with peers.
- Connections between professionals.
- Procurement and supply chain professionals to create a synergy by gathering them together and give them the opportunity to share their knowledge.
- Possible employees and procurement and supply chain professionals to find a job/offer a job.

Table 3. Research design plan

Questions	Source(s)	Method(s)	Analysis Type
What is BuyerNetwork.net and for what purposes and by whom it has been established?	Founders and Company Documents	Participant Observation Interview Document Review	Content Analysis
How has the establishment plan been made? How did the project idea come forward?	Founders and Company Documents	Participant Observation Interview Document Review	Content Analysis
How has lean entrepreneurship methodology been used for this project?	Founders and Company Documents	Participant Observation Interview Document Review	Content Analysis
Accepting BuyerNetwork.net as an example company, what are the advantages and disadvantages of lean entrepreneurship methodology for vertical social network sites?	Founders and Company Documents	Participant Observation Interview Document Review	Content Analysis

- Procurement and supply chain professionals to get education with/without simulations about career specific knowledge.
- Procurement and supply chain professionals to determine problems of supply chain and procurement practices via discussion topics/forums and question-answer module.
- Procurement and supply chain professionals to harness knowledge about supply chain productions and services.
- Procurement and supply chain professionals to monitor sectoral informations easily

Ideation, Concepting, and Commitment: The Emergence of the Project Idea and Project Planning

Supply Chain Management and similar courses have been integrated in "Business Administration" field of study in the universities recently. But there is a lack of knowledge in theoretical and practical bases. As the nature of this field, procurement and supply chain professionals mostly get knowledge and specialization from sectoral practices. Additionally, the job itself forces one to get specialization and knowledge in some sub-fields such as construction supply chain management, mining supply chain management, hospitality supply chain management. Thus, these kind of specialization and knowledge are very important for those who want to have/has a career in this field, especially in the ever-changing global competition area.

In this manner, there has been an emergence to create a platform for procurement and supply chain managers to connect each other and, share and harness knowledge. Some qualitative researchs (in-depth interviews and focus group discussions) have been conducted with the professionals. By doing so, it has been aimed to understand their needs and wants. Firstly, "Does vertical social network sites motivate users to be a member?" question has been asked and responses have been gathered. Other questions are stated below:

- Who are the target users/stakeholders? Which web sites, social networking sites, blogs and forums they follow? How and how often do they use these platforms?
- What are the needs of target users? And how much of it have been met?
- Which contents are "trend topics" on the internet about this field? And how much of it have been met for target users?
- Which factors stand out for target users to choose specific social networking sites?

As can be seen on Table 4, there are some examples of participant comments for the ideation process which categorized with the functions of the SNS. They are expressed as networking, personal development, career development, sharing information and knowledge, training (conference and seminars), taking special opportunities offered by professionals and socializing. Participants have used more or less similar comments that haven't fully cited in this study. With these comments, some features occurred which can be seen below in a matrix.

Table 5 briefly states the features of social networking sites by comparing mainstream SNSs and BuyerNetwork.net. Since it is a vertical SNS, it allows users to read job-related publishments such as non-academic e-journals (e.g. 'Satınalma Dergisi' ['Purchasing Magazine']). In addition to above mentioned features, some additional features added in accordance with the findings of the research results. For example, there is Satınalma Uzmanları (i.e. Purchasing Professionals) Group[2] on LinkedIn but it

Table 4. Some examples of participant comments for the ideation process

Participant No	Function of SNS	Participant Comments for the Ideation Process
1	Networking	"Members can connect to each other, being in-touch, communicate online, can reach all the new sectoral updates and can share their experiences about their work."
2	Personal Development	"Members can enhance their personal development by reaching experts, and getting information about a subject that they do not fully have information about but need for it."
3	Career Development	"Members can reach information about the companies that they want to work for, can get in-touch with the people who already work for that companies and in doing so, they can have the opportunity to make their presence known."
4	Sharing Information and Knowledge	"Website can have a databank that can support members to develop their careers. The members can share their presentations, work-related experiences and projects that do not violate the rights of privacy of the companies."
5	Training (Conference and Seminars)	"Member-specific training programs, conferences and seminars can be organized. This can increase members' knowledge on some topics and also it can strengthen the communications and networking among members."
6	Taking Special Opportunities Offered By Professionals	"Website can allow members to take special opportunities offered by procurement and supply chain professionals."[1]
7	Socializing	"Since it is defined as a social networking website, the members can socialize; can share photos, videos or other contents to socialize. LinkedIn have this function. So this platform can provide this too."

is lack of job-related communication tools and, despite 5057 members in the group, there isn't effective discussion environment. This is mostly because the platform should follow LinkedIn's community management approach. BuyerNetwork.net fill this gap with its job-related events such as discussion groups and face-to-face events.

After the main research studies and their results have been finalized by the founders, other researches have been conducted to;

- Identify of the need for software development,
- Identify of the need for qualified human resources,
- Account of the project cost for establishing the social networking site,
- Identify of the project calendar.

Other then the founders of the company which are both project coordinators, there are 4 people who are working for the company; 2 of them are software development experts, one of them is business development expert and one is a graphic designer. They provide necessary software developments working as a virtual team by collaborating.

Validation, Scaling and Establishing: The Implementation of Lean Startup Methodology on BuyerNetwork.net

Eliminating the waste operations is in the core of lean thinking and it has widely been popularized with Toyota's operations in this field since 1970s. First, it has been used by industrial operations, then, service and many other types of operations. Agile and lean software developments have been implied by lean

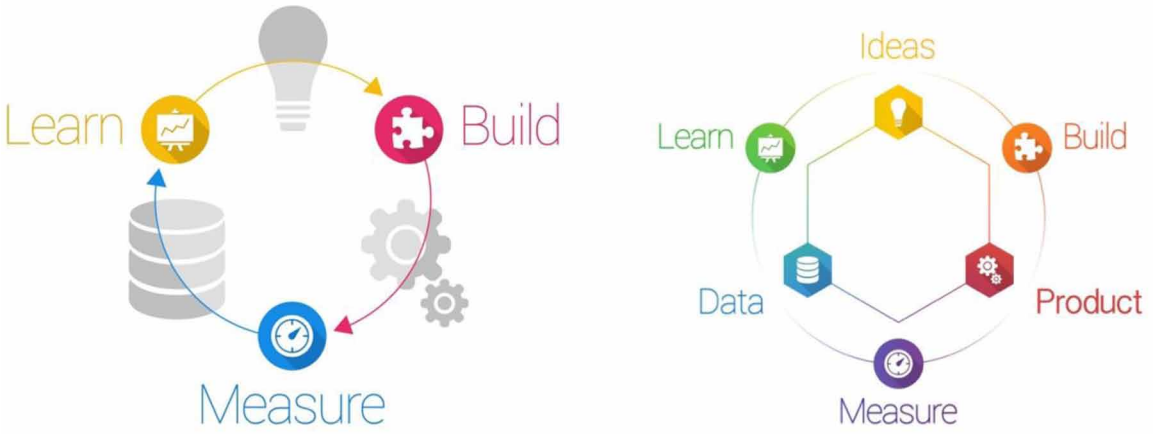
Table 5. Matrix of product features

Features of Social Network Sites	BuyerNetwork	Facebook	Linkedin	Twitter
Connecting Other People	✓	✓	✓	✓
Sharing Instant Updates	✓	✓	✓	✓
Creating a Profile	✓	✓	✓	✓
Sharing Videos, Photographs and Links	✓	✓	✓	✓
Creating Surveys	✓	✓	✓	
Creating/Replying Discussion Sections	✓			
Creating a Resume	✓	✓	✓	
Creating Groups for Field of Interests	✓	✓	✓	
Creating a Corporate Page		✓	✓	
Creating a Corporate Profile	✓	✓	✓	✓
Sending Private Massages	✓	✓	✓	✓
Free Usage for All Services	✓			✓
Publishing Job Postings	✓		✓	
Being International	On the Agenda	✓	✓	✓
Containing Job-Related Games	✓	✓		
Containing Job-Related Publisments (e. g. E-Journals)	✓			
Sharing Files	✓	✓	✓	
Commenting on Contents	✓	✓	✓	✓
Writing Blog Posts	✓		✓	
Mobile App	✓	✓	✓	✓
Design for Mobile Devices	✓	✓	✓	✓
Simultaneous Chatting	✓	✓		
Search Option	✓	✓	✓	✓
Editorship of Academical Experts	✓			

thinking method in the software development practices since they can be adaptable with the changing conditions.

Lean Thinking has been integrated to startup literature with the popular book of Eric Ries. In the *Lean Startup* (2011) book, he explains the lean entrepreneurship method. While reducing all the unnecessary processes through product and/or service development, the aim is to spend all the sources and time only for the development process. Ries (2011) offers a methodology that explains how to practice lean thinking in startup companies. He mentions that new ventures should focus on product and/or service development and offer "minimum viable products" (MVPs = lean products that can be produced for customers' need and wants at the base level) at the first stage. Ries also explains that while some researches have been conducted to understand what customers need and want, it is clear that they don't exactly express their deep thoughts and needs. Thus, he predicts a feedback circle about MVPs that put on market while gauging and developing the success of this products and/or services (see Figure 4a and 4b).

Figure 4. a & b. Build – Measure – Learn (BML)9 Feedback Loop
Source: Ries, 2011 p. 111.



Ries (2011) emphasize the concept of "validated learning" by mentioning the importance and value of learning process for startup companies. According to him, product and/or service development failures can be a way of experiencing and adopting it to the new processes. In this regard, failures can be prevented. These understanding grounds on BML Loop.

When establishing BuyerNetwork.net, this concept has been adopted. First, product features have been determined by examining user needs and wants deeply by in-depth interviews and focus groups with the target user groups. In the technical analysis, a pilot copy of the networking site has been established and asked for target customers (users) to use it with open access on BuyerNetwork.net website. Harnessing instant and continuous feedback and analysing these feedbacks are very important for lean entrepreneurship method. Thus, it has been adopted for the BuyerNetwork.net case.

Rapid-launching system in the lean thinking is essential for the establishment process. Almost %25 of the websites in the internet provide their online infrastructure from Wordpress content management system which is a market leader and dominate the content management market by having %60 of it (Gelbmann, 2015). Its infrastructure has provided the necessary add-ons and other technical background for the short-term purposes of BuyerNetwork.net. In this regard, after the software technology research, Wordpress content management system has been chosen for compensating the short-term needs.

This system has been planned by the project team according to the feedbacks of the users while covering all the purposes of the establishment authentically. Firstly, continuous developments and improvements have been made. Then, the stabilization of the software has been done by the project team to make infrastructure and databases to operate problem-free on the server-side.

The first version of the networking site (MVP version) brought into use on the Wordpress system and, in a short time, over 1000 users became a member of the website. Meanwhile, many features have been tested and confirmed for further usage. At this stage, the language was Turkish to prevent the foreign language problems for users. Then, browser adaptability has been worked through since it is a very important factor for web applications. In this regard, reliable datas have been gathered for the possible future big-scale researches/projects. Updates have been made for the project and business plan according to the experiences that has been gained through this project. For example, database platform has been changed to provide active users a better service and maximize their benefits while using this platform.

BML circle has been adopted in the process of the product as a MVP. Real experiences of the users have been gathered through this circle method and it has provided to improve the service continuously (see Figure 5).

Figure 5 summarizes BML feedback loop for BuyerNetwork.net. User statistics, users' real wants and needs have been considered for usage specific developments. Backend and frontend software problems, user experience/user interface (UX/UI) problems have been solved within the system. The current version of BuyerNetwork.net is authentic by its very nature. Lean thinking, harnessing validated learning method by learning from user experiences of MVPs and focusing on product and/or service development have given the opportunity to gather target users' real needs and wants. In this regard, project has been developed and succeeded.

Advantages and Disadvantages of Lean Startup Methodology on Vertical Social Networks

It is essential to mention the advantages and disadvantages of lean startup methodology on vertical social networks. In this study, they are emphasized on BuyerNetwork.net as an examplary company. The most important advantage of lean startup methodology is that it gives a roadmap to 'focus on value' and 'eliminate other practices which do not create value'. In this regard, it is important to determine that which activity creates a value and which does not. In the industrial sectors, these activities are mostly clear to determine; but in a startup company it is mostly not. Customers decide which activities are valuable. Thus, to focus on value, Build-Measure-Learn should be adopted to determine the valuable activities and customer feedbacks should be learned by validated learning method for the product and/or service

Figure 5. Build-Measure-Learn (BML) Feedback Loop for BuyerNetwork.net
Source:(© Eric Ries, THE LEAN STARTUP (2011). Reprinted by permission of the author.)

development processes. If there is a decision failure of which is valuable and which is not, that would be a disadvantage of the company. So, the decision must be properly made.

In the BuyerNetwork.net case, this method has provided a supportive role for entering to market fast and gaining competitive advantage among potential rivals. Thus, the company has focused on value created for the customers, which are procurement and supply chain professionals in this case. It provides a platform which they can share knowledge, get sectoral informations, connect to peers etc. Most of its tools are free to use, but there are some company specific solutions. Since the company establishment process has been based upon lean thinking, practices that do not create value have been eliminated. For this process, customer development is an important concept. It has been accepted as one of the basic elements of the establishment process to get rid of any decision failure.

CONCLUSION

This study examines BuyerNetwork.net through a case study method by explaining establishment process from start to finish with the lean startup methodology. Digital entrepreneurship is also mentioned since the networking site is a digital platform (above mentioned complete/extreme digital entrepreneurship) and the company runs on that platform. It provides related theoretical background by linking them on digitalization and lean thinking.

In this study, "BuyerNetwork.net", which has been established on a digital platform, has been examined with lean startup methodology. The research part has provided the answers to "why" and "how" questions about the overall process for lean startup establishment on a digital platform. In regard to the results, it has been deduced that lean startup methodology can be practiced and brought to a successful outcome for vertical social network establishment processes. In addition, it has been seen on BuyerNetwork.net that with qualitative researches, customers' needs and wants can be determined deeply before offering MVP(s) to the market and the research results (mostly customer feedbacks) can be used for MVP producing processes.

In the lean thinking, "focusing on value" and "eliminating non-valuable practices / activities / products / services" are been overemphasized; differently, customers are the core factors since they determine what is valuable and what is not. In this manner, MVPs should be confirmed by real experiments to determine real wants and needs of the customers. In the BuyerNetwork.net case study, it has been seen that this process is really important and should be well-evaluated and practiced for entrepreneurs who want to adopt lean startup methodology in their business plan. BuyerNetwork.net case provides a guidance for a lean startup methodology for a business which do business on a digital platform. These kind of platforms are on the rise. Since digitalization is an important concept of todays, more and more startup companies -some of them are unicorns such as Uber, AirBnB etc-. are doing business in the digital-sphere.

This study stresses the importance of getting customer feedback by using BML loop. It points the importance of form an MVP to see whether it meets the customer needs and wants. The aforementioned case show that digital products/services are different from physical ones. Since they need software experts (some kind of skilled human resources) to be developed, they should be tested and retested again and again. Moreover, they can contain many features that customers seek to use for their needs and wants.

In conclusion, this study gives an opportunity to show the establishment process of a digital-born company by emphasizing the importance of developing successful business plan, adopting lean thinking

and providing new products and/or services in the online-sphere. Since the Single Case Study method has been adopted, more than one case studies might provide a broader perspective, comparison and generalization. For different sectors and businesses, same methodology can be adopted by scanning practices and processes in enhanced research studies.

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KEY TERMS AND DEFINITIONS

Case Study: A qualitative research method about a contemporary phenomenon which is set within its real-world context when the boundaries between phenomenon and context are not clearly evident.

Digital Entrepreneurship: Entrepreneurship activities which are associated with some degree of digital goods or services, or with other forms of digital activity.

Lean Start-Up: A temporary organization which is designed to search for a repeatable and scalable business model while minimizing unnecessary over-costs to customers, suppliers and environment.

Minimum Viable Product: Lean products that can be produced for customers' need and wants at the base level.

Start-Up Company: A temporary organization which is designed to search for a product/market fit and a business model.

Vertical Social Network: Some kind of specialized online SNSs which serve basic features plus some other special features for some target group of people.

ENDNOTES

[1] Some free training programs have been organized. One of them is "Decision Making for Procurement Professionals" which has been held at Istanbul University Conference Hall (Date: May 4th, 2016).

[2] See the link: https://www.linkedin.com/groups/4320974/profile

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Chapter 55
Digital Marketing Strategy for Affinity Marketing:
Utilising the New Marketing Arena

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ABSTRACT

Integration of digital marketing into overall business strategy is no longer an option, it is imperative for success. Yet, not all have tapped into this. Another opportunity that could leverage an organisation in today's competitive environment is affinity marketing. Successful implementation of affinity marketing has the potential to enhance participation, raise revenue, increase retention and provide a mutually beneficial arrangement for the partners involved. Yet, despite its appeal and the popularity it achieved in the late 1980s and early 1990s, uptake of the scheme has slowed down. Whilst some affinity partners have embraced digital marketing to an extent, most are not using it effectively to drive and sustain their affinity marketing scheme. Cognisant that affinity marketing is still a lucrative area, this chapter sets forth a digital marketing strategy for affinity marketing, e-affinity marketing, as this is where the added value for the 21st century customer is envisioned.

INTRODUCTION

Businesses in the 21st century are hugely reliant on the internet to support the growth of their organisations. Whether one should integrate internet technology as part of their business plan is no longer questionable, but rather a matter of how it may be most effectively deployed (Michael Porter, 2001). The growth of and investment in digital marketing is astounding. For instance, an industry survey conducted by Pricewater house and Cooper (PwC) and sponsored by the Interactive Advertising Bureau (IAB) has shown that in US alone the revenue generated for half-year 2014 totalled $23.billion, 15% higher than the previous year (IAB, 2014). Coupled with the digital era, affinity marketing presents a unique opportunity for organisations to strengthen their competitiveness as well as build on their customer's loyalty. The internet presents the ultimate interactive and integrative communications system (Schultz, 1996).

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Given that affinity marketing (i.e. the triadic relationship between the affinity group, the customer and the service provider) is said to be built on the affinity that customers already have with their affinity group, integrating and implementing digital marketing effectively has the potential to further enhance the customer-affinity group as well as the customer-service provider relationship.

Given the minimal integration of digital marketing in driving affinity marketing, the challenge is to determine the extent to which marketers are using it and to propose ways of enhancing usage. As noted above, unlike most media the internet is interactive and provides marketers with a wide variety of potential uses that range from marketing research to advertising and selling. One of the most significant contributions of the internet is that of value-added marketing – adding value to visitors' experience by allowing marketers to give them additional information as well as services. "The concept of value-added marketing creates loyalty to one or more homepage sites and consequently to the homepage sponsor. Such loyalty is the corner-stone of building lasting relationships with customers" (Husted & Whitehouse, Jr., 2002, p.4).

In the face of today's rapidly changing environment, with the advent of a technology revolution and associated trends such as social media, customers' needs and demands (and even decision making processes) are changing. Recent studies have elicited that companies which master the process of digital integration are 2.5 times more likely to convert their customers (Bughin, 2013). Unfortunately, affinity marketers have not risen to the challenge. The investigation by the author has shown that most affinity marketing schemes are not adequately visible on the internet, therefore failing to capitalise on the opportunity that the digital platform presents.

This chapter intends to provide a strategy that enables affinity partners to integrate their business plan with digital marketing as a key component to drive success. The rest of the chapter is organised under three main areas: the new marketing arena; affinity marketing and digital marketing; and strategic integration. The new marketing arena gives an overview of the 'technology behind digital marketing', looking at the impact of technology and the internet. It also introduces such concepts as e-business, e-commerce and e-marketing with a view to clarifying terminologies, as well as to help put digital marketing into context. The first section will also outline some of the popular 'digital marketing strategies' adopted by marketers to date. Part two on affinity marketing and digital marketing reviews the origins and core values of affinity marketing under the section 'affinity marketing – the big opportunity', highlighting some of the challenges faced by affinity marketers. It then explores how this could be utilised to formulate objectives for e-affinity marketing. Part three – 'strategic integration' – begins with an investigation into 'affinity marketing on the web', a key step in planning the process for e-affinity marketing strategy. This is followed by a discussion on 'knowing the customers', as understanding visitors' needs is an important step in determining what they are offered. Then the 'strategy to activity' proposes steps to help set appropriate strategy and related activities based on knowledge of the target group. The last step in the process – 'performance analysis' – is designed to review the effectiveness of the new initiatives.

1. THE NEW MARKETING ARENA

Aghaei et al. (2012) describes the four generations of the web as follows: Web 1.0 as a web of information connections, Web 2.0 as a web of people connections, Web 3.0 as a web of knowledge connections and Web 4.0 as a web of intelligence connections (the future). The internet has grown from strength to strength since its innovation phase 1964 - 1974 (creation of the fundamental building blocks), through

the institutionalisation phase 1975 - 1995 (when large intuitions were provided funding and legitimisation), up to today's commercialisation phase 1995 – present (private corporations take over, expand the backbone of the internet and local services) (Laudon & Travis, 2013). By the end of 2014, the number of internet users in the world is predicted to reach almost 3 billion, with two-thirds of them coming from the developing world (ICT Publication, 2014). Today, the web provides a tremendous opportunity to reach customers directly. A recent survey of digital marketing spending indicated that up to 2.5% of a company's revenue is used in this area (Gartner, 2013). This report suggests that the three top digital activities key to marketing success are the operation of a corporate website, social marketing and digital advertising. Social media is undoubtedly gaining in prominence, with over 72% of internet users now active on social media. The likes of Facebook and Google+ now have over 1 billion users and the potential to attract more (Laudon & Travis, 2013).

Advances in technology and the evolution of marketing are inseparable. The printing press, radio, television and now the internet are all examples of major breakthroughs in technology that also advanced the field of marketing. Technology has the ability to open up new markets and to radically change existing ones. The rapidness of changes in technology makes it necessary to continuously study consumer behaviour. As soon as one thinks that they may have a grasp on what their archetypal consumer wants, those wants will have changed. In the developed world, the digital revolution is changing the way we choose and buy our products and services. People are now going online on a daily basis to fulfil needs such as banking, shopping, recreation and communication.

Some marketing principles never change. Companies must meet the needs of their customers, the need now is digital integration, which is further fuelled by digitally enabled social networking (more commonly known as social media).

The Technology Behind Digital Marketing

The terms internet marketing, e-marketing and digital marketing are often used interchangeably. However, e-marketing is sometimes considered to have a broader scope than internet marketing since it refers to digital media such as web, e-mail and wireless media, but also includes management of digital customer data and electronic customer relationship management systems (E-CRM systems). The term 'digital marketing' was first used in the 1990s and was then described as 'the marketing of products or services using digital channels to reach consumers (Dorie 2012). The key objective is to promote brands through various forms of digital media. To help clarify these alternative terminologies and definitions, in collaboration with the Institute of Digital Marketing, Chaffey (2005) proposed an all-encompassing explanation of digital marketing, describing it as an activity that involves the application of technologies which form online channels to market; that's web, e-mail, databases, plus mobile/wireless and digital TV.

The internet began in the late 1950s in the military and was gradually advanced by computer scientists. The digital revolution, also called the third industrial revolution, is the change from analogue, mechanical, and electronic technology to digital technology (Ryan & Jones, 2012). The digital age as we know it now began with the internet and the Web 1.0 platforms of the early 1990s. This was a rather static world in which users could get the information they desired but it could not be shared on the web. There was no such thing as interaction, as the only activity was reading of content. In 1993, we saw the entrance of the first clickable banner ad and by the next year online magazine Hotwired had begun to purchase huge numbers of banner ads. This was the first step towards shifting the market into a new digital age.

Web 1.0 then slowly progressed into Web 2.0. This is not a new version of Web 1.0; it is about enhancing how people use technology. People were no longer passively taking in information, but instead the internet became a sort of super-highway where users could directly interact with both other users and businesses, the collaborative potential enabling users to share, interact and communicate via rich media content such as Facebook, Instagram, YouTube, FaceTime, Skype and many more. In the early 2000s, supported by the capabilities of broadband and fibre optics, numerous networks and social platforms were developed. This finally enabled Web 2.0 to become truly social. Social media has now become a thriving entity.

In the 2000s and the 2010s, as digital marketing continued to get more sophisticated, it became recognised as an effective technology to enable and foster a relationship with more concisely targeted consumers. With this came the need to formulate a strategy specifically tailored to meet the demands of the internet audience. Digital marketing has changed drastically since its conception in the early 1990s and will continue to change.

Which Digital Marketing Strategy?

Although the term 'strategy' has been used in many different contexts, they are all synonymous in being described as the means to achieve a goal. One simple definition is that it is "a plan of action designed to achieve a long-term or overall aim" (Strauss & Frost, 2014, p. 72). In comparison to traditional strategy, e-business strategy is described as "the deployment of enterprise resources to capitalise on technologies for reaching specified objectives that ultimately improve performance and create sustainable competitive advantage" (Strauss & Frost, 2014). This is inclusive of information technology components such as the internet, digital data, databases, etc.

There are several tools that have been developed or adapted by marketers in their effort to integrate digital marketing strategy into their overall business strategy. Chaffey and Chadwick's generic digital marketing strategy development process (2006, 2012); Chaffey and Smith's 'SOSTAC© Planning Framework for e-Marketing' (2012); and Strauss and Frost's 'E-Marketing Plan' (2014) being amongst such theories. The foundation of these strategies is traditional marketing with common elements, such as; assessing the marketplace; defining objectives; selecting a strategic approach; implementing actions or activities; measuring results or performance (being comparable).

When considering the formulation of a strategic plan suitable for e-affinity marketing, first and foremost one has to examine the unique features inherent to affinity marketing. The review of generic and specific digital marketing strategies, as well as current best practice, can also aid the building of an e-affinity marketing strategy as it will undoubtedly unveil some of the most essential elements required in order to develop a robust digital marketing strategy. Therefore, highlights from some of the notable literature mentioned in the subject area are discussed below.

In a comprehensive study on internet marketing, Chaffey and Chadwick (2006) suggest that the internet marketing strategy should follow a similar form to the traditional strategic marketing planning process and should include: goal setting, situation review, strategy formulation and resource allocation and monitoring. The authors highlight that this plan should also take into consideration external and internal factors that could affect the organisation. In their discussion of digital marketing, the authors further outline three key steps that need to be followed: defining the online opportunity, selecting the strategic approach and delivering results online.

A similar concept was proposed in in the late 1990s by PR Smith, who developed a marketing planning system represented by SOSTAC©, which stands for situation, objectives, strategy, tactics, actions and control. This model was voted as the third most popular marketing model by the Chartered Institute of Marketing (CIM). This could be attributed to its simple, all-encompassing features. At a later date, in 2008, Chaffey and Smith proposed an overall strategy process model for strategic internet marketing - the SOSTAC© planning framework for digital marketing strategy development, which incorporated unique features and capabilities of the internet.

The environment, strategy and performance (ESP) model created by Strauss and Frost (2014) is an alternative approach to e-marketing strategy, which builds on the idea that businesses need a well formulated process on which to determine the success of their strategy. ESP is supported by key marketing tools such as the SWOT (strength, weakness, opportunity and threat), and e-marketing mix to create a comprehensive strategy.

Deviating from the process or plan orientated approaches described above, Ryan and Jones (2012) identified five key components that generally form the foundation of a digital marketing strategy as follows; knowing your business; knowing your competition; knowing the customer; knowing what you want to achieve and knowing how you are going to do it. The authors argue that this process "forces you to sit down and analyse the market in which you are operating in with a critical eye, and to really think about the different components of your business and how digital marketing can help you to achieve your business goal" (Ryan & Jones, 2012, p.23).

Another recent work with an alternative focus is Scott's (2013) investigation of the use of social media, in which he discusses the importance of setting a clear goal when building a digital marketing and PR plan. Here, the author places emphasis on a buyer orientated focus in the context of the organisational goals. Scott suggests that organisations should learn as much as they can about their buyers and segment them into groups identified by 'buyers' persona'. This, he notes, should be the first and single most important step that an organisation needs to take in creating a digital marketing plan. Scott also explained other components that need to be included in the overall planning, such as tactics for the implementation and measurement of the marketing effort and success.

What is clear from the review is that the digital marketing strategy must support and be integrated with the overall business and marketing plans. The review has also shown that there is no single common approach to building a digital marketing strategy, nor should there be one. But, there are essential elements that every marketing strategy must have. This should include (but not be exclusive to); setting digital goals or objectives; analysing the situation; knowing one's customer; setting the strategy and tactics by which to execute it and having a control mechanism for evaluating performance. To the same effect, one must design a strategy or plan that is well structured and comprehensive in the context of the specified sector. With an informative overview of the key components required to build a digital marketing strategy, let us now turn to the context in which we want to develop it for – affinity marketing.

2. AFFINITY MARKETING AND DIGITAL MARKETING

Affinity marketing is widely recognised as a scheme that:

Involves customers who already have sympathy to one brand (be it commercial, not-for-profit or another membership organisation) being sold another service, by another organisation, with the endorsement of the affinity organisation and using its channels of communication. (Mintel, 2000)

Considering how affinity marketing fits within the broader field of services marketing, while most of the studies to date placed it within the context of relationship marketing, associations of the topic have also been made with cause-related marketing. The first time affinity marketing appeared in association with cause-related marketing was in Varadarajan and Menon's (1988) work on the concepts of cause-related marketing. In this work, the authors described affinity marketing as an extreme type of highly targeted cause-related marketing. Varadarajan and Menon (1988) defined cause-related marketing as:

The process of formulating and implementing marketing activities that are characterised by an offer from the firm to contribute a specified amount to a designated cause when customers engage in revenue-providing exchanges that satisfy organisational and individual objectives. (Varadarajan & Menon, 1988, p. 123)

Similarly, Macchiette and Roy (1992) suggested in their study of affinity marketing that the revenue generated by affinity could be seen as cause-related marketing. Soon after, in Schlegelmilch and Woodruffe's (1995) comparative analysis of the affinity card markets (the most popular affinity marketing scheme in the USA and the UK) it was suggested that affinity credit cards fit with cause-related marketing because a firm (the card issuing service provider) uses an association with a designated cause (for example a charity) to market its product or service. Another view that follows the same line of discussion is Worthington and Horne's (1992) proposal that affinity marketing is a sub-set of cause-related marketing, representing a step-change in the nature and intensity of the triadic relationship between the commercial and non-profit partners and consumers. Both cause-related marketing and affinity marketing are premised on the idea that linking specific products to a credible and respected cause or non-profit organisation (in return for a contribution to that cause or organisation) will make the product offering more attractive to consumers (Ross et al, 1992).

Currently, there is growing interest in the use of cause-related marketing as a corporate communication strategy in encouraging sales and as a tool for competitive differentiation (Bigné et al., 2012). Therefore, due to their similarity, equal interest could be expected for affinity marketing. Moreover, one should also note that the role of information communication technology in philanthropy is growing. There is a new culture of generosity, for instance in the UK, between 2007 and 2008 online donations almost doubled, rising from 4% to 7% of UK wide giving (Honoré, 2011). In light of the role of technology and the 'big opportunity' presented through affinity marketing, this section starts with an in-depth review of affinity marketing, highlighting the key principles underpinning its foundation. It then explores how this could be utilised to formulate 'objectives for e-affinity marketing'.

Affinity Marketing: The 'BIG' Opportunity

The first significant academic perspective of affinity marketing was offered by Macchiette and Roy (1992), who described it as a blending of affinity and existing marketing concepts. Affinity, they suggest, is "an individual level of cohesiveness, social bonding, identification and conformity to the norms and standards of a particular reference group" (p.48), while the marketing concept focuses on the "expectation of benefit for the individual, satisfying consumer wants and needs" (p.48). Therefore, the main component in

affinity marketing is the customer/affinity group relationship, upon which the affinity marketing scheme is leveraged. Affinity marketing is therefore based upon a strategic partnership between complementary brands, in which a mutually beneficial triadic relationship is formed between the group, the members of the group and the service provider of the product being used for marketing purposes.

There were several organisations linked to affinity marketing schemes. For example, work related organisations, charities, educational institutes and leisure clubs could all be linked to such a scheme. It is worth noting that different types of affinity groups are likely to exhibit differing types of relationships (Worthington, 2001; Laing et al., 2004). This is suggestive that each type of group is influenced by different sets of values that could potentially affect an individual's decision making process with regards to an affinity product. Popular industries that utilise affinity schemes include financial services (often related to the issuance of credit cards), insurance, communications, travel and tourism.

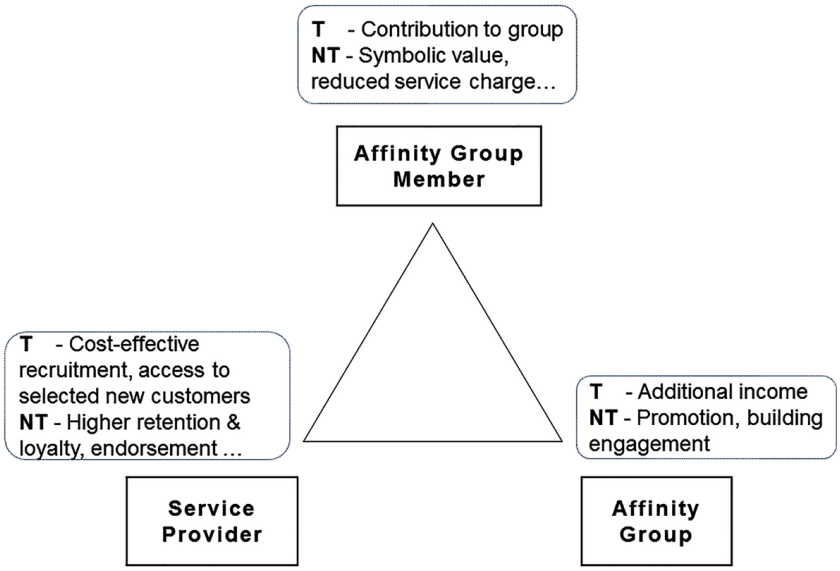
In examining affinity relationships and related schemes, one also needs to be aware that strength of these relationships may vary. Consequently the strength may influence customers' decision making processes and levels of engagement with the affinity group and associated partners, be it offline or online. In addition, the nature of the customer - service provider relationship needs to be taken in to consideration in order to get a full picture of the triadic relationship. This will enable us to gauge why and how the relationship developed, the extent to which the affinity group affects the relationship and how this could aid in the development of a digital strategy.

As previously noted, the affinity marketing partnership (described as a triadic relationship) is based on Macchiette and Roy's (1992) 'affinity interaction model'. The model depicts the triadic relationship formed between the consumer, the affinity group and the commercial organisation. Varied adaptations of the triadic relationship have since been proposed (Mekonnen, 2012, Worthington. 1997). In a triadic relationship it is assumed that a long-term ongoing relationship is formed. Moreover, it is believed that value is created to all partners involved in the triad, provided the relationships are managed well (Worthington, 2001). The triadic relationship provides tangible and non-tangible benefits to all the partners involved (i.e. the customer, the affinity group and the service provider). A summary of these benefits are illustrated in Figure 1.

Utilising the concept of affinity marketing, affinity credit cards provided the main focal point for affinity schemes, especially in the early days of the development and growth of affinity marketing. Consequently, most of the literature on the subject is based on affinity credit cards. Affinity cards were also the earliest adopted and have been perhaps one of the most successful affinity products. Therefore some of the examples in this chapter may draw on affinity credit cards to demonstrate key concepts in relation to digital marketing

Affinity credit cards are like conventional credit cards for the most part, except that they are affiliated to particular affinity groups and it is therefore presumed that they are taken out by people with common interests. Usually, an affinity credit card will display the logo of the particular affinity group, along with the name of the service provider and the card scheme mark (Visa or MasterCard). The key difference between the affinity credit card and the generic bank card is that when a member or supporter of the affinity group signs up for the card, a payment is made by the affinity credit card service provider to the affinity group. Most affinity credit card agreements include both an initial donation from the service provider to the affinity partner (ranging from £5 to £10 per card issued) and an ongoing turnover related payment (usually around 20p to 25p per £100 spent on the card). The USA is the leader of affinity marketing and can often serve as a useful indicator for the UK market. A recent report on credit cards conducted by the USA's Government of Accountability Office (GAO, 2014) indicated that the University

Figure 1. Triadic relationship and associated benefits: The case of affinity credit cards
Key: T- Tangible benefit NT- Non-tangible benefit



of California received about $1.5 million through its agreement with FIA card services, the largest payment to an institute of higher education in 2012. The University of Cambridge, whose alumni affinity credit card launched in 1993, had 10,000 card holders by 1999 and had generated over £250,000 for the university by that date (Mintel, 2000). Thus, there is undoubtedly a 'big opportunity' to raise funds and promote the standing of an organisation or a cause through affinity marketing.

Affinity Marketing Challenges

Looking at the affinity card industry in particular, despite sounding like the ideal partnership, the decline in the number of charity credit cards available is a sure sign that these partnerships have encountered some problems. Horne et al. (2000) have shown that there was a gap in how the affinity partners understood the benefits each gained (i.e. there was a knowledge gap between the customer, the affinity group and the service provider). Such a gap in knowledge could potentially lead to mismanagement of the scheme, particularly mismanagement of the customers and possibly even lead to the dissolution of the customer-service provider relationship (Mekonnen, 2012). Such problems could hamper the growth of the affinity marketing industry.

Mintel (2004) has reported that the number of affinity credit cards in issue, as a proportion of all credit cards, has fallen from a peak of 8.6% in 1998 to 3.4% in 2003. More recently, a market research report on affinity credit cards has indicated that payment card affinity schemes fell in number by over 25% between 2008 and 2010 (Finaccord, 2010). This report also notes that many credit card schemes have been discontinued either through lack of demand or lack of profitability. Supporting this, in a study relating to all types of credit cards in the UK, Euromonitor (2011) reported that the total number of personal credit cards that use affinity has fallen from 69,927.4 million in 2005 to 55,894.3 million in

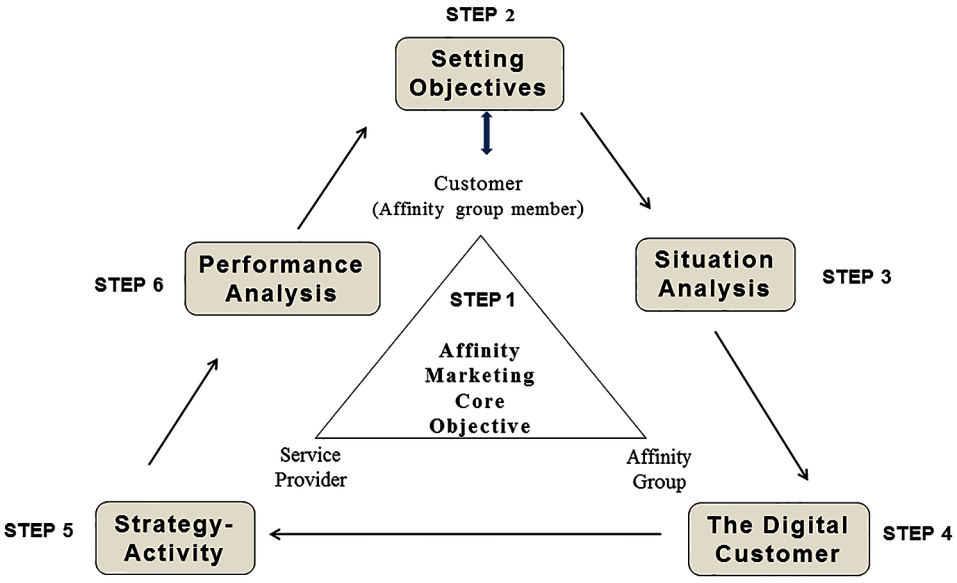
2010. However, the reason behind the fall was not explored. Furthermore, due to the difficulty in obtaining access to customers holding affinity products, there is a gap in understanding customers' attitudes towards this product and the nature of the relationship customers have with their affinity groups. More often than not, affinity partnerships end due to one member of the party failing to receive comparable benefits to the other (Bumell, 2013). A recent example of this can be seen in the demise of the Lloyds Banking Group's partnerships with charities such as Cancer Research UK, the NSPCC and the Scottish SPCA. In the case of Cancer Research UK, Lloyds ceased offering their charity credit card in 2012 after a 23-year partnership which raised a total of £14.5 million for the charity (Howard, 2012).

There is no known study to date that explains why the growth of affinity marketing schemes has stagnated, or any that have considered why there is limited integration of affinity marketing in the digital landscape. Yet the coupling of these two areas has huge potential in capturing a unique market. Having reviewed alternative digital strategies for business and the core concepts of affinity marketing, let's now turn to the setting of a plan for e-affinity marketing in the 21st Century.

3. STRATEGIC INTEGRATION

This strategic integration identifies the key steps required for planning a digital marketing strategy for affinity marketing. The 'E-Affinity Marketing Planning Process' presented in Figure 2 illustrates the step-by-step process for creating an e-affinity marketing plan. Each step is not necessarily conducted in isolation and there is likely to be an iterative process of back and forth to fine-tune essential elements that need to be reviewed within each step.

Figure 2. E-affinity marketing planning process



Setting E-Affinity Marketing Objective

One main area highlighted in relation to planning a digital marketing strategy is the need to clearly identify the goal or objective desired from the digital channel. It is important that organisations build on their overarching objectives in the advent of digital integration. Likewise, affinity marketing schemes should follow the same ethos, as it is an extension of the channel or means by which the organisation reaches customers. Therefore, to help create objectives for e-affinity marketing, the recommendation is to initially evaluate the core values related to the scheme and then consider how this can be enhanced or achieved via digital channels. Informed by knowledge of the core objective, the next step in the process is setting e-affinity marketing objectives (Step 2).

A review of digital marketing strategies to date indicates that most of the e-marketing planning tools proposed begin with an evaluation of the environment before commencing with the designated steps. However, given the nature of affinity relationships and the overarching aims and principles underpinning affinity marketing, this paper opted to diverge from this approach as it was felt necessary that the digital objectives for e-affinity marketing should be defined from the outset.

In the SOSTAC© model for digital planning, the objective is denoted by the statement "Where do we want to be?" It is further noted that the model can be used to identify what a business wants to achieve through online channels, as well as to question what the benefits might be (Chaffey & Smith, 2008). This model is encompassed by five broad benefits of, reasons for or objectives of e-marketing: 1) to grow sales 2) to add value 3) to get closer to customers 4) to save costs and 5) to extend the brand online. What is striking about these objectives is that most of it is already aligned with the principles and aims underpinning affinity marketing.

In digital marketing, there are a number of different objectives that can be set; for example, lead generation, acquisition, engagement or retention. In previous studies it has been proposed that an *explorer* could be converted to a *supporter* – thereby strengthening the customer-affinity group relationship as well as the customer-service provider relationship (Mekonnen, 2012). Therefore, if one was to consider a charity group seeking to raise more donations through long-term commitment, one objective could be to convert x% of its episodic donors or members on the newsletter mailing list to the affinity credit card scheme by July 2016. As shown by Mintel's 2000 report, customer acquisition through affinity-based direct mail communication to a 'warm' audience may yield a 6% to 7% response, whereas direct mail into the mass 'cold' market may only yield at best a 1% response. Therefore, it could be said that such a strategy has a high potential of succeeding, given that the target audience are already said to have sympathy for the affinity group. Ultimately, the objectives should relate to what an affinity group and partner aspires to achieve in their overall business objective. Once the objectives for e-affinity marketing have been clearly defined, the next step is to analyse the digital marketspace in the context of affinity marketing.

The remainder of the discussion in this section logically follows the rest of the e-affinity marketing process demonstrated in Figure 2 and is organised accordingly from Step 3 through to Step 6. Step 3 reviews the current practice of 'Affinity marketing on the web' (situation analysis on Figure 2). The next logical step would be to ensure the needs of affinity marketing customers are understood, in both an online and offline sense (Step 4, the digital customer on Figure 2). This is a fundamental requirement for any business striving to succeed in today's competitive environment. *'Knowing the customer'* is crucial for affinity marketing given the unique affinity relationship that the scheme is leveraged upon. Based on the analysis of the situation and the customers' persona, strategies for e-affinity marketing

need to be identified (Step 5, strategic-activity on Figure 2). The last step in the process is to formulate a control mechanism with key performance indicators (KPIs) to measure and analyse performance (Step 6, performance analysis on Figure 2).

Affinity Marketing on the Web

The situation analysis (Step 3 of the process in Figure 2) should provide an overview of your organisation (who you are, what you do and how you interact and trade online) by addressing internal and external factors impacting on the business. For e-marketing, it is suggested that this analysis should include growth in users, changes in the market place as well as examples of good and bad e-marketing practices (Chaffey & Smith, 2013 and Strauss & Frost, 2014). Extending this, in the context of e-affinity marketing analysis an assessment of members or supporters' engagement with the group via the web should also be included.

It is important to have an honest and realistic baseline of your current capabilities and activities in order to define a meaningful digital marketing plan for the future. In order to analyse the situation in the first instance, affinity partners (in particular the affinity groups) should consider encompassing the following areas and answering related questions:

1. **Identification of the Digital Customer:** The affinity group needs to know who the digital customers are (with a demographics breakdown), how they interact with the brand, and what platform(s) they use.
2. **SWOT Analysis:** What are the strengths, weaknesses, opportunities and threats of digital integration in relation to the affinity scheme to the organisation as a whole. This should be inclusive of the affinity groups internal capabilities, skills and knowledge with respect to digital marketing.
3. **Competitor Analysis:** The affinity group should identify its competitors and assess how they compete. In terms of added value, to what extent have competitors incorporated an affinity scheme? Competitors overall product offering (i.e. inclusive of price, customer service, and their key differentiators). Furthermore, affinity groups should take this opportunity to assess their competitive position with respect to digital marketing in the industry they operate in and in relation to their close competitors.
4. **Digital Channels Analysis:** The affinity group should list the various digital channels used and success of each in different areas of the organisation. In other words the affinity groups should be able to assess the scope, depth and effectiveness of their current digital marketing activities across the range of digital channels.

Currently it is apparent that the main presence of affinity marketing on the web is on the affinity groups website. This could be attributed to the complicated nature of the triadic relationship and due to the fact that the initial contact with the affinity group members or supporters is often made via the affinity group. However, once the customer sign up to the affinity scheme, the affinity product provider is primarily in charge of the relationship, and subsequently the one that has regular contact with the member with regards to the scheme.

Taking the above into consideration, following on the affinity credit card theme, the author investigated the presence of the affinity marketing scheme on the websites of affinity groups. Past studies have shown charity, sports, and university affinity groups to be amongst the most popular ones from the

array of affinity groups at present (Mintel, 2000 and Mekonnen et al., 2008). Therefore, the websites of 10-15 affinity groups within each of the above category were investigated to evaluate the current situation. Visibility and activity of each group in relation to the prominence of the scheme in the homepage as well as related sub-pages were examined.

An e-commerce presence map is one way of identifying presence in the context of the website, email, social media and offline media, with presence identified on different platforms including the traditional desktop, tablet, and mobile (Laudon & Traver, 2013). Activities one should look for when evaluating presence should include search, display, newsletter, conversation, engagement and sharing. Ideally an extensive investigation of all of the above would be recommended, but in this case the author had already uncovered that current digital integration of affinity marketing to be minimal. Therefore, the information the researcher was able to unearth was limited.

The key findings from the investigation into affinity scheme presence on the web include the following:

1. In extreme cases there were affinity groups with a robust website dedicated to the main function, but they did not have a page on their website for the affinity schemes which they are participating in offline. Therefore, in these cases no further investigation could be conducted.
2. With the affinity groups who had their affinity scheme represented on the website, at the time the investigation was conducted, with the exception of a few the affinity schemes were not visible at all on the homepage. In a few of the cases where it appeared on the homepage, it was only visible as a side banner ad.
3. Where the affinity groups had incorporated the affinity scheme in their website, it was noted that there was no link associated to the scheme on the homepage. This suggests that affinity schemes may not be ranked highly in terms of the organisation's priority for digital integration.
4. In most cases it is evident that unless a potential digital customer actively searches for the affinity scheme, with existing knowledge the scheme, there was not much chance of the customer finding out about the scheme whilst navigating through the homepage. For the most part, there does not appear to be any consistency as to how the affinity groups are leading potential customers to the site dedicated to the affinity scheme. Out of the three categories investigated, universities appear to have adopted a relatively similar step for customers to reach the site dedicated to the affinity scheme. They all appear to lead their members or supporter to the page hosting the affinity scheme via the alumni page, for which the link is often visible on the homepage.
5. Once customers reach the page related to the affinity scheme, if they wish to proceed with signing up for the scheme, they will then be directed to the partner's (affinity product provider) website to complete the registration.

On the whole, all the affinity groups investigated appear to have the technological capability to fully integrate the affinity scheme as part of their digital activities, as can be evidenced by the depth of the activities they have integrated for some of the functions relating to the organisation's main offerings. For example, the University of Cambridge's magazine page gives visitors several opportunities to interact, e.g. play crosswords, download the magazine, link to the CAM reader app, etc. In comparison, the page related to the affinity scheme only has general information and a link to the service provider. Generally speaking, there is no indication to show that the same level of effort is exerted for affinity schemes.

For many of the affinity groups, although the affinity scheme may not be their main priority in relation to their overarching business objective, if harnessed it has the potential to add value to the customers experience and consequently build a long-term relationship for all parties involved.

Knowing Your Customer

Once the overarching e-affinity marketing objective has been derived from the core values underpinning affinity marketing (Step 1 and 2) and the situation analysed (Step 3), the affinity groups needs to focus on their customer (Step 4) and work towards an appropriate digital strategy that meets customer's demands.

Identification of digital customers in situation analysis looked at a more generic set of information exploring their demographic breakdown, how they interact with the brand, and what platform(s) they use However, here the emphasis is to extend this knowledge and get a deeper understanding of customers' value in relation to their affinity relationship and the affinity scheme, with a view towards building a persona for the digital customer. A better understanding of how affinity group members or supporters perceive their group's unique qualities, social status and size may provide a way of assessing the strength of their 'affinity', therefore analysing their receptivity to affinity marketing. When an organisation considers the design of their site, they need to understand the differing mind sets of the visitors in order to reach them by building an effective content strategy (Scott, 2013). Scott demonstrates this point by explaining how a college website could have multiple goals such as: 1) Keeping alumni happy so that they donate money to their Alma matter (differentiating between the young and the older alumni), 2) Recruiting students (with sites that need to be tailored for both high school students who may be considering the college as well as the parents reviewing the college, with different information needs), 3) keeping current students happy. In total, five groups are identified here. By understanding the persona of these five groups, the college can create appropriate content to cater for each set of visitors. Similarly, when considering creating of an effective e-affinity marketing site, affinity groups needs to first understand the behaviour of each group of customers that are likely to visit the site.

With e-affinity marketing the affinity group can start by segmenting potential customers based on existing knowledge of the characteristics exhibited by members of the affinity group. For instance, three types of affinity marketing customers - *communicators, supporters* and *explorers* were identified in a recent study related to understanding their relationship with affinity marketing (Mekonnen, 2012). Explorers were primarily driven by opportunities in the marketplace (benefit sought: individual-functional). For communicators, conveying their profession as part of their identity was a strong influencing factor when considering an affinity scheme such as an affinity credit card. For supporters, the functional benefits (donations) were the main reason for acquiring the affinity product. With this knowledge in mind, for example, a professional group's website could place emphasis on the symbolic value of the affinity product on the page dedicated to the affinity scheme. Furthermore, the group could also promote the symbolic value of the scheme on its homepage as one of its online value propositions.

It is also important to recognise that the strength of relationships varies and customers with different strength of relationships (for instance high, medium or low) will require different levels of engagement. Once the organisation has a clear picture of its potential e-affinity marketing customers, it then needs to plan its digital strategy with these groups in mind. Subsequently, the marketing channels used, message, content, layout and structure, as well as wording and language intended to describe what the affinity group provides, should be guided by the defined persona (Scott, 2013).

Strategy to Activity

Having recognised the 'big opportunity', defined digital objectives in line with the organisation's core values and objectives (Step 1 and 2), conducted a situation analysis to assess the affinity scheme's presence on the web (Step 3) and defined the digital audience in relation to the affinity scheme (Step 4), the next step in the process is to set out a strategy and set of related activities (Step 5). This should be formulated to enable the affinity marketing partners to fulfil the objectives set.

Affinity partners should consider the following three steps in setting and implementing the strategy:

1. Initially, affinity partners need to clearly specify what they want to achieve. Strategy is the long-term vision and should be set for a defined period. There should also be an approved budget allocation. For example (continuing on the theme of the affinity credit card), if we revisit the example used in Step 2, if the objective is 'to convert x% of the members on the mailing list for newsletter to the affinity credit card scheme by July 2016', the strategy could be to send periodic communication to the target audience, from the mailing list. In this strategy the affinity group should strive to understand the existing customer database and learn how it interacts with the website. In addition the strategy should also question how the affinity group is currently communicating with its existing customer database?
2. The next step is the tactic. Tactics are the detailed plans to implement the strategy and tend to be short-term and flexible (Chaffey & Smith, 2012 and Strauss & Frost, 2013). Continuing on the theme of the affinity card example from Point 1 above, at this stage the affinity group can determine the exact online activities or communication channels suitable for each target identified. Furthermore, decision regarding the content and frequency of the communication can also be taken.
3. In the final stage the partners need to specify how each activity will be managed. Given the complexity of the scheme, partners may have different objectives and levels of responsibility at different stages in the relationship. This includes everything from the promotion, to the sales and on to the maintenance of the scheme. This is evident if we look at the nature of the triadic relationship demonstrated by the infographic diagram (Figure 1), which indicates the variety of benefits to be gained by each partner. The process of building the affinity scheme also demonstrates different levels of responsibility. For instance, whilst the introductory and initiation of customers often falls upon the affinity group, the signing up of customers is the affinity product provider's responsibility.

Earlier studies have already indicated that there has been a gap in how the affinity partners understood the benefits each gained by each (Horne et al., 2000). Mintel (2004) has also reported how the complex nature of triadic relationship might lead to a problem in relation to how the customers are managed. Technically, the affinity groups might feel that they should have a say in the relationship, since it is assumed that the customer will be a member or supporter of their organisation. Besides, it is assumed that the affinity group would obviously have been the host group that provided the service provider with details of the customers' names and addresses in the first instance. However, in reality it generally tends to be the service provider that takes control of the customer relationship in affinity marketing schemes. For example, with affinity credit cards, the service providers know who the card holders are, they speak or communicate with them regularly via email and the monthly statement; ultimately, they provide the customer service to their card holders. Moreover, due to data protection requirements, the affinity groups were not even always told which of their members have actually arranged a financial product via the

scheme (Mintel, 2004). Therefore, when devising and implementing the e-affinity marketing strategy it is critical that both partners are involved in the design, management and maintenance of each tactical e-tool, as both will benefit if the site is fully optimised.

Performance and Analysis

The final step in the process of strategic integration is 'performance and analysis' (Step 6, Figure 2). This is designed to measure and analyse the performance of the website in order to determine the success of the strategies and the plans. As the result is intended help future developments of the site, this is indicated as an iterative process with the final arrow pointing back to e-affinity marketing objectives.

Performance analysis is primarily led by the objectives set at the outset, with the help of web analytics. Web analytics is the measurement, collection, analysis and reporting of the internet data for purposes of understanding and optimising web usage (Web Analytics Association WWW, 2008, p.3). Analytics is not just a tool for measuring web traffic, but can be used as a tool for business and market research, and to assess and improve the effectiveness of a website. The partners involved in the triadic relationship should be able to measure, monitor and review their e-affinity marketing campaign, updating and modifying elements as required.

Often the objectives set at the beginning should guide the identification of KPI at the start of the process. Other areas that need to be considered are the frequency of reporting and the analysis of performance, questioning why it is happening. Furthermore given the complex nature of the triadic relationship partners should also determine who measures what and reports to whom and finally who takes appropriate actions arising (what should be done about it). As with the previous step (strategies – activities) this is another area where the responsibilities and terms performance and analysis need to be clearly defined and agreed between the affinity scheme partners.

CONCLUSION

This paper was inspired by the dearth of literature and lack of practical guide on optimising affinity marketing schemes through digital integration. There is no known study to data that explains why the growth of affinity marketing scheme has stagnated or one that looks at why there is limited integration of the scheme in the digital landscape. Yet the coupling of these two areas has huge potential in capturing a unique market. The Internet is an ideal platform to target and engage customers, consequently encouraging a long term relationship. Moreover it has been shown that the role of information communication technology in philanthropy is growing, with donation via the internet nearly doubling between 2007 and 2008 (Honoré, 2011).

This paper proposes a strategic integration plan which identifies six key steps required for planning a digital marketing strategy for affinity marketing, 'E-Affinity Marketing Planning Process'. Initially, the core values related to the scheme needs to be evaluated (Step 1) as this will enable clear and concise e-affinity marketing objectives to be set (Step 2). Then the current situation or current practice of affinity marketing on the web needs to be reviewed (**S**tep 3). The next step is to understand affinity marketing customers' persona (Step 4). Knowing the customer is fundamental for any business striving to succeed in today's competitive environment. Following this based on the situation analysis and the customers' persona, strategies and activities for e-affinity marketing need to be identified (Step 5). Finally the last

step in the process is to formulate a control mechanism with KPIs to measure and analyse the performance of the scheme (Step 6).

On the whole all the affinity groups investigated appear to have the technology capability to successfully integrate affinity scheme as part of their digital activities, as evident by the depth of the activities they have integrated for some of the functions relating to the organisations main offerings. But the activities supporting the affinity scheme appears to be limited. Thus it is apparent that affinity groups are not exerting the same level of effort on their affinity schemes digitally as they are doing so in other areas of their website. There may be a number of factors contributing to the lack of the schemes presence on the web. For instance lack of digital collaboration between the affinity partners and not having a clearly defined responsibility with regards to the management of the scheme online could be possible reasons worth exploring.

Knowledge and understanding of customer is an asset for any organisation for better segmenting and management. As Scott (2013) has suggested, if organisations can segment their customers into distinct groups then it makes it easier to create content targeted to each group identified. As it stands the affinity scheme sites investigated did not exhibit segmentation or targeting. Yet there are some known characteristics associated with affinity marketing customers (Laing et al., 2004, Mekonnen, 2012; Worhington, 2001). For instance the typologies identified as 'explorer', 'communicator' and 'supporter' can give good insight as to what affinity marketing customers associated with a professional or a charity group would expect from an affinity scheme such as an affinity credit card. Such knowledge could be used as a starting point when formulating personas for e-affinity marketing customers in different sectors.

It is undeniable that all partners involved in the triadic relationship could benefit given that the digital integration is implemented and managed correctly. Specifying clear strategies guided by the digital objectives aligned with the core values underpinning affinity marketing is crucial to the success of the scheme. The strategy then needs to be implemented and executed properly with tactics formulated that takes into consideration partners responsibility. In the past affinity marketing schemes had faced some challenges with regards to customer ownership and responsibility. This needs to be clarified as failure to do so could impair successful digital integration. Whilst the initial engagement of the customers may primarily fall under the affinity group, management of the scheme is often undertaken by the affinity scheme service provider. With regards to converging and conflicting interests relating to customer ownership the affinity group and the affinity service provider should have an agreement in place as to how to manage the customers in the event where the terms of the partnership have to be altered or if the partnership has to end. This is strongly tied with good communication, sharing information, and collaborative working without compromising customers' confidentiality. Affinity partners' efforts in promoting the scheme to customers need to be aligned. Without breaching confidentiality, a possible plan of action for the service provider could be to collaborate with the affinity group in providing periodic updates to the customers. From the customers' perspective, lack of informative continuous communication could lead to relationship weakening (Mekonnen, 2012). This relates to communication during the periods when the customer-service provider relationship was stable as well as during the process of dissolution (Mekonnen, 2012). To avoid such pitfall the digital integration of affinity scheme, needs to ensure that there is a schedule or plan in place to harness communication online. Furthermore affinity partners need to understand the nature of communication desired by different segments.

Through performance analysis continuous improvement and sustainable growth could be achieved. Web analytics will bring this to life. The right KPI need to be set for this to be effective. Affinity marketing on the web has been explored to a degree but for the most part an untapped area.

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KEY TERMS AND DEFINITIONS

Affinity Relationship: A relationship built on the notion of cohesiveness, bonding, liking, identification and related concepts.

Affinity Scheme: A way of adding value through differentiation by designing a product that is of interest to members, employees and supporters of the said affinity group.

Cause-Related Marketing: A marketing activity where by a product is linked to a cause or non-profit organisation in return for a contribution to that cause or organisation and to make the product offering more attractive to consumers.

Digital Integration: In the context of marketing, this refers to integrating online efforts and aligning it with overall business objective.

E-Affinity Marketing: Refers to the promotion and sales of products endorsed by affinity groups through the internet.

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Chapter 56
Digital Media Affecting Society: Instruction and Learning

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ABSTRACT

The proliferation of the use of digital media for learning and instruction continues to be investigated and pondered as the advance of a broad range of technologies eclipses currently available traditional text and face-to-face learning modalities for K-12 and higher education instruction. Digital media's affect on educational processes and delivery, an analysis of existing research reviewing whether digital media is benefitting educational outcomes in instruction and learning, and recommendations for the future are the primary goals of this chapter. Investigation into each of the aforementioned topics separately reveals an intersection that is far from being maturely assessed. The topic of digital media affecting how people learn will elicit further research as education continues to call for an increased focus on high outcomes while also increasing the adoption of digital media resources for the transmission and acquisition of knowledge.

INTRODUCTION

The proliferation of the use of digital media resources in the field of education continues to be investigated and pondered as the advance of a broad range of technologies eclipses currently available traditional text and face-to-face learning modalities for K-12 and higher education instruction in the public and private spheres. Digital media's effect on educational processes and delivery, an analysis of existing research reviewing whether digital media is benefitting educational outcomes in instruction and learning, and recommendations for the future are the primary goals of this chapter. Investigation into each of the aforementioned topics separately reveals an intersection that is far from being maturely assessed. Adoption of digital media for instruction is rising, and is predicted to grow indefinitely. The topic of digital media affecting how people learn will elicit further research as education continues to call for an increased focus on high outcomes while also increasing the adoption of multimedia resources for the

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transmission and acquisition of knowledge. Implications for the future are mixed with hope for positive progress, and suspicion that digital media will make all areas of education less of an engaging enterprise and more of a commodity to be consumed.

The creation of instructional digital media by learners, not just its consumption, is another aspect of sweeping change throughout society that deserves investigation. Learners of all types continually create evidence of their learning outcomes in the form of media—papers, projects, presentations, and group reports. Written, text-based, forms of communication no longer hold the appeal they once had in a world filled with digital media. Students can (and often do) create digital video at the push of a button on a daily basis. They learn visual literacy techniques that increase their abilities to create info graphics and web pages that combine multiple elements of digital media together in the hopes of generating more engagement by audiences of all types. Teachers and professors alike are beginning to understand that communication through the written word is no longer the only essential skill to instill in their learners. The ability to work well with digital media software and hardware is increasingly becoming undebatable as an essential learning outcome.

Finally, some researchers make the assertion that digital media does not affect essential outcomes like reading, writing, mathematics, critical thinking (CT), problem-solving abilities (PSA) and other types of learning goals set in schools at any level. It can be argued that if digital media produce similar learning results in comparison to other forms of media, then the best choice for instructors is the cheapest and most-easily-acquired form of media available. Professor Anthony Grafton of Princeton University explains that all aspects of any medium's elements, including art and binding (as with plain text sources), create an environment that affects knowledge consumption and cognitive processing abilities (Prpick, Redel, & Grafton, 2011). For some, it is not safe to assume that digital media bears any different affect on users than a non-digital form of the same material. For others, there is certainly an effect to be observed throughout society by the wide spread use of digital media. Mayer and Moreno (2003) propose that individuals process pictorial and verbal information differently in their minds, thereby establishing digital media's affect on the mind as something separate from text-based materials. The problem of cognitive overload can stifle learning, the researchers explain, as more information can be presented through digital media than can be presented through text-based materials. In the context of instruction and learning, is access and consumption of digital media (with its ability to present many different types of information to a consumer all at once) ultimately a negative or positive effect of the influence of technology throughout the greater society? Strategic planning and focused utilization may be the best way to integrate digital media in the educational arena in order to maximize positive effects.

BACKGROUND

Digital Media, Cognitive Load, and Cognitive Learning Theory

Cognitive theories related to the effects of digital and multimedia on learning and instruction include research into the visual and verbal channels for information processing and knowledge acquisition combined with the argument that these two channels are not unlimited in their abilities to gauge phenomena and cause heavy loads to weigh on cognition (Mayer & Moreno, 1998b). These cognitive load theories include three types of memory stores: (a) sensory memory, (b) working (sometimes called short-term) memory, and (c) long-term memory. Sensory memory captures the text and visuals in their most exact

form, as well as auditory sounds, for a very limited amount of time. Working memory takes the sensory memory and allows for manipulation where the raw material from the sensory memory can be made into a model that includes spatial representations. For example, if a person hears the word "cat" they tend to immediately imagine a picture of one instead of an image of a bird. Long-term memory is deep storage where retrieval into working memory is problematic and unreliable at times for a variety of reasons (Mayer, 2005a).

Digital multimedia learning theory is consistent with learning design theories like cognitive load theory (Alasraj, Freeman & Chandler, 2013; Plass, Moreno & Brunken, 2010; Sweller, 1999; 2011), and the integrated model of text and picture comprehension presented by Schnotz and Bannert (2003). Schnotz and Bannert's (2003) model includes a structure mapping hypothesis which states that in order for visual materials like digital media to aid in learning they must be integrated well with corresponding textual information where it has been found that "interactions of . . . graphics, and text seem to be the key determinant of comprehension and performance in learning from [digital media]" (Rinck, 2008, p. 186). Each of the aforementioned theories lead to the sense that multiple channels (e.g., visual, verbal) working in concert together play a key role affecting memory and information processing in the minds of any type of learner at any age range (Mayer, 2005a). After starting with their initial proposition, the researchers develop their theory by explaining that there are limits to what people can mentally process when learning. The problem of cognitive overload brought on by digital media can stifle learning as more information can be presented through digital media materials than can be presented through text-based materials. Herein lies the need for their exploratory study eventually leading to nine suggestions for reducing the load that media can place on learners' minds. Mayer and Moreno (2003) provide definitions for their core concepts. They explain that they define media-based learning as "learning from words and pictures, and . . . 'multimedia instruction' as presenting words and pictures that are intended to foster learning" (p. 43). After providing these definitions, the researchers begin to link them directly to common education outcomes like science, technology, engineering and mathematics (STEM), CT and PSA.

Since digital media is generally developed to facilitate increased learning in a more efficient manner, Mayer and Moreno (2003) provide ways to mediate the damage that can be done by overload of information through digital media consumption. An example of digital media damage is found by Wolf (2007) reporting that screen reading quickens the brain's senses and lessens the cognitive ability to "deep read." Calls for a "slow-reading" movement juxtaposed against the fast-paced nature of digital media use this type of research to support claims that digital media is detrimental to learning (Rosenwald, 2014). Mayer and Moreno (2003) use familiar terms when they argue that they define "meaningful learning" as deep "understanding of . . . material, which includes attending to important aspects . ., mentally organizing . . . into a coherent cognitive structure, and integrating . . .with relevant existing knowledge" (p. 43). This is where the clear connection to the investigators' research into digital media and learning outcomes can be found. They expand their connection between the mind and media processing by explaining that there are three channels for processing in the mind when it encounters images, text, and sound together as an information resource. Mayer and Moreno (2003) identify a

[1)] Dual channel [where] humans possess separate information processing channels for verbal and visual material, [2)] Limited capacity [where] there is only a limited amount of processing capacity available in the verbal and visual channels, [and 3)] Active processing [where] learning requires substantial cognitive processing in the verbal and visual channels. (p. 44)

These aforementioned channels provide a framework for the identification of five major ways in which overload can block learning and instructional outcomes. The scenarios include periods when only the visual or audio channel are taxed individually, times when both are overloaded, times when one or both channels are overloaded by essential and non-essential information, periods when one or both channels are overloaded by information that is presented in a poor manner, and finally times when the learner holds the wrong information in one channel and not the other.

Schema Theory and Mental Models

Concepts on schema became influential in the fields of cognitive psychology and education in the 1970s, and inspired learning and instruction research with picture and text processing, and in the world of television viewing (Krauskopf, Zahn & Hesse, 2012; Hayles, 2012; Seel, 2008). Schemas encompass organized collections of information with how pieces of information relate to one another. Schema Theory works under the understanding that human knowledge is collected in the human mind under such schema. Schemas can be modified, reassembled, and then integrated with other schema containing new and different pieces of knowledge (Hansen, 2012; Alessi & Trollip, 2001). Mental models are dynamic and active representations of knowledge that serve to make what is invisible visible, help to create analogies between what is known and not known, or integrate pieces of coherence with unexplained phenomena (Seel, 2008). Mental models can be created in the minds of learners by the use of schema and other elements. These models can be helped by text, pictures, and video—combinations of which are what is now known as digital media (Block, 2014; Buckingham & Willet, 2013; Clark & Feldon, 2005; Hegarty & Just, 1993; Sharp, Bransford, Goldman, Risko, Kinzer & Vye, 1995; Shrock, 1994). Images alone have the vast ability to help students make sense of things they have not witnessed first-hand. Combine images with text and audio for simulation, or other forms of digital media, and instructors find the job of transmitting knowledge much more enhanced and learners are enticed to explore educational or entertainment content more deeply (Bull & Kozak, 2014; Dunleavy & Dede, 2014; Flew, 2014; Gold, 2012; Goldman, Pea, Barron & Derry, 2014; Schwartz & Heiser, 2006; Hayles, 2012; Tyner, 2014; Van Dusen, 2014).

The application of schema and their accompanying schemata allows the brain to map what the senses perceive in a mental model. Images in the schema and spatial relations that structure the images are mapped to semantic understanding through digital media in ways different from traditional text or audio of the past. This means that mapping is a process that aids in mental model development from images, text, and other media sources, and also helps an individual evaluate the model that was in his or her mind before interacting with the media itself (Rouet, Lowe, & Schnotz, 2008). Mapping is part of the process of critically segregating information for better understanding and eventual decision making desired with the development of learning outcomes. When learners are asked to take a test, or make decisions, they are essentially being asked to map schema in their minds to form mental models that allow for the finding of the "right" answer to a particular question. Digital media creates fundamentally different mental models in the minds of learners in educational environments leading to potentially worse or better outcomes depending on the subject matter combined with media delivery type (viz., audio, video, multimedia, etc.)

Clark and Kozma on Digital Media's Impact on Learning and Instruction

Richard Clark (1994) makes the assertion that media does not affect critical thinking (CT) skills, problem- solving abilities or other types of learning goals set in schools. Clark states that the true essence of

all "media research question[s] is [that they are part of many] similarly confounded questions in educational research" (p. 27). In Clark's mind, media research is subordinate to instructional design research, because it is the design of instruction that influences learning regardless of media used. Digital media, therefore according to Clark, has no affect on society in terms of instruction and learning. The media does not matter, and if replicable media produce similar learning results, then the best choice for instructors is the cheapest and most-easily-acquired form of media available at any given point in time. Robert Kozma (1994a) responds by reframing the concern of media influencing learning from a design science (R. Glaser, 1976; Simon, 1996) perspective rather than from a natural science point of view that seeks to explain human cognitive interaction with the world not created by humans. Kozma explains that educational technology using elements like digital media is a design science deserving critique and analysis observed from relationships between human-created tools and other humans completely separate from the natural world. He offers a response to Clark that asserts that both instructional methods and elements like digital media "influence learning and they frequently do it by influencing each other . . . methods take advantage of a medium's capabilities in well-designed instruction . . . One cannot simply replace one medium with another in a design and hold everything else constant, as Clark . . . suggests" (1994b, p. 11). Both Clark and Kozma provide a review of the literature to support their claims about the effects of digital and multimedia on education. Kozma, however, provides a quantitative data analysis from a study using his 4M:Chem software that allows students to see the results of their chemistry-related course activities. Kozma's research shows that both the instructional methods used and the digital elements affected overall student learning outcomes. He then asks how this phenomenon is possible.

Kozma claims that learning is assessed not so much by the instructor or through the methods used, but by looking at learning "as it happens and [collecting] data on the ways students interact with the system as they learn" (1994b, p. 12). This view is similar to Mitra's (2007) idea that learning occurs through the theory that education is a self-organizing process. In order to find answers, Kozma conducts a separate study and describes how five students from his first experiment participate in a second experiment where they demonstrate how they learned from 4M:Chem. The students show significant abilities to form inferences about particular chemical events through viewing video sequences in the software. This is the combination of media/medium and instructional method affecting learning outcomes consistent with the hypotheses Kozma desires to see. He concludes, refuting Clark's 'replaceability challenge' by stating, "If two [media] treatments yield a similar outcome it does not mean that they resulted from the same cause . . . [and the outcome] does not identify what that cause is . . . if you want to know what causes learning, you have to look at it as it occurs" (1994b, p. 13).

CURRENT ISSUES

Much debate on digital media replacing traditional media information resources in the field of education, along with the resulting effect on learning outcomes, is found in the literature. Comparisons of digital media's affects on learning outcomes can be generalizable only to a certain degree due the fundamental differences between outcomes like science, technology, engineering and math (STEM), language comprehension, CT, problem-solving ability (PSA), and more obtuse outcomes like moral judgment, and psychological/physiological behaviors. Of the extant studies available to-date, most carry mixed results of the basic learning effects of digital over traditional physical resources.

Digital Media Content vs. Traditional Instruction Content: "Mindtools" and Digital Media Affecting Learning Outcomes

Jonassen, Carr, and Yueh (1998) identified early forms of web-based digital media under a term they call "mindtools" describing how digital media computer applications challenge outcome skills by requiring students to think deeply about what they are seeing and hearing on a screen instead of merely accepting the premise that rote absorption is the primary educational goal. In their descriptive meta-analysis of different digital media tools, the researchers connect these various forms of media to educational outcomes such as: (a) interpretation, (b) inferences, (c) manipulation, (d) semantic organization, (e) linguistic evaluation, (f) visualization, (g) prediction, (h) elimination, and (i) inference. They ask, "Why do Mindtools work, that is, why do they engage learners in critical, higher-order thinking about content?" (Jonassen et al., 1998, p. 12). What the researchers assert here is that, in fact, individuals who are challenged in their learning environments (classroom location, materials, access to information/date, etc.) through any sort of combinations of input other than one (e.g., visual alone or audio alone or print text alone) are the individuals who wind up thinking the most about the content contained therein. If this maxim is true, digital media where individuals can both see and hear, or read and hear, or even see, hear, read, speak, and manipulate will engage outcomes more than their counterparts using traditional learning tools (like text alone) and techniques (e.g., lecture). Jonassen et al. (1998) also determine that individuals using "mindtools" as early forms of digital media are capable of more critical thought through ideas that would not be present without the actual use of the tool first. This coincides with the basic idea of learning-tool scaffolding as the genesis for all human innovation: The development of electricity, for example, leads humans toward critical inquiry into the powering of all sorts of tools, like radios, which leads humans to the idea of mass communication over long distances which eventually begins the CT behind the creation of the idea of the internet.

Jonassen et al. (1998) contend that ultimately digital media-type tools are direct descendants of constructivist thinking about learning and education derived from earlier education pioneers like John Dewey (1897; 1909; 1916; 1933). The researchers note that digital media extends the capability of computers to move beyond simple presentation by "engaging learners in reflective, critical thinking about the ideas they are studying" (Jonassen et al., 1998, p. 15). Under this model, computer digital media information is another powerful partner in the learning process. It is not a merely upgraded and advanced way of storing information for reading and memorization, or for reference.

Mills and Exley (2014) studied a similar outcomes in K-12 students aged 8 to 10 years. A digital writing classroom was used as the environment where the research question centered on the time used by students to create text in a digital media environment. The study was conducted over 40 school weeks. Dialogue about writing in the digital classroom was the main method of analysis. The dialogue was recorded digitally and then coded. The results showed that digital media used as a format for writing gave a more explicit time frame for the K-12 students. Writing with physical paper and pen did not carry the same structure in the minds of the learners. More thoughts and content generation occurred in the digital environment. An overall assessment of the quality of the writing, however, was not assessed.

Liao (1999) conducted a comprehensive meta-analysis of over 45 studies conducted between 1986 and 1998 investigating the role of hypermedia on student achievement in many areas. The vast majority of this media research is heavily focused on subject-specific areas (e.g., historical facts, practical mathematics, language assimilation) instead of more over-arching concerns like ethics, intelligence, emotional response, or CT. What was found was the extant research on digital media's influence into

student achievement shows mixed results. If no instructor intervenes (via live instruction, video, chat, etc.), digital media provides a larger effect on student outcomes. With the introduction of instructor interaction, however, text and other forms of traditional information sources become more effective at positively impacting outcomes (Okutsu, DeLaurentis, Brophy & Lambert 2013).

Stoney and Oliver (1999) found that learning outcomes can be enhanced, and more strategically focused upon, by adding digital media to learning environments. The researchers tested their hypothesis by means of one instructional unit inserted into one collegiate finance course focused on accounting. The design of the study called for the replacement of one of the traditional face-to-face instruction days with an equivalent digital media unit accessed by students during a time of their own choosing. The subject of the intervening treatment was a simple stock price valuation simulation where students had to decide how to pick stocks to increase the profits of a simulated portfolio. Eight students were separated into four groups for analysis of their discussions produced during and after engagement with the digital media treatment. The researchers analyzed and coded student activity looking for evidence of time spent utilizing the digital media content juxtaposed against time spent engaged in discussion rooted in the outcomes for the course. The cognitive activities of the students were grouped into two sub-groups: low-order activity and high-order activity. Low-order activity was defined by the researchers as discussion requiring little to no decision-making, cognitive engagement, or problem-solving effort (Stoney & Oliver, 1998; Stoney & Oliver, 1999). High-order activities were described as being any combination of discussion related to: prediction, strategy, contemplation of new and pre-existing knowledge, consideration of belief and evidence, eliminating falsities, and deducing uncertainties.

The findings of the study showed marked learning outcomes increases due to interaction with the digital media unit. All students were required to discuss and make decisions based on the content of the digital media content regardless of how much time was actually spent with the treatment. The evidence related to outcomes advancement was shown through analysis revealing that the more time students spent with the digital media, the more students exhibited higher-order skills. The particular media used in this study was not created by the course instructor or by anyone at the same university. The treatment materials were created by an outside firm specializing in the particular subject fields of business finance and accounting.

Alexander (2014) investigated increases in student engagement through the use of digital historical images to be integrated into presentations for K-12 students. The research cites disengagement research calling for more teacher effort as a primary reason for the attempts at using digital media to bridge the gap between what K-12 want to pay attention to during their leisure time and what they are challenged to focus on in school. Using the Technological Pedagogical Content Knowledge Framework (TPACK) framework, the students were analyzed on the interplay between their teacher's content, technology knowledge and instructional methods (Mishra & Koehler, 2006). Using two sixth-grade history classes, Alexander found that time devoted to the assignment at-hand increased dramatically using digital media. The students reported enjoying the assignment task much more than the teachers enjoyed designing it. The use of digital media was more burdensome to the teachers due to unfamiliarity with the technology and perceived learning curve. The outcomes received from the students, however, justified the integration of digital media within the class.

Thomas, Coppola, and Thomas (2001) questioned whether elements found in online classrooms (including digital media) had a demonstrable effect on learning outcomes. Their study was wide-ranging, mostly including the effect of learning management system (LMS) integration on outcomes. Included in their study was a measure for digital media's affect by way of on-demand video of course content.

The study used a standardized assessment for CT in a pre and posttest design method on three different sections (three different instructors) of the same master's degree-level information systems course. The ages of the participants were between 20 and 29. The instructor was not the creator of all of the content for any of the courses. One class was conducted in a traditional face-to-face class format, one was conducted totally online via an LMS (Blackboard©), and one was conducted face-to-face with electronic treatments including on-demand video. The researchers define the third type of treatment of electronic classroom as "an interactive multimedia electronic classroom networked to the Internet and housing a video/ audio/ keyboard/ mouse broadcast-on-demand system" (Coppola & Thomas, 2000, para. 45). 20 to 40 students per course served as participants for the study.

This investigation found that the third digital media treatment section of the MBA course did show increased mean scores improving (11.00 pretest to 14.28 posttest) on the CT test over the Blackboard course. Posttest CT scores from the Blackboard course were actually lower (11.28 to 10.32) pretest to posttest. Final grades, however, were highest for the traditional face-to-face course. No analysis of teaching style was conducted during this study. A perceptions questionnaire was given at the end of the study asking participants to rate how they felt their method of instruction helped with their acquisition of CT skills. As with the final grade reports, the students in the face-to-face class were the most likely to report that they perceived their learning skills had improved most without technological assistance of any kind. At the end of the study, the researchers mention the need to extend their research to cover the same course taught by the same instructor to better control for pedagogical methods concerns.

Cavalier and Weber (2002) explored the effect of digital media on the learning outcome of moral decision-making through the use of a one-factor three-level experiment where students were surveyed after one group studied the case of burn victim Dax Cowart with only text materials, one group with only a 1-hour VHS documentary, and a third group only with an interactive digital media program created by a third-party vendor. The study was replicated the following year with three different sets of students as participants and using new graders different from the first study. The groups in both years ranged in sample sizes of 21 up to 38 undergraduate philosophy students. The students enrolled in the courses as a requirement for their major. The results of the experiment showed that performance in (a) understanding the complex perspectives and positions of the case, and (b) analyzing the case with respect to its morally relevant details was higher in the groups who were affected only by the interactive digital media program during the first year of testing. Statistically significant differences were not observed, however, in the study's second year. Aside from mixed results in both study periods, other problems with this study arise when considering the quality of the learning materials given to participants, and the fact that the materials were produced by three distinct creators.

Redsell, Collier, Garrud, Evans, and Cawood (2003) conducted a stratified cluster randomized controlled trial of bedwetting children (n=270) undergoing psychological treatment at 15 different nurse-led clinics for their condition. The students viewed and compared bedwetting mediation information in digital multimedia format with text that was mirrored word-for-word in content. The digital media learning materials contained an interactive assessment component not present in the text. The researchers' study showed no significant difference between the two information sources' ability to impact the learning outcomes (e.g., time to dry and remaining dry) of medical information for a specific condition post completion of the study and six months after completion.

Kumta, Tsang, and Hung (2003) used 163 final-year medical students in a study aimed at directly gauging the effects of digital media instructional materials on learning outcomes in an orthopedic surgery context. The study was randomized using a control and experimental group. The researchers begin their

narrative with a fundamental problem of education and outcomes where the observable world is filled with so many information sources. This fact makes it difficult to distinguish between what sources will help solve problems and which will not. The researchers say lecture-based curricula are too commonplace, antiquated, and conventional, and therefore "not well-designed to develop . . . analytical thinking and problem-solving skills" (para. 1), because of inundation of information. Digital media sources, the researchers attest, can mediate this problem. The stakes are higher with medical students, because lack of proper cognitive skills can mean patient harm. The researchers find that their small study with web-based tutorial sources "led students through a thinking pathway that facilitated the development of higher cognitive skills such as analysis, application, and evaluation" (para. 18).

The researchers split their participants into 11 groups of 15 students who all attended a 3-week module on orthopedics throughout the span of their final year in medical school. Next, the researchers randomly assigned each group to a Study or Control group. A multiple-choice pretest was given to all participants before the experiment began. The Study group was exposed to a web-based clinical case simulation (CCS) program designed by the researchers, but tested by existing orthopedic surgeons, to foster logical thinking abilities in the students. They were not given any other lecture-based or digital teaching materials. The Control group was given a standard lecture-based curriculum supported by text materials and optional tutoring. At the end of 3-week module, both sets of students were tested on their knowledge and CT abilities in the arena of orthopedics. The researchers note there was no significant difference between the results of the Control and Study group on the pretest. There was a statistically significant difference on the final test at the end of the 3-week module with the Study group scoring higher than the Control. The researchers note that their study was small and limited. But they give commentary to their findings by suggesting their research demonstrates that "well-designed web-based tutorials stimulate students to think and . . . complement . . . teaching resources . . .foster[ing] better clinical and critical thinking skills in medical students, without subjecting them to an information overload" (para. 23).

Barlett and Strough (2003) conducted a 3-semester-long study where samples (25 min/61 max) of undergraduates in seven different Social Psychology courses taught by six different instructors each term were given one of three different methods of instruction: (a) traditional lecture, (b) traditional lecture with course guide, and (c) digital media with course guide. While the digital media in this study was, in fact, created by the same instructor in some of the courses, the products were not the same due to the inclusion of so many different instructors used in the study. Final grades in the course were the primary measure used to gauge the impact and effectiveness of the instructional method and information source used in each case. The final results showed that it was the course guide, not the delivery of traditional lecture or digital media, which improved final grades. The researchers note that redesigning their study so that "a comparison of traditional and multimedia formats when neither is accompanied by a course guide would be useful in understanding the unique contribution of multimedia formats" (p. 337).

Sheldon and DeNardo (2005) sought further explanation on the difference between how digital media video affected educational outcomes in prospective freshman and upper-level pre-service music education majors. The researchers' study design included two groups (n = 116 prospective freshmen) and (n =130 upper-level) music education majors. Each participant was shown a digital video of a particular musical interaction from two earlier studies (Sheldon & DeNardo, 2004). The researchers describe the 20-minute media treatment as,

The . . . examples consisted of music in special education interactions . . . with mainstreamed groups and people who were mentally retarded, had cerebral palsy, were hearing-impaired, learning disabled,

geriatric, abandoned, or were juvenile delinquents; music education interactions . . . with general, instrumental, or choral groups at the elementary, middle school, and high school levels; and professional, formal music performances . . . that included a piano concerto with both full orchestra and soloist shown and a violin solo accompanied by piano with only the violinist shown. (p. 7)

Each of the aforementioned segments in the treatment was displayed for one minute followed by two seconds of blank screen. The participants were required to watch the presentation, not speak to one another, and simply write down as many observations as they could describing each segment. Assessment by the researchers was made according to two criteria: factual and inferential content of the participants' written observations.

The final results were, like other studies, somewhat mixed. It was hypothesized that the upper-level student would score higher as their experience level would correlate more to what they saw through the digital media treatment. While this was most often the case, it was not always the case. In some instances, the prospective freshmen demonstrated more understanding about the segments they saw on screen. One-way ANOVA was used to compare scores. Post hoc analysis on certain demographic data connected to each participant (viz., GPA, class rank and ACT score) did show consistent correlations. Higher values in these measures equated to higher levels of learning regardless of student status.

Montgomery (2014) used K-12 students in a third-grade classroom as subjects for a study on critical democracy engagement through the production of digital media. Educational outcomes for students of all types mostly commonly come in the form of written text (digital or physical). This study explored the use of digital audio (viz., podcasting) as an outcome demonstrating students willingness to criticize aspects of government. The research found that the third-grade students in the study were much more willing to research governmental issues related to democracy, because of the need to create their podcast assignments. Consistent with Jonassen's (2014) assertion of digital media as mindtools for learning and productivity, the students output and engagement was positively impacted by digital media being incorporated into their learning and instructional environment. The students were using the digital media as mindtool "technology [that represents] what they know versus learning from technology as in traditional tutorial or drill and practice sessions" (Marra, 2013, p. 266). Students were not only more willing to share their views, because of the digital media, but they were also more willing to read and study their given topics because of the introduction of digital media requirements into their classroom experience.

Gerjets, Scheiter, and Schuh (2008) worked with 80 (48 female, 32 male) undergraduate students at a traditional German university. These students were presented with three complex word problems to be solved in an online digital media environment. A navigation bar was always present with the problems to be solved. The navigation bar contained links with information related to solving the problem at hand. Students had the ability to self-select how many links, and which links, they wanted to use to help solve the problem. They could not look at the information contained in the links while attempting to solve the problem. Students could only use this aspect of the digital media environment before attempting a solution. An added value question was included with each "tip" given via the links that asked the students if they felt the information they received was helpful. The researchers say the dependent variables for their study were "problem-solving performance for the three . . . problems, time spent on studying example pages, and mean time spent per example retrieved [from the hyperlinks]" (p. 82). The results of this experiment found a significant difference in solution performance between genders, but not between how many tips were used via the media links. The only other significant factor found was with students

who reported low prior knowledge of the problem material before interacting with the media links. As hypothesized by the researchers, the experiment suggests that digital media link prompting for "cognitive processing might result in a better problem-solving performance, particularly for learners with low prior knowledge" (p. 83).

In a second experiment, the researchers used 31 German high school students (14 female, 17 male) in the ninth grade. The students worked in a computer mediated course (CMC) environment where they worked on algebra problems. Each student was given an 11-item pretest that gauged their prior understanding of algebra concepts before beginning work on the main problems. The concept of "pre-knowledge" in the work of Gerjets et al. (2008) is an essential component for the overall understanding of deep-thinking toward problem solving using digital media. The ninth grade students in this study were first given examples of algebraic concepts in scenarios typically not emphasizing mathematics, viz., biology, chemistry, and politics. They were required to simply read and study the concepts in this first phase of the experiment. They were allowed use their web browser's forward and backward buttons to help guide their cognitive processing of the material during this phase. It was the second phase of the experiment that required the students to solve 21 algebraic problems. The researchers note they were interested in differential effectiveness and therefore "a second independent variable was manipulated within the transfer distance of the 21 test problems that learners had to solve subsequent to the learning phase" (p. 86). The actual learner's solution performance on the 21 questions in the test phase was the dependent measure for the study. Ultimately, the researchers find that the ability to use digital media to view and interact with seemingly unrelated content in the same context of an intended problem (viz., algebraic equation problem solving) will positively affect a learner's ability to solve targeted related problems. The researchers find interactive media comparison tools "help learners to abstract . . . [and] compare examples that share the same cover stories across problem categories facilitat[ing] later problem-solving performance" (p. 87).

Kingsley and Boone (2008) conducted a quasi-experimental, pretest/posttest design study on the effects of digital media as an augmentation to the existing text and lecture content of a middle school American history class. The researchers compared pre and posttest scores for the students in control and experimental groups using a two-tailed *t*-test (unequal variance), because single-tailed *t*-tests are not as sensitive to unknown changes in the direction of mean test scores. Like the Barlett and Strough (2003) study, Kingsley and Boone (2008) used multiple sections of classes taught by multiple instructors (four, all female in total) for a total of 184 participants (93 aggregate in the experimental treatment group, 91 aggregate for control groups). The researchers in this case, however, conducted their research by pulling participants from three different schools. They also used digital media created by a different vendor from the text material used in the subject course sections. Gender, age, and experience level of the instructors studied were noted in descriptions of this experiment, but not studied in-depth. The results of the study showed a significant difference between the control and experimental groups with the experimental displaying 12.2% higher scores on the posttest assessment of their knowledge of American history subjects. In this particular study, the addition of digital media improved students' ability to meet the requirements of a standardized assessment based on NCLB guidelines for middle school student knowledge about American history. Whether or not the digital media provided more, better or clearer information as compared to the traditional instruction experienced by the control group was not discussed or studied by the researchers. The digital media was added to traditional instruction, in this case, not set up as a substitution for traditional instruction or instructional course materials like texts or print articles.

Following Kingsley and Boone's study, Smith (2012) investigated a similar aspect of digital media used for instruction and learning on K-12 students in an Algebra class. The media was used as a complete replacement for the instructor in the case of this study. Seeking to answer the question of whether or not digital media can make a physical instructor irrelevant to K-12 students, the researcher found interesting results. Students in the study had higher levels of self-regulation and lowers levels of intimidation through the use of digital media. A very large number of the students (ninety-three percent) preferred the teacher's "digital media presence" over their physical presence. The researcher indicates that, in the very least, digital media takes some of the pressure off the learning experience by depersonalizing aspects of instructional interchanges between teachers and learners.

Xu, Oh, and Teo (2009) conducted a one-factorial experiment with randomly assigned participants in two groups at a 1:1 gender ratio. The study tested the differential effects of text and digital media advertising on mobile consumers' perception and behavior. Forty-one males and 41 females were recruited from a large university to received simulated advertisements on their mobile devices in text or digital media format depending on their vicinity to a particular vendor in a simulated mall. The researchers found that digital media advertising information improved a viewer's attitude toward a product and significantly increased the intention to buy vs. text-based advertising. Their study also showed that digital media was more of an irritation, but provided more information and entertainment value over text.

Serra and Dunlosky (2010) conducted a digital media study on undergraduate students at Kent State University. Two groups (n=40 for each) were initially studied with a third later added at the end of the research. The study participants either read 500 words (digitally displayed) on how storms develop, or they viewed similar, decreased amounts of text with images added to explicate the same content. The third group in the study examined showed no significant change in learning using text only versus digital media, while the original two groups did. All three groups also believed they would learn more through the use of digital media. The researchers provide commentary cautioning the overuse of digital media, as this heuristic did not always show improved learning, even if learners come to believe it is always a superior learning information source over text. They cite this as a reason for future research linking learning belief with learning format and outcomes performance.

Starbek, Erjavec, and Peklaj (2010) conducted a quasi-experimental pretest/posttest study on 3rd and 4th grade students to gauge overall content acquisition in a course module centered on genetics. The researchers used four comparable groups where the first group (n=112) received instruction only via lecture, the second (n=124) only by reading a text, the third group (n=115) only through two short computer animations, and the fourth (n=117) only through images combined with text on a screen. Their study showed evidence that digital media was a better instructional tool over text for the specific material to be acquired—the understanding of a single dynamic process. The researchers call for additional research to be performed due to the type of understanding the students were required to learn. The researchers say their study is ultimately not indicative of digital media's learning effects toward learning facts, data or other types of knowledge. This study's finding is a consistent precursor to what Hwang, Chu, Lin & Tsai (2011) found in their K-12 study involving fifth-graders in another science course centered on instruction involving the differentiating different species of butterfields. Their study used digital media as a mindtool which also successfully increased students' abilities to understand and learn the required material.

Chuang and Ku (2011) conducted a study comparing Chinese-language learning materials in combined text and image form against the same material presented only in images combined with digital audio narration. Their study resulted in mixed findings where the control group of undergraduate students (text with images, n=33) did not significantly differ from the experimental group (n=33) of undergraduate students in terms of posttest and delayed posttest performance on language learning assessment. There was a significant difference, however, found between the two individual test occasions. The overall results directly contradict Mayer's (2001) modality principle which suggests that text combined with images on the screen is a superior form of information acquisition over images combined with narration, because the mind working on both the visual and nonvisual channel (in tandem) devotes less time to each, thereby reducing learning potential.

Serin (2011) studied the effects of digital media on student ability to use information to make inferences and solve particular problems. The researcher's method included 26 fifth-grade students in a control group and 26 in an experimental group from a single school. In the study, the participants learned about general information on the Earth, the Sun and the Moon. Serin (2011) used a mixed design (pre and posttest) study to assess the impact of digital media created by the researcher and presented to the experimental group students three hours per week for three weeks. The control group did not have the media treatment added to their lessons for the three weeks during the study. The results of the study showed a statistically significant increase in problem-solving outcomes for learners receiving digital media treatment.

Serin, Bulut Serin, and Sayg (2010) used a self-created tool for their assessment of learning outcomes, and a general content-based assessment on the subject matter of the "Earth, Sun and Moon" to collect data from the participants in the study. Cronbach's (1951) Alpha for the self-created tool was reported at .85 with a KR-20 reliability level at .72. The contents of the digital media were also created by the researcher, and included some level of interactivity beyond simply watching, listening or reading in combination on a screen. The results of this study showed mean scores on the self-created tool to be significantly higher for the experimental group. Equivalencies of the groups were assessed by way of initial *t*-tests. Kolmogorov-Simirnov Z was used to determine normal distribution of the scores. The efficacy of the process of the experiment was assessed using ANCOVA. The researcher concludes with a general call for similar studies in different disciplines (and at different education levels) to be carried out using the same pre/posttest design with digital media content used as an experimental treatment.

Recently, Kayaoglu, Dag Akbas, and Ozturk (2011) used an achievement test to assess the impact of digital animation versus print text in two undergraduate English-language learning courses. Pretests were given to the control (n=22) and experimental (n=17) groups showing equivalent abilities before the introduction of the two different forms of learning materials. The researchers created both material types. The results of the study showed increased assessment scores on the posttest for the experimental group given only digital media animation as a means for learning English. Anecdotal opinion on learning via animation versus text was also collected from the participants and teachers, indicating that they were more excited to learn language via animations. The researchers caution, however, that excitement and statistically significantly higher posttest scores are not a justification to replace print text with digital media completely in all cases, because there was ultimately no difference between the groups in terms of overall increase in achievement. The students in both groups increased their performance on English language assessment at the end of the testing phase. In the end, both text and digital media each work to increase overall language performance.

IMPLICATIONS, POLICY AND PRACTICE

Universal Design, Self-Organizing Education, and Digital Media

Universal Design for Learning (UDL) is potentially the most provocative process design change for instruction and learning born in the 21st century. UDL attempts to account for educational theories that support there is no one-size-fits-all approach to learning appropriate for students in any setting (NYC Department of Education, 2014). Before the advent of digital media, education was delivered solely in either face-to-face environments supplemented by drawn visual aids, static images and print books, or remotely through printed material. In some cases, radio and television signals were used for instruction as well, but this market was relatively small and insignificant in comparison to massive commercial market for broadcasting radio wave signals (Saettler, 2004). Due to the advent of digital media for learning, UDL is unleashed allowing for more modalities of learning a single subject which, in theory, will benefit more students in terms of learning outcomes and efficiency.

Digital media development, deployment and adoption has started a trend where once there were only a few modalities supported and endorsed for learning to now all options, permutations and learning scenarios being supplanted by a great many ways to learn. The "many" modalities are almost entirely digital in nature today due to the introduction of the World Wide Web in 1995 (Segal, 1995). The World Wide Web allowed the mass distribution of digitized text via HTML, and from that point forward, learning and instruction have never been the same. Once it was considered wonderful and democratizing for the masses to be able to read because of the Gutenberg's Printing Press (Gray, 1999). The Printing Press spread human knowledge quicker and more efficiently than any other technology prior. The masses, in this case, were required to find and purchase printed text once they were taught and encouraged to read. Still, this was a much slower process for knowledge acquisition and understanding than what occurred through the proliferation of digital print.

Textbooks used for education, and even the revered *Encyclopaedia Britannica*, have now succumbed to digital text (Sollisch, 2012). More and more students each day are finding digital text content they can use for educational purposes at the touch of a keystroke. Students, parents, educators and even some librarians ask, "Why purchase, read, and especially, be burdened with carrying print books when you can get the same content online through a digital device?" Due to physical sizes and weight, and the assumption that digital text content will always be cheaper than traditional print content, formers supporters of physical text content are running away from this format in favor of e-text. Even some librarians themselves are endorsing the elimination of print books from libraries. In the K-12 environment, boards and administrators take this scenario one step farther by eliminating print materials and school libraries entirely. Double-digit year-over-year decreases in school library funding are now common. Connecting the notion of literacy to libraries has also been dropped from the strategy of the U.S. Department of Education through its voluntary elimination of the $20 million Literacy Through School Libraries grant (Siu-Runyan, 2011).

The textbook in digital format is still in jeopardy due to the "many" digital audio, video and multimedia content options. Students in today's digital media environment have numerous choices for entertainment to occupy their minds throughout a day's time. These "many" choices compete with educational resources for the consciousness of learners. Digital media, as an influencer of the process of education, comes from the inherent form of the technology. Educational content, as well as un-related entertainment content, all are now delivered in the same form. These media are simple files sitting on interconnected

servers in cyberspace only distinguishable by file extensions (e.g., .mp3, .mp4, .m4a, .png, .jpg, .js., .flv., etc.) and file size. Before the internet, digital content sat resident on digital media—memory cards/sticks, CDs/DVDs, disk drives. The digital media still needed a physical form in order to be consumed by a learner in the similar fashion that books used to be the media needed for the printed word. Instruction today is guided toward the discovery and the linking of digital media content directly to learners' media devices (tablets, computers, and smartphones). The form of the digital media is no longer a going concern influencing the process of instruction and learning (Gikas & Grant, 2013; Keskin & Metcalf, 2011; Wu, Wu, Chen, Kao, Lin & Huang, 2012).

Digital Media and the "Self-Organizing" Educational Process

In 1999, Sugata Mitra facilitated the installation of a computer terminal in an open area of a slum in New Delhi, India. This experiment, eventually known as the Hole-In-The-Wall experiment, resulted in a number of surprising educational outcomes (Orvis, 2006). Children in the New Delhi slum were encouraged to interact with the computer terminal in their neighborhood. Through their uninterrupted and unfacilitated interaction, the children were able to show the ability to learn through interactive digital media delivered via the internet through the terminal. Calling this development, Minimally Invasive Education (MIE), Mitra (2009) and his colleagues show more evidence of interactive digital media's ability to massively affect education without the need for human intervention. Through the installation of 21 additional internet computer stations, MIE allowed the children in the New Dehli slum to accomplish the following:

- Learn English to communicate—with no prior knowledge of the language,
- Not need to be "taught" how to use a computer and digital media; the media "taught" and self-empowered the children to learn on their own,
- Create their own media through drawing images on the computer screen,
- Increase STEM-based scores at their home schools,
- Modify their own social interaction skills because of the ability to remotely see and hear (digital media) about other people and places (Mitra, 2007; Mitra, 2009).

The Hole-In-The-Wall project was expanded to Cambodia in 2004 after the results of the 1999 efforts worked against the original hypotheses that learning without a teacher through the internet, combined with large language barriers, was nearly impossible. Through MIE, Dr. Mitra seeks to explain that the internet delivering interactive digital media has the power to change the landscape of education as it is has been known since the educational methods were first inspired by Horace Mann (1848) and John Dewey (1897) in America in the 19th Century preceded by British Education developed in the 12th Century. Interactive digital media's ability to enable students is unprecedented, understudied and still in early development. Mitra (2007) also conducted another experiment where 32 children in groups of four working with the internet and digital media together on one station, and not on their own with their own computer, showed equal learning outcomes compared to children with a physical teacher over longer term breaks (two months between pre and post tests) with the non-teacher connected children interacting together with digital media above working alone with digital media.

Mitra and his team's research lead to an argument that education in itself is a self-organizing system where instruction is the vehicle (executed in his experiments entirely via interactive digital media) that can be experienced in a solo or group setting like traveling in a bus can be experienced as a rider or as

a passenger with many participants resulting in differing outcomes depending on their role as driver or rider. Learning in this case, therefore, is a phenomenon that emerges from the self-organizing system enabled entirely by interactive digital media. There are limitations, however, to replacing physical teachers and physical media with digital equivalents. Perhaps these limitations are only found in the amount of access learners have to content online. Regardless, in settings where access to quality physical teachers and classroom mediators is limited, interactive digital media can be an acceptable (and perhaps preferred) replacement vehicle in the Self-Organizing Learning Environment (SOLE) that education is argued to be in the 21st Century (Mitra & Dangwal, 2010).

Learning environments that were previously only face-to-face for both K-12 learners and higher education students are seeing interactive digital media as an information source threatening to completely replace all three of the following learning methods: (a) asynchronous chat, (b) printed textual readings, and (c) face-to-face lectures (Kurzweil, 2005; Masten & Plowman, 2003; Thompson, 2011; Talbert, 2013; Vinge, 1993). Beyond the advantages given to learners via MIE, interactive digital media provides many advantages, including "the liberty to proceed or recede allow[ing] self-pacing [and] an immeasurable interconnectivity to information in a variety of possible combinations, sequences, and mixture of resources which shape . . . higher-order thinking" (Teoh & Neo, 2007, p. 28). Interactive digital media is also a very attractive information paradigm when compared to asynchronous chat via text, printed textual readings, and lecture, because it provides a combination of movement and sound that many find as a superior source of entertainment. Entertainment methods and educational methods, however, are not always in parallel in their ability to demonstrate high outputs of happiness on par with learning outcomes. The problem is that there is not enough good data on the impact of digital on outcomes in K-12 and higher education to warrant replacing these older information formats entirely. Furthermore, while educators everywhere are becoming more unified in their calls for more consistency in outcome skill development, there debates on assessment that may never end.

It is understood that higher education, for example, desires an overall increase in the areas of STEM and CT. No generally agreed upon assessments for STEM and CT outcomes exist, however, and this situation combined with the fact that there is not enough data on the impact of replacing older information formats (viz., text, imagery, chat) with digital media shows a potentially dangerous convergence implying interactions yet to be maturely assessed when targeting a variety of educational outcomes (Cottrell, 2014). While Mitra's experiments may show equivalent outcomes for some STEM learning objectives in K-12 learners via the use of digital media, assessing something like English grammar skills of his New Dehli learners may very well show little improvement over a traditional one-term, face-to-face English as a Second Language (ESL) course.

FUTURE RESEARCH DIRECTIONS

David Wiley (2013) explains that digital media tools like Open Educational Resources (OERs) have been found to be better at increasing educational outcomes versus traditional texts. Wiley also cites an extensive research project from Nature comparing the quality of content from Wikipedia to peer-reviewed, for-purchase traditional text materials, viz., Encyclopaedia Britannica (Giles, 2005). The parity in the number of errors in like-minded content sections of the various information sources tested demonstrates the power to be found in digital media educational resources, some of which allow free access to material commonly used by students toward their learning outcomes. Britannica responded to Nature's research

with a comprehensive negation of all results (Encyclopaedia Britannica, 2006). Similar to the Clark (1994) and Kozma (1994a: 1994b) debate 20 years ago, Nature has returned with another response, providing access to its research data and methodology and leaving room for future debate. What is undeniable is that learners want open digital content, and will use it as proliferation increases. It is also important for teachers, parents, school administrators and educational researchers to accept that students will augment instructor-created (or approved) digital content with random content they find on their own. This may skew research efforts in the future as researchers lose less and less of a sense of which digital media (approved or unapproved) is helping/hurting students' learning outcomes. If educational digital media content from anywhere (and hosted everywhere) is increasingly becoming impactful toward learning objectives, further research is warranted before wholesale adoption begins.

Google's Potential Edge in Transforming Instruction and Learning

Perhaps the single greatest concern in regards to digital media's potential affects on education throughout society is Google, Inc.—specifically in the form of one of its most popular subsidiaries, YouTube. While scientists and researchers debate the form, function and impact on outcomes of digital media in the learning ecosphere, Google has been slowly allowing for the creation of the worlds largest and most free educational institution (albeit devoid of an organized curriculum). Combining Google search and Google Scholar with YouTube gives an individual the power to learn more from digital media than ever before. The convenience of educational and instructional content to be found on YouTube, for many users, trumps that of any traditional school or training center. If an individual wants to learn how to change the brake pads on their vehicle, YouTube will potentially be able to store digital media content related to a users' exact year, make and model of vehicle teaching him or her how to perform a specific action over and over again. If users want to know which version of a particular mobile device is most durable, YouTube can contain hundreds of digital media recording durability tests for one particular mobile device adding to potentially thousands of hours of video on every mobile device every made.

Siva Vaidhyanathan's (2012) book, *The Googlization of Everything*, offers a clear warning about the disruption Google and its subsidiaries can enact onto society at large. In addition to Google Search dominating individuals' ideas of what search engines are, and YouTube providing a dominant instructional digital video platform, Google has entered the educational hardware ecosphere with its very low cost and low-priced Chrome books for student access to its web browsing software and open productivity suite, Google Docs. In an educational environment where "dollars-per-student-spent" on technology equates to quality education at the same time that taxation for funding education is viewed by some as an abuse of civil rights (Rodriguez, 2014), Google can circumvent the notion that more money technology is better not through empirical research on learning outcomes, by providing completely integrated content, hardware, software, operating systems, mobile connectivity and remote broadcasting (through Chromecast) a very low price point. Essentially, Google is building the structure for the world's largest database of instructional information, digital text, video and audio media, and delivery hardware and software at a fraction of the cost to a user versus any traditional learning environment. And, many of their digital media offerings connect students to information for free.

The bulk of the future of educational digital media may already be in the hands of one corporation that does not declare itself to be a school of any type. Large-scale efforts to offer MOOCs (massively open online classes), whose basis for existence is the presentation of digital media to learners in a free (or nearly-free format), are already supported by long-standing, well-capitalized traditional brick-and-mortar

institutions. Coursera is partnered with over 75 American traditional institutions of higher-education including Ivy League universities and large state institutions like the University of Virginia. They also are partnered with some of the largest universities from over 25 other countries (Coursera, 2014). A rival, EdX, offers courses from traditional higher education powerhouses MIT, Harvard, the University of Texas and others. They boast 200+ individual courses, 400+ faculty and 100,000+ online certificates granted so far (EdX, 2014). What, however, about the total amount of digital media needed to deliver this educational experience? The amount of raw educational content from these leading MOOC institutions, which comes solely in the form of digital media, pales in comparison to what can be found on Google servers today. All Google needs to do is begin charging for their services, and the ease of acquisition of their educational content can yield a sizable profit, or none at all; they are at their leisure to begin operations as an educational institution with a varied and diffuse instruction base. Essentially, Google may already be the largest educational institution on earth—all due to the advent of digital media throughout society. The company already has the search tool needed to aggregate their content into instructional, and even curricular, modules of their own.

Regardless of the source of the content, future work should explore what digital media is doing inside the minds of learners as it is presented to students in conjunction with text and other material types as the future of routine adoption of digital media-capable, cheap, lightweight, and mobile devices continues to supplant the traditional physically printed word (Hu, 2011; Hurdle, 2011; Schaffhauser, 2011). Studies that seek to indicate that a mixture of material types yields the best educational outcomes may become more necessary as ADA requirements, the long-standing impact and debate of Multiple Intelligences Theory (Gardner, 1985), and the newest addition of Universal Design for Learning (Orkwis & McLane, 1998; Gargiulo & Metcalf, 2012) impact all levels of education. The presentation of the same material in a variety of different formats (involving different or the same authors) could be found to hinder certain outcomes and improve others. Determinations on which outcomes are preferred in certain educational environments are a perplexing problem necessitating future research.

CONCLUSION

Throughout this chapter, a review of literature and concerns related to digital media's effects on society within the context of learning and instruction has been presented. The prevailing finding is that digital media is being created and consumed at ever-increasing rates, yet the outcomes in the minds of learners affected by digital media are not easy to predict or always moving in the desired direction. It is known that people are using digital media each day to gain knowledge, understand concepts and learn new ways of seeing the world around them. Digital media provides an unprecedented opportunity for the whole of society to instantly access instructional content to learn more concepts than any set of humans in recorded history.

Instructional and learning outcomes and digital media continue to be pressing issues for educators seeking strategies to improve the educational experiences of students. The need for increased accountability within the formal educational atmosphere also shows no sign of abating. As digital media takes over as the dominant form of classroom information source, assessment of its impact deserves attention. Challenges persist in linking learning outcomes and objectives to the influence of digital media in the classroom as K-12 and higher education advances through the remainder of the century. Historically, literacy—a goal achieved through engagement with the reading and creation of physical text—has been

one of the chief concerns of education. As literacy has become more of a virtual guarantee (Central Intelligence Agency, 2012) for students in developed nations like the United States and Western Europe, more focused learning outcomes like STEM, CT and PSA take center stage. Learners can read and write text, but what can they do with what they have learned and how do they explain what they deduce, feel, believe, and know? Digital media will impact these outcomes as it presents information to and interacts with the cognitive ability of all learners. Finding how well the interaction is accomplishing educational outcome targets is now the necessary research goal.

Discussion between researches like Clark (1994) and Kozma (1994a), rooted in foundational assertions like Marshall McLuhan's (1964) "the medium is the message", provides some of the main catalysts for the need for future research. Kozma's refutation of Clark's replaceability challenge ultimately wins the going forward, because all digital media are truly not equal, and therefore, reaction and observed learning outcomes will never be equal across seemingly replaceable digital media types. Digital media types contain their own distinctive educational traits and will produce unique learning outcomes, if students under their influence can demonstrate what they assimilate as they learn. Mayer's (2001; 2005a, 2005) research into media and cognitive load give caution to instructors to assess effectiveness of media instead of adopting a "more is best" approach to the inundation of student minds with as many types of digital media as possible.

All digital media objects are increasing rapidly in development and deployment in all types of educational environments, because of their perceived benefits and efforts to conserve time. Importantly for research considerations, however, is that digital media research shows many mixed results on the impact of this popular and popularly easy-to-use and create medium on learning outcomes. Foundational research like Azevedo, Moos, Greene, Winters, and Cromley (2008), Mayer and Moreno (2003), Stoney and Oliver (1999), Thomas et al. (2001), Starbek et al. (2010), and Sullivan-Mann, Perron, and Fellner (2009), followed more recently by Kayaoglu et al. (2011), Serin (2011), Smith (2012), Marra (2013), Rodriguez (2014), Alexander (2014), and others described in this chapter and found in additional readings, give direction on how to conduct digital media versus traditional learning resource impact assessment studies in a variety of educational settings targeting many different instructional outcome goals. The limited amount of comprehensive research focused on the impact of digital media on learning and instruction is ironic considering (a) the sheer number of students using digital materials today, (b) the large number of digital media objects being created each hour, (c) the assumptions about their benefits to knowledge acquisition, and (d) the high degree of self-efficacy students feel about their engagement with digital media in learning environments despite mixed results on actual outcomes performance. Overall, finding solutions to the problems of cognitive overload combined with access to digital media material and determining what these media do to learners' brains in terms of outcomes serve as major influences for future research needs, as well as future strategic planning about digital media object distribution to students.

Teachers and instructional designers aspiring to design and use digital media that includes educational content that is convenient for a mass audience, entertaining to multiple senses, and potentially absorbed very quickly (versus traditional text-driven content) will find insight from exploring the research found in this chapter, and from any future replicating research going forward. As popular as digital media may be, educators today are potentially faced with many difficult choices regarding the use and popularity of digital media over older information formats (Broussard, 2014; Flood, 2012; Kurzweil, 2005; Vinge, 1993). While this chapter has reviewed the historically substantiating literature, the importance of text-based materials to learning is evident over hundreds of years of tradition since the time of the invention

of the printing press. It cannot be ignored, however, that digital media changes the educational landscape in a way that is often initially perceived as a universal benefit containing few, if any, potentially negative learning consequences. Why would students not want to learn via a method that combines text with audio, video, and/or images? Why would this medium not be the best option in all cases for learning? Students do, in fact, a) believe that they are learning more through content-equivalent digital media, b) enjoy not being required to purchase a non-digital materials, and c) look forward higher outcomes for themselves after taking courses using digital media. The literature shows that perceived higher outcomes through digital media, however, are not always realized. Individual learners are viewing their educational experiences with digital media as a benefit before actually knowing how well or poorly they perform on examinations within courses or on their final grades.

Pursuing the questions found in this chapter will impact various types of educational leaders and policy makers as they struggle to meet the challenge of the mass adoption of digital media content for learning. Institutions can use questions like these as strategic markers for conversations regarding directions for the advancement of their own student learning goals and objectives. Regardless, the need for further research on the topic of digital media affecting society through learning and instruction is clear. Better understanding of how to either decrease the damage done to educational outcomes by digital media, or how to better integrate the positive cognitive benefits of traditional learning information materials into digital media, is a goal that will benefit students in the future.

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KEY TERMS AND DEFINITIONS

Digital Media: Any single item or set of items combining text with audio, video, or images for the purpose of conveying information leading to meaning in the mind of a user.

Education: The transfer of understanding, skills and/or knowledge from one source to another.

Instruction: The process of delivering education from one source to another.

Learning: The demonstration of understanding acquired through various aspects of educational experience.

Mental Model: Active and dynamic representations of knowledge that visualize the invisible by creating analogies between what is known and not known.

P-20: Pre-school through traditional undergraduate education in the United States.

Schema: Organized collections of information containing understanding of how each individual piece in the collection relates to one another.

Traditional Media: Any single item or set of items only relying upon physical form for the conveyance of information leading to meaning in the mind of a user.

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Section 5

Organizational and Social Implications

Chapter 57
What Does Digital Media Allow Us to "Do" to One Another?
Economic Significance of Content and Connection

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ABSTRACT

The purpose of this integrative review of theory and research is to assess the economic impact of digital media in ways that are unreached by instrumental means of measuring economic activity. Specifically, we use three overarching arguments identified from a review of the literature that broadly defines the economic force of digital media content in contemporary society. We contextualize those arguments in terms of current issues in the field and gaps in the research base before concluding with a discussion of the implications of what we learned for education, civic engagement, social practice, and policy.

INTRODUCTION

The purpose of this chapter is to interpret the economic significance of digital media through three general arguments about digital communication in contemporary society. Understanding linkages between digital media and social networks enables a view of economic significance driven by digital media's potential to shape human life. In the rapidly shifting digital world, moving beyond explicitly financial or monetary measures of economic activity shifts emphasis away from reactive analysis of completed sales toward proactive understanding of change and exchange as a core feature of human culture. Such a view helps

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interpret tensions in education surrounding literacy. It affords analysis of changes in human communication readily, but not yet fully, commodified economically. Such a perspective, we argue, is necessary for productive thinking about literacy as a social practice, literacy education, civic engagement, and policy.

SUCCINCT OVERVIEW OF THE RESEARCH

We begin with an integrative review of theory and research on the role of digital media in contemporary society's global economy. Definitions of *digital media*, *contemporary society*, and *global economy* are best formulated as systems within systems. For example, in Nick Couldry's (2012) *Media, Society, World: Social Theory and Digital Practice*, he lays the foundation for a new sociology of digital media as a means of dealing with the complexities of living in a 21st century media-saturated world that extends beyond the social to include the economics of production and consumption. Amid unceasing calls for education, policy, social practice, and civic engagement to "keep up" with digital media, Couldry asks a moral question that holds a key, we argue, to understanding the nested economic impact of systems within systems. What does digital media allow us to "do" to one another?

The term *digital media* defies attempts to reach consensus on its meaning. We review literature on the construction of digital media as content (print and nonprint) that has been digitized and thus potentially ready for dissemination on the Internet. We echo the insistence from various fields of research on digital media that digital media content is a kind of tip of the iceberg for the ways digital media is reorganizing and managing our actual and metaphorical households and villages. Starting with content serves as a starting point for discussing digital media's broader impact on our lives in the broad sense that Couldry intends.

Below, we pursue three arguments we identified from a review of the literature that broadly define the economic force of digital media content in contemporary society. We then contextualize the arguments about digital media content in terms of relevant social, political, and economic factors that mediate the production of digital content. This approach makes it possible to assess economic impact of digital media in ways that are unreached by instrumental means of measuring economic activity (e.g., Boggs, this volume; Chambers, 2013). We seek to capture the essence of how digital media affects the "management of the household or village" (Author C's interpretation of etymology of *Greek oikonomia*).

Argument #1

Digital media in a contemporary society—one that requires a global marketplace to satisfy daily needs—is multimodal (i.e., composed of images, sounds, and bodily performances, as well as oral and written language).

One result of the breakdown between formal and informal learning (Dabbagh & Kitsantas, 2012; Hull, Stornaiuolo, & Sterpont, 2013) is the opening up of spaces in which users explore new online ways of participating and communicating specifically in multimodal ways—ways that require collaboration, production, and dissemination of one's own digital texts as opposed to mere consumption of such. Media production has always been multimodal, but digital media makes multimodality a core feature of interactions with economic potential.

However, digital media *content* and digital media *space* suggest quite different economic possibilities. On the Internet, digital content generated by users, such as a Facebook post, could change nothing or everything, and it seems impossible to predict. However, the social *space* created via Facebook has far more stable, predictable, *tradable* economic value. The newsworthy buying and selling of social media pillars and startups is only one part of the picture. Innumerable businesses make calculated investments about the potential for their enterprises to succeed through merger into digital spaces produced by other vendors.

These developments are not insignificant. They represent a major disruptive innovation in the production of social space. Lefebvre (1992), in Geography, proposed that a place like a city or a rural area at a particular time was a social construction, a kind of script guiding behavior in service of a set of controlling interests. The rapid production and valuation of distinctive online spaces underline digital media's role as a socially produced economic space.

How many downloads per dollar investment? How much traffic is generated by a slicker website? How do customers relate to new products through online video, live chat, and so forth versus traditional print and telephone support? How many purchases per ten new followers? How many additional reservations per dollar spent for online services? These questions resemble those of the shopkeeper or farmer, yet they are following, according to Lefebvre (1992), an overarching ideological and economic script. The distinction between content and space points up the economic importance of digital spaces as socially constructed tools that alter day-to-day activities, job creation, and balance sheets.

Moreover, the situations elicited above largely rely on existing spaces that attract investment. Online *learning* spaces represent a different but equally important multimodal digital media environment where, again, digital content by no means indicates economic impact. In the case of Wikipedia, for instance, donations purchase server space and employ editors, but the economic impact of readily available information cannot be quantified. Yet it is unquestionably greater than the economic footprint of the web encyclopedia organization. Online learning spaces marshalling experts' knowledge resources daily shape economically significant choices worldwide, from when to plant corn and beans to projected trading values of those commodities. Networks of various kinds have formed to define formal and informal research agendas for their particular areas of expertise. However, these networks that connect digital media content and digital media spaces participate in complex economies beyond the traditional buying, selling, and distribution of goods and services. The economic impact, then, is a matter of potentiating connection.

Online learning communities spanning the early grades through higher education (Ito, Gutierrez, Livingstone, Penuel, Rhodes, Salen et al., 2013) have used "connected learning" to evoke this sense of potentiality. A report of the work (http://dmlhub.net/sites/default/files/ConnectedLearning_report.pdf) presents the concept:

It advocates for broadened access to learning that is socially embedded, interest-driven, and oriented toward educational, economic, or political opportunity. Connected learning is realized when a young person is able to pursue a personal interest or passion with the support of friends and caring adults, and is in turn able to link this learning and interest to academic achievement, career success or civic engagement. This model is based on evidence that the most resilient, adaptive, and effective learning involves individual interest as well as social support to overcome adversity and provide recognition. (p. 2)

The nine case studies detailed in the report demonstrate how the connected learning framework addresses our interest in knitting together education, civic engagement (both local and global), social practice, and policy.

Numerous research projects confirm Ito et al.'s orientation toward choice and cultural relevance in the expansion of digital media as an economically meaningful part of life (e.g., Kleine, 2010; Mansell, 2001; Selwyn, 2004). In sum, then, digital media is crucially multimodal, both in terms of digitized content as well as in the social interactions it mediates: the production of new social spaces and the facilitation of learning for economically significant action.

Argument #2

Given all the frenetic activity associated with online broadly-defined text productions, virtual collaborations, and novice dissemination efforts, a savvy consumer will make decisions about what digital content is worthy of attention and what is not.

Nearly two decades ago, an economist named Michael Goldhaber (1997) predicted that the *economics of attention* increasingly important in the global age, as a glut of information, news, and entertainment flooded communication pathways. He rested his economics of attention on the commonly accepted notion that a resource that is in short supply will be in high demand. The scarce resource, for Goldhaber, was human attention.

Attention economy is not a *laissez faire* theory of digital media that gives market dynamics responsibility for producing quality. Instead, scarcity of attention guides the designs of digital spaces, efforts to regulate access to certain kinds of information deemed "spam" or antisocial, policies that protect intellectual property, and campaigns to grant or increase access to digital media. Each of the above areas assumes the economic importance of interwoven online and less-connected aspects of our lives. Garnering and controlling attention via digital media is an important part of altering economic behavior, especially, but also political and personal as well.

The attention economy helps explain why digital media is an unstable constellation of ever-changing platforms. The quest for high ranks in search engine results illustrates how attention economy drives the continual refinement of information delivery on the web. Again, the economic impact of attaining high rank on Google has obvious yet hardly quantifiable impact. More importantly, the development of new opportunities for interacting digitally results in fundamental changes in human interactions, driven indirectly by quests to stay on top of search engine rankings, earn privileged status in a mobile app store, or otherwise justify investors' risk.

Argument #3

The role of digital media in contemporary society's global economy is reflected in the speed with which memes—e.g., phrases, images, videos, sound effects, songs and the like are copied and spread rapidly by Internet users—typically without regard for whether the message or intended meaning is clear or not.

With few exceptions, digital media content readily accommodates strategic re-use. Internet memes express digital media's affordance for sharing and re-combination. However, they expose a serious vulnerability of discussing digital media as content only, since the importance of memes rests in their strategic use

and popularity (i.e., social elements), and their power (i.e., political and ideological elements). Online strategic sharing of excerpted information for new users' purposes underscores the weakness of a content-oriented assessment of digital media's work upon us. Economically, the meme stands for digital media's capacity to blend the human and nonhuman elements of geographically, politically, and even temporally disparate groups or divided people otherwise enjoying fellowship. The production of new households or villages manifested in massively or locally popular memes displays the economic muscle of digital media as it works upon us.

A common critique of digital media's apparent disregard for accuracy in communicating messages online is harbored in memes that go viral. For example, in a 2002 TED talk, Dan Dennett, a philosopher and cognitive scientist, unleashed a barrage of ideas that led to 1,266,365 views as of October 26, 2014 about why memes are dangerous and in need of monitoring (www.ted.com/talks/dan_dennett_on_dangerous_memes?language=en). Briefly, Dennett argued that a meme is often misused, even abused, with each repetition of an idea that a meme comes to represents. To prevent a meme from being caricatured by people intent on turning a benign idea into a variant idea that is dangerous when spread by individuals bent on serving their own needs or causes, Dennett claims we must be ever vigilant. He likens a meme to a virus, giving Richard Dawkins (1976) credit for that term, which spreads and becomes toxic to those who have no immunity to it. Here, Dennett is speaking of cultural memes—ideas tolerated in one community but viewed as abhorrent in another community.

For example, the well-known meme featuring Don Draper from the television show *Mad Men* has gone viral with the saying, "They say a woman's work is never done. Maybe that's why they get paid less" (Gallagher, 2014). Here, we see a message being spread online that depicts the reality that women are paid less than men in the work force today. Yet, the premise behind *Mad Men* is to actually bring those issues of injustice to light (Gallagher, 2014).

For purposes of illustrating Argument #3, we used Dennett's TED talk on dangerous memes as the impetus for mining a substantive body of critical media research (Meehan, 2002; Smythe, 2006). Key to interpreting that literature is a knowledge of how the feminist political economist Eileen Meehan's (2002) research shifted an earlier focus on large-scale, impersonal media corporations and their shaping of cultural commodities and media markets to a focus on women who worked in the media industries. Meehan argued that despite what pleasures a viewer outside the commodity market, which at that time equated to white, 18-34 year-old heterosexual males, television was an agent of oppression. Expanding on Meehan's earlier claim, we see a parallel in some video games' digitized content that results in online harassment of women http://www.democracynow.org/2014/10/20/women_are_being_driven_offline_feminist). The market potential of such misogynist online video games demonstrates the economic muscle of digital media as it works to transform women into mere commodities.

CURRENT ISSUES IN THE FIELD

The purpose of this section is to describe the linkages between the three more general arguments already identified and the specific relationships of power that embed themselves in those arguments. We begin with an observation that occurred to us as we read broadly in the literature on digital media: that is, technology today creates an exciting terrain for society to create in ways it has been unable to do before now. People with access to the Internet are able to navigate the digital mediasphere with relative ease despite an abundance of information that comes at them from every angle and at all times. It is an

incessant display of affordances that individuals before the 21st century could not have imagined, except perhaps in a science fiction film that provided viewers with a glimpse into all that could be connected in a world of touch screens and other digital devices.

Yet, the freedom such affordances provide in terms of communication channels, especially those with nontraditional ways of communicating, makes digital media content and digital media spaces compete for the user's attention. For example, what "app" on a phone will help us create that perfect touch to our photo? Which "hashtag" on a social media site, such as Twitter, will most quickly reach a group of like-minded folks to let them know a new song has just been released? What can we add to our online profile to draw people to our page? These questions point to an overall bigger issue, namely, how, and more importantly, *why* does one have time to interact with most, or even some, of the digital media available today? Furthermore, if digital media is multimodal, readily available, and participatory how do the consumers and producers impact the spaces in which they are connected through the digital media? While there are no easy or simple answers to these questions, slicing it into smaller bits, such as the three sub-issues examined next, is as good a starting point as any.

Digital Media's Challenge to Traditional Print Literacy Practices

Multimodality refers to forms of communication that extend beyond print only. Briefly, multimodality views "representation, communication, and interaction as something more than language" (Jewitt, 2011, p. 1). As noted previously in this chapter, boundaries between formal and informal learning are being broken down (Dabbagh & Kitsantas, 2012; Hull, Stornaiuolo, & Sterpont, 2013), and our society is taking a more connected approach to its interactions (Ito et al., 2013). The problem, however, is that multimodality challenges traditional print-based literacy practices and not all parents, researchers, administrators, teachers, and teacher educators like the changes they see occurring. For example, high-stakes testing remains on the radar and continues to draw heated debates. Standardized tests come in for their share of critique largely because they traditionally privilege print-based reading and writing skills at a time when many young literacy learners with high-speed Internet access are using multiple modes of communication and digital media (e.g., still and moving images, sounds, gestures, and live performances) to interact with others within both local and global spaces. Thus, the disconnects in learning that can develop when traditional literacy practices meet technology-rich, multimodal ways of perceiving are quite stark and create challenges on all fronts (Leu, Kinzer, Coiro, Castek, & Henry, 2013).

Due to "changing relationships to truth and authority—in which knowledge is no longer certain or stable" (Jewitt, 2001, p. 3), we now are experiencing "mediated interactions" in which knowledge is consumed, produced, and disseminated in a variety of complex ways all of which impact the economic capital within the digital sphere. To limit our understanding of these (social) complexities would be to act as if "social, cultural, and historical conditions of societies" were not interconnected at all (Jewitt, 2011, p. 5). In other words, while multimodality has "emerged from linguistic theories" (Jewitt, 2011, p. 6) and pulls from a traditional foundation, it allows us a certain flexibility to engage with and question what constitutes a text. Furthermore, multimodality helps us see why and how people become authors of texts, how texts are read within situations, and how we can analyze these mediated texts, as well as the responses that they produce outside of the traditional definition of print-based language only.

When we look beyond the traditional definition of language, we start to see how a variety of "modes" facilitate varieties of participation in digital media environments. Kress (2011) defines a mode as "a socially shaped and culturally given resource for making meaning" (p. 54). For example, youth use media

that is "converged around multifunctional screens that integrate voice and text communication, image and video, games, photography, music, television, print, and apps" (Ito et al., p. 28). These user-friendly tools train us for a new economy in which digital media allows and requires us to connect to others in ways that extend beyond *meanings* into new forms of formal and informal economic activity.

Thus, as our contemporary society becomes more globally connected through digital interactions, literacy practices shift. In these digital media spaces, it becomes possible to be used by our literacies even as we use them for our own purposes (Brandt & Clinton, 2002). For this reason, efforts to expand literacy practices of students become entangled in economic imperatives of forging connections among local and global communities.

This entanglement works upon literacy education in multiple directions. Teachers may be using digital media to help prepare students to engage with the literacy practices that allow them to participate in the global economy through connected learning opportunities (Ito et al., 2013), but regional or national political and economic interests—represented by departments of education, educational textbook publishers, and curriculum and assessment developers, to name a few—work to standardize outcomes of formal schooling that do not necessarily focus upon those opportunities. Testing demands, financial commitments to curriculum developers, and the politics of education can stifle the difficult work of building authentic classroom connections with local and global communities. As a result, many classrooms still privilege print-based language uses over digital media.

As Ito et al. (2013) suggest, it is not that society should abandon traditional literacy skills, but instead it should focus on "diversifying and multiplying entry points and pathways to opportunity and meaningful participation in society" (p. 34). Students' literacy futures, identities, and opportunities as productive consumers and producers within society today collide with efforts of a strong central government to safeguard existing economic commitments to the teaching profession, manufacturing, publishing industries, higher education, and other economic dynamos of bygone years.

By allowing our definitions of texts and their meanings to encompass multimodality through digital media, we allow students more opportunities to use language in ways that value their experiences, knowledge sets, beliefs, and learning spaces. Furthermore, this expansion of the traditional definitions that privilege print-only texts leaves room for innovative projects such as the Europeana Space Project (http://www.europeana-space.eu). This project focuses on creating "new opportunities for employment and economic growth within the creative industries sector based on Europe's rich digital cultural resources." Thus, its strength lies in its ability to use available digital media in ways that incorporates multimodal "language" to prepare students to be effective members in a global society. At the same time, the development of new literacies among students position them to be exploited by the potentially adverse economic conditions of the new work order (Gee, Hull, & Lankshear, 1996). Under its terms, the buzzwords of the new economy—democratic, horizontal organization and collaboration—mask economic directions that preserve status quo and maintain traditional boundaries of wealth and power.

In order to communicate effectively within the global landscape, we build "language toolboxes" to help us understand how messages are represented in a variety of formats and what they are supposed to mean to others and to ourselves (Ivarsson, Linderoth, & Säljö, 2011, p. 203). Within the economic sphere, advertisers want consumers to use their toolboxes to embed every part of their company's message into their daily lives. Ivarsson, Linderoth, and Säljö (2011) believe that "representations serve as resources for communicating and meaning making, and they are essential to all human practices including perception, remembering, and thinking and other psychological activities" (p. 201). For this reason, the "mediated action," or the process of integrating the producer's message into our daily lives, is always important to

keep in mind (Ivarsson, Linderoth, & Säljö, 2011, p. 211) when we are trying to understand the space in which a text's content develops its economic impact for its audience.

When we consider digital media content here, we see that if the content is taken up by a company's consumers, then this consumption is the driving force behind all of the mediated actions that re-delivers the message in a variety of multimodal formats. Using the Internet as an example, we know that websites are feeding us unique content (through words, images, videos, and the like) that we potentially consider in our own lives. This process of expanding the Internet to become a means of navigating, thinking, speaking, and living is an attempt to foster at once an individual's own representation and a conduit for vast new domains of economic participation. Thus, with the proliferation of potential for asserting meaning comes immeasurable "traffic," or a volume of digital media activity on which its economic power rests. And, if more immeasurable traffic is present, then one must begin to question if consumers are duped, or, in fact, quite savvy with the digital media with which they work.

Media Dupes or Savvy Consumers?

Prior to the 1970s when Stuart Hall's (1973) work in what came to be called "cultural studies" made its mark in intellectual debates, media audiences were viewed as mere dupes of popular culture and mass communication. Though not digitized at the time, media producers' content was thought to represent the way people were positioned in the world and their inability to do little to counteract such representation. Hall, who was then Professor of Sociology in England's Open University, downplayed the role of media content and its influence on viewers' meaning-making abilities. Hall contended that images do not have stable meanings, and that producers' intentions at the time of creation do not guarantee that audiences will take up such meanings. It would be a mistake to characterize Hall as believing that media nearly five decades ago, and especially contemporary digital media, have no real and significant social, political, and economic effects on the world. He realized fully the influence of content and its intersection with powerful forces in society, especially in relation to what gets represented in the media. However, we contend that only with Latour's (2007) work on reassembling the social so that it accounts for nonhuman actants—a term that Latour (2007) used to denote an entity whether human or nonhuman that modifies the actions of another entity (e.g., pouring vinegar on baking soda)—has it become possible to trace associations "between things that are not themselves social" (p. 5). Latour boldly separated his work from postmodernism's attempt to deconstruct grand narratives that have long held people to hegemonic practices, which harm rather than advance their freedoms. In Latour's words, "Dispersion, destruction, and deconstruction are not the goals to be achieved but what needs to be overcome" (p. 11). Proponents of new materialism who have incorporated much of Latour's work continue to redefine the role of nonhuman actants. Most recently, posthumanist philosophers (e.g., Braidotti, 2013) and New Materialist scholars such as political theorist Jane Bennett (2010) use Latour's (2007) and Deleuze and Guattari's (1987) concept of assemblages—ad hoc groupings of human and nonhuman elements—to argue that agency is not strictly a human capacity. In Bennett's (2010) words, the material elements in an assemblage, "while they include humans and their (social, legal, linguistic) constructions, also include some very active and powerful nonhuman actants: electrons, trees, wind, fire, electromagnetic fields" (p. 24). To this list of nonhuman actants, we would add digital media.

Just as Latour and the posthumanist movement have sought to even the playing field that was central to Hall's (1973) concern about representation and the media, so too have education researchers worked to demonstrate the interface between human and nonhuman actants. For example, Bigum, Knobel,

Lankshear, and Rowan's (2003) research illustrates how digital media content and space exacerbate tensions that exist between the highly regulated economics of attention inside schools as contrasted with the relatively deregulated economics of attention outside schools, particularly in situations where mass media and new communication technologies dominate.

Specifically, Bigum and his co-researchers studied a group of Grade 9 boys who attended a rural school with Internet access in northern Australia's eastern coast. Their participants were initially viewed as "disadvantaged" in terms of "the lads' 'inability' to carry out the kinds of literacy based activities regarded as mainstream for Grade 9 English" (p. 103). Inside their school's regulated curriculum, the Grade 9 boys attracted negative, even punitive, attention—the kind that often resulted in instruction that merely re-inscribed the boys' sense of failure. However, when Bigum et al. intervened with a project that involved the boys in constructing a website on motorcycles—an interest that stemmed from a previous project in which they created a motorcycle magazine—the "disadvantaged" lads were positioned as experts in an area that attracted positive attention from their peers and supervising teacher.

This role reversal (going from "disadvantaged" to expert) demonstrates digital media's mediating effects on traditional ways of thinking of defining "failure" and its supposed fixed or permanent place in education discourse. We submit that with digital media as a player, so-called failure is an idea that teachers and students might jointly challenge in their effort to engage with learning on their own terms. In doing so, they might also find reasons to discard previous negative evaluations of student performance.

Digital Media's Disruption of Traditional Meaning Making

Researchers working within contemporary digital media culture, especially in the realm of social media, have reported numerous instances in which the *effect* of people's interactions is more important than the content or meaning derived from those interactions (Varis & Blommaert, 2015). An earlier recognition of this phenomenon is attributed to Vincent Miller (2008), a sociologist and social researcher who noted that in the digital age, "We are seeing how in many ways the Internet has become as much about interaction with others as it has about accessing information" (p. 398). Anyone who participates in Facebook and Twitter is well aware of how memes (or signs that go viral, such as the Don Draper meme discussed earlier) are more characteristic of networks involving human and nonhuman entities than they are of communities in which social interaction is not dependent on the internet.

Particularly in the digital world, relying on the disruption of meaning as a motivating factor in producing and consuming media content is complicated by issues of fair use and the marketplace, especially when transformative remixing is involved. Joyce Valenza (2009), a school library media specialist in a suburban Philadelphia high school, explained *transformativeness* this way:

When a user of copyrighted materials adds value to, or repurposes materials for a use different from that for which it was originally intended, it will likely be considered transformative use; it will also likely be considered fair use. Fair use embraces the modifying of existing media content, placing it in new context.

Examples of transformativeness might include: using campaign video in a lesson exploring media strategies or rhetoric, using music videos to explore such themes as urban violence, using commercial advertisements to explore messages relating to body image or the various different ways beer makers sell beer, remixing a popular song to create a new artistic expression. (Valenza, 2009, para. 6 and 7).

Legal backing for Valenza's interpretation of transformativeness grew out of a study conducted by Aufderheide and Jaszi (2008) at the Center for Social Media in Washington, DC, in which the researchers concluded that a "significant set of creative practices is potentially both legal and at risk of curtailment by currently discussed ways to control online piracy and theft of copyrighted works" (Executive Summary, para. 2).

Using copyrighted material to make something new—what noted media scholar Renee Hobbs (2010) calls *repurposing*—is still a gray area in the field of legal studies due to recurring battles over pirated content. As a result, researchers who want to study the use of digital media for creative purposes have increasingly turned to nonprofit organizations such as Creative Commons (CC) (www.creativecommons.org) for guidance in how to share content legally. A study by Alvermann, Beach, and Johnson (2014) is a case in point. The co-researchers designed a public website, Becoming 3lectric (www.becoming3lectric.com), for the purpose of studying the degree to which remixing digital content would push the boundaries of authorial intent and ownership. They settled on a CC license that met their university's requirements for studying and protecting human subjects. As a result, contributors to Becoming3lectric are legally able to collaborate, repurpose, and share their remixes while retaining their choice of options. For instance, contributors may not want to allow any commercial repurposing of their work, but still allow others to build upon that work if they are credited for it. Or, they may opt to upload their work without granting others any remixing privileges or the right to analyze their work.

With its various licenses for working flexibly and responsibly with digital texts, CC helps people forge new ways of disseminating multimodal content that might otherwise be impossible. Furthermore, as Suthersanen (2007) has pointed out, "Nowadays…do-it-yourself tools, including the CC licensing regime, empower and enable individual authors of literary and musical works to retain more control over their work" (p. 60). Theoretically, CC has flattened the global marketplace in terms of who can participate, as well as what kinds of knowledge count.

GAPS IN THE RESEARCH

Two major topics in the literature on the role of digital media in contemporary society's global economy for which little research has been generated are these: inequality in economic opportunity and the general fallout from untapped digital spaces and connections.

Inequality in Economic Opportunity

Speaking at the American Educational Research Association's tenth annual *Brown v. Board of Education* lecture, Gary Orfield (2014), Distinguished Research Professor of Education, Law, Political Science, and Urban Planning at the University of California, Los Angeles called for a new civil rights agenda. Specifically, Orfield argued that while the United States continues to celebrate Martin Luther King, Jr. and other civil rights leaders, as a nation it currently is failing to focus on the rights that are being lost. He specifically called attention to the fact that close to 60 years after *Brown v. Board of Education*, 40% of Black and Latino/a students are in what he described as "intensely segregated schools . . . with about twice the poverty concentration of the schools of Whites and Asians" (p. 273). To further complicate attitudes of low expectations for children in poverty schools in which advanced intellectual

work is viewed as being beyond their reach, all too often scarce digital technologies are used for basic skill and drill activities.

Echoing Orfield's grim observation, Ito and her colleagues (2013) described what they perceive as a downward trend in equal opportunity for society's least well off students: Over much of our nation's history, expanding educational opportunity has been, in fact and in perception, a key element in the 'rising tide that lifts all boats.' [Currently], after thirty years of steadily rising economic inequality in the United States, that tide is now running out, and our educational system may be doing more to perpetuate and even to increase inequality than to expand economic opportunity" (p. 13).

In their discussion, Ito et al. (2013) point to educational institutions as places that cater to only a certain group of students despite the fact that the economy and work force have become increasingly competitive and limited even for job seekers with a college degree. They draw from their pool of data to argue that educational institutions offer programs with alternative career paths to meet an increasingly diverse applicant pool. And, as previously discussed, they recommend that institutions "expand and diversify meaningful life options and pathways available to young people" or else they will be "reinforcing an educational system that only serves the interests of elites, breeding a culture of competition for scarce opportunities (Ito et al., 2013, p. 14).

In sum, claiming that currently a majority of institutions' responses to the need for equality in economic opportunity is unacceptable, Ito and her colleagues (2013) call for an increased awareness of how "in a world of global interconnections and rapid change, effective learning is lifelong and integrated into the real world of work, civic engagement, and social participation" (p. 14). For this awareness to grow and become second nature to society's way of thinking about inequality, a major shift in how we define *opportunity* must first occur.

A study funded by the William T. Grant Foundation (Carter & Reardon, 2014) is a starting point. This report begins to fill a gap in the research literature on the role of digital media in contemporary society because it lays out a strategic research agenda, which if heeded, could produce more than simply advocating for social justice and access to high-speed internet. Briefly, Carter and Reardon (2014) strategize a research program that would have researchers focus on the following questions: a) how do unequal opportunities occur insidiously over time, b) what social processes preserve inequality, c) which strategies can reduce the consequences of social inequality, and d) what mechanisms are at work that make the distribution of inequality taken for granted?

Fallout From Untapped Digital Spaces and Connections

Digital media content is reorganizing and managing numerous aspects of our lives on a daily basis as Couldry (2012) contends. However, less often studied and reported in the research literature on adolescents' out-of-school uses of digital media is the point that interactions between human and nonhuman actants have valuable economic potential. School-age young people's preferences for producing and learning with multimodal texts that combine moving and still images, sounds, performances, icons, symbols, and the like suggests that their ways of telling, listening, viewing, and thinking in out-of-school digital environments have potential for informing both their in-school identities as learners and hence the trajectories they will follow after graduation (Alvermann, 2010; Ito, Horst, Bittani, boyd, Herr-Stephenson, Lange et al., 2008; McClenaghan & Doecke, 2010; Rennie & Patterson, 2010; Skinner & Hagood, 2008; Thomas, 2007; Walsh, 2008).

Yet it is generally the case that the work of students who self-identify as users and producers of multimodal digital texts on their own terms and time is rarely visible to teachers. Alvermann (2011) linked this phenomenon to other research that suggested four barriers to teachers becoming aware of what their students are producing online in after-school hours. Briefly, she relied on two key tenets to analyze research findings on young people's out-of-school use of digital media. The first is that today's youth interact with each other and the web in ways that rely on collective meaning making, which Jenkins (2006b) describes as a condition in which "none of us can know everything; each of us knows something; and we can put the pieces together if we pool our resources and combine our skills" (p. 4). The second tenet is that literacy is a social practice (Gee, 1990; Street, 1993) and thus implicated in social reasons for getting things done (Barton, Hamilton, & Ivanic, 2000), whether for social, ideological, or economic gain. Experiencing social connectedness while engaging collectively in online literacy practices affords a sense of belonging and an opportunity to identify with others who have similar interests but may vary in their skills and access to material resources.

Among the numerous findings that Alvermann (2011) reported are several that point to barriers, which if overcome, could open spaces for more freely exchanging information, motivations, and accomplishments. The first of these was the prevailing assumption that multimodal digital content distracts. A second barrier consisted of socially constructed artificial dichotomies between in-and-out-of school learning (e.g., schools must be held accountable for covering a set curriculum whereas after-school online learning is just for fun). Third, the results of some studies Alvermann (2011) analyzed suggested that professional development efforts aimed at building teachers' awareness of the role of digital media in their students' lives fall flat when attempts at mediated action result in short-lived interventions that rely more on talking the talk than walking the walk. Finally, a fourth and all-encompassing barrier was the mistaken assumption that age-old tensions between institutional authority and youth identity politics could be easily resolved. When schools and adults are positioned as experts on all topics and students (novices) on few or none, the potential for in-school learning to capitalize on the digital literacy skills, interests, and competencies that youth are free to explore, trade, and expand on in online spaces.

IMPLICATIONS FOR EDUCATION, CIVIC ENGAGEMENT, SOCIAL PRACTICE AND POLICY

Here, our purpose is to highlight the implications of this chapter's integrative review of theory and research on the role of digital media in contemporary society's global economy. Specifically, we address implications for education, civic engagement (global and local), social practice, and policy. In doing this, we draw from each of the three arguments in Section 1 of the chapter that play out in overlapping ways through supporting evidence (Section 2) or lack thereof (Section 3) to inform this last section on implications.

Education

With the increasing focus on new literacy practices and digital media within classrooms today, there is not a question of *why* we should study digital media in contemporary society today, but *how* we should and can study its implications for the global economy. When preparing students with the skills they will need to be productive members of the global economy, we know that we are currently preparing them

for jobs that have yet to be created with skills that may become outdated. Teachers, and by extension educational researchers take on moral responsibility for the ways in which we position children to have their skills exploited economically.

Nonetheless, as previously discussed, "multiple forms of literacy have been named in the literature including information literacy, visual literacy, computer or digital literacy, and media literacy, but there is considerable overlap between these forms" (Considine, Horton, and Moorman, 2009, p. 471-472). The problem is not how these multiple forms of literacy overlap, but instead, how we begin to help today's students navigate these overlaps to better understand their role in contemporary economies.

When we take a "critical" approach to how media and culture are impacting classrooms, we bring an "understanding of ideology, power, and domination" to help students explore "how power, media, and information are linked" (Kellner & Share, 2007, p. 8). For these reasons, there is an increasing need for today's students to actively and critically consume and produce in both the classroom and their lives outside of school, too. With the expectation of their increased engagement comes responsibility to help students ask, as we have in this chapter, what should digital media be able to do to us?

For example, Jocson's (2010) study that noted the need for "critical multiculturalism" (p. 78) is important to consider when we think about the "dialogical relationship between consumption and production and what it means for youth who actively engage various media forms" (p. 79). In fact, as we know, "many young people are not just consuming cultural media but also producing and distributing their own" (Jocson, 2010, p. 80). For Jocson, her qualitative research focus on the process, product, and practice (p. 80) helped her understand the students' poetry through her critical multicultural lens. She notes that "to understand the poem is to understand the actual production" (Jocson, 2010, p. 84) and that "youth are active consumers as well as knowledge producers who with support from others are able to participate in a democratic order and confront social inequities in their lives" (Jocson, 2010, p. 86). The process she describes here and the outcome ties back to the role reversal that demonstrates digital media's mediating effects that allow students be the experts in spaces that extend beyond the classroom walls.

Economically, the technological changes encapsulated by the term digital media signals the possibility for classrooms to move out of a perpetual "research and development" existence. Students can create in a variety of ways that extends beyond classroom walls or the pages of a book. Their posts can go viral, earn money, shape policy, solve meaningful problems, and attract all manner of attention. Instead of focusing on how to keep these mediated intersections of multimodal digital media and print-only language uses from occurring in schools, we should be actively invite them in by "creating school discourse that is not separate and distinct from the blurred discourses of our lives outside of school" (Alvermann & Hagood, 2000, p. 203). When we keep the doors open to the possibilities of digital media and literacy, we create opportunities for all to be valued in and out of school, both now and in the future.

We continue to see that "young people are tirelessly editing and remixing multimodal content they find online to share with others, using new tools to show and tell, and rewriting their social identities in an effort to become who they say they are" (Alvermann, 2008, p. 8). In other words, today's students' literacy practices are both narrative as well as connective especially as these texts become more social.

For this reason, the social nature of literacy practices today gives all of us a new way to think and connect with those around us. In fact, literacy is not just limited to the "local" realm either, such as the classroom. Literacy infiltrates, disjoints, and displaces local life (Brandt and Clinton, 2002, p. 343). It is never just the local impacting literacy practices, but instead the transaction that takes place within that moment: the consumption and production of media with the tools to disseminate "new" informa-

tion in a "new" way created by the consumer, which invites new literacy forms that essentially connect everyone everywhere.

However, what do these new literacy forms mean in regards to today's classrooms? Because we are placed in social situations that "call for critical approaches that make us aware of how [the] media construct meanings, influence and educate audiences, and impose their messages and values" (Kellner & Share, 2007, p. 8), we need to help students move past the obvious meanings and work on a deeper level with the texts in front of them. And, because these mediated, "new" texts are constantly changing in form, it is important for them to understand why and how those changes are being made, including how different formats impact our reading of those texts.

Typically, the "critical component of media literacy must transform literacy education into an exploration of the role of language and communication media in order to define relationships of power and domination that are ultimately deeply embedded in ideological notions" (Kellner & Share, 2000, p. 8). For this reason, students need to see how authors of multimodal messages are consuming (including billboards, music videos, newspaper articles, and novels to name a few) and positioning them as consumers with many mediated messages.

In addition, by helping students to understand how they are already being positioned in the real world by their critical productions (e.g. blog posts, tweets, lyrical raps), we can help many students see connections between their in and out of school literacy practices. "We live in and move in a material world; the things in it—objects, visual representations, machines, and tools—take part in our dramas of meanings as well" (Gee, 2012, p. 185). Thus, students "dramas of meanings" are created in all that they do; yet, the need to help them navigate those many connections and meanings continues to be critical since they are already consuming, producing, and sharing digital media on their own.

Civic Engagement

The production of new social spaces engenders new forms and avenues of civic engagement. Numerous large-scale social movements on every continent underscore the role of social media in landmark social protests. Part of educating students, then, is helping them understand how to manipulate digital media, through which they may be working on a daily basis, to serve civic engagement purposes.

Jones (2011) emphasizes the fact that these communication spaces, or sites of display, become "social occasions in which particular configurations of modes and media coverage in a particular time and space in order to make particular social actions possible" (p. 114). Of course, "the problem with examining sites of display outside of the context of their use by 'watchers' to perform particular social practices is that what people can do with different sites of display alters radically in different contexts" (Jones, 2011, p. 114). Thus, every site of display, or composition space, changes depending on who is viewing it, from what angle it is being viewed, and how it is positioned and embedded within other sites of displays before it may be repurposed within the digital sphere.

In other words, sites of displays are where the reader/viewer actively participates and makes meaning of the constructed text, emphasizing a symbiotic relationship between social practices and itself (Jones, 2011, p. 116). Because sites of display involve social practices, they do become a form of social interaction, where the viewer can become a part of the action by creating her or his own meanings, and social identity/identities as well.

When we think about the attention economy and schools as sites of display, we recognize the restrictive norms for language use that represent the antithesis of the flexible stance needed for civic engagement.

Language use within schools traditionally focuses on what is deemed as a "success" (such as writing a five paragraph persuasive essay) versus what is deemed as a "failure" (such as devaluing that same essay created through a video narrative). If schools devalue students' language by restricting them from creating and sharing information in meaningful ways, then students' attention will be spent on what matters to them and what gives them the most social capital, or power, within society. Thus, it's not about the highest score on a test; it's about how many new followers one gets on Twitter thanks to a strategic tweet at just the right time, for example.

Within contemporary society, we all navigate a text-mediated world in which time, space, identity, and meanings are intricately connected. By using these components as tools, we can create digital texts that accommodate the amount of time we have while moving from one place to another and sharing within a public or private digital space. For this reason, it is increasingly important to understand that "meanings are made across time, across space, in and through matter" (Lemke, 2011, p. 143). However, as educators and researchers, we cannot be afraid of this mediated world and must focus on working towards a common goal of considering how both local and global civic engagements are impacted by these mediated meanings.

"Grassroots social movements, nongovernmental organizations (NGOs), scientists, activists, governments, and some businesses resist IP [intellectual property] with a range of tactics, both inside and outside the policy world, in local, national, and international venues" (Schweidler & Costanza-Chock, in-press, p. 4). Regarding digital media, this point suggests that meanings and knowledge are privileged and guarded closely by those organizations/powers in charge. Yet, if our goal is to unlock the potential of digital media, we must work towards ways of using what we learn from social practices that have the potential to inform policy.

Social Practice

Studies that focus on digitally mediated actions in 21st century learning environments (whether formal or informal) share a common characteristic: "irreducible tension between cultural tools, on the one hand, and agents' active uses of them, on the other" (Wertsch, 1998, pp. 518-525). This is the case even when tools are redefined to reflect Latour's (2007) thinking on human and nonhuman actants. Regardless of whether those actions are socially distributed or directed at individuals, networked digital media technologies ensure that social practices associated with online production, distribution, and consumption are partially dependent on one's audience—whether approving or even disapproving audiences (de Castell & Jenson, 2004).

This factor plus a growing awareness in the field of education that it is the quality rather than the quantity of attention that matters have influenced researchers to focus on young people's penchant for curating online texts that have potential for later remixing. In studying the social practices around remixed texts, for example, Ian O'Byrne and Greg McVerry (in press) found consistent evidence in support of contemporary's youth's movement away from individualistic consumption of commercially prepared texts toward an ethos of collaboration in producing their own socially constructed texts. Yet, as O'Byrne (2014) also reported, there is a general disregard among youthful online curators for applying critical literacy skills as part of their social practices in remixing.

Mellinee Lesley (2012) found a similar disregard for social practices that involve critical thinking. In her study, technically savvy adolescent girl writers did not automatically apply their knowledge and experiences in ways that reflected sophisticated critical thinking skills. For the girls to be able to apply

those skills, Lesley argued, it would require a teacher's investment in instruction on how to frame critical literacy in socially relevant spaces that fostered online text production, distribution, and consumption. Moreover, Lesley contended, without a critical framing of such texts, the girls in her three-year ethnography were likely to find it difficult, if not impossible, to resist the dominant ideologies coming at them on all sides. Succumbing to a loss of voice or personal agency on the part of her participants in *Invisible Girls* was not a finding that Lesley viewed as helpful or even tolerable.

The centrality of pedagogy in mediating people's online social practices was a key finding in Korina Jocson's (2015) design-based action research project. In choosing to theorize through a new media literacies perspective the cultural production of digital texts and use of DIY tools, Jocson learned that the undergraduate and graduate students enrolled in her semester-long teacher education course needed her to intervene at various points in order for them to grasp the importance of developing an ethos of collaboration, participation, and distributed expertise in online text production. This finding has direct implications for working with youth who have not experienced, or at least do not indicate, an awareness of the need to use critical literacy in socially constructed online spaces.

Policy

Privileging language over other modes of communication is common in education as well as in civic and social practices in which digital media plays a role, at least in part because of centuries of print publishers' careful management of intellectual property rights. As technology has made other modes of communication as replicable and able to be distributed as print, concomitant expansion of digital media and its economic significance has major ramifications for policy. Vast national and international economies possess inertia that digital development, education, and intellectual property policy must balance against the need to prepare for uncertain but certainly different economic futures. The decade of economic engines "too big to fail" and educational reform efforts that thwart their own mission (Au, 2011) sound somber notes for U.S. and international policymakers.

Efforts within industry to promote forward thinking in terms of literacy education have gained considerable credibility (e.g., Partnership for 21st century skills), but the underlying economic narratives are lost here and there in patriotic and altruistic abstractions. On the other hand, the real potential for learning and doing through acquisition of literacies in digital media environments has local economic importance beyond preparing a nation's workforce or ending poverty.

Building on Lanham's (2001) work that critiqued the linguistic bias in traditional text production, de Castell and Jenson concluded "... new multimodal technologies of representation…actually consolidate, extend, and improve upon [one's] literate capabilities" (p. 392). Yet who has access to these technologies is a perennial issue for social justice researchers in their attempt to influence policy makers. Digital media's role in influencing how content is distributed via the marketing of social capital through clicks, likes, views, followers, and shares (Terranova, 2012) is not inconsequential.

As discussed earlier, the role of digital media content is reflected in the speed with which memes (images, videos, sound effects, songs and the like) are spread rapidly by Internet users, and typically without regard for whether message is clear or not. This phenomenon, coupled with the breakdown of distinctions between real-world and virtual experiences, which Voithofer (2005) called attention to nearly a decade ago, are associated with the human-computer interface that most of us (including policy makers) take for granted today. However, more mundane observations (mundane, that is, to people outside the field of education) are those that stake out a future for researchers entering the professions 10 or 15 years

hence. What do we mean by this? Here, we're referring to a Pew Internet Report published in 2012 that concluded for most teachers and students alike, "research" means "Googling" or relying on Wikipedia for their information. Reacting to this observation, some teachers we know (as well as those participating in the Pew Report) admit that for their students "doing research" has shifted from a relatively slow process requiring various levels of inquiry to a "hurry-and-get-it-over" one-step process that consists of selecting bare-minimum information to complete an assignment. Whether those in policy-making positions are aware of this development is up for speculation.

Beyond the speed and superficial processing of information today is an ongoing discussion in the academy "about the nature of the participatory democratic utopia and participatory culture and how groups take (or do not take) advantage of the affordances new and emerging media" (Jenkins & Carpentier, 2013, p. 265). In the article cited here, media critic Henry Jenkins concedes that he has contributed to the utopian nature of participatory culture by failing to make distinctions between descriptive and normative language such that all too often we are lured into believing our participation is something more than superficial—something that can lead to our empowerment, when it cannot because the groups who are in control of "that something" are not about to relinquish their power over it.

Ending on a more positive note, we would call attention to Michael Dezuanni's (2014) four-year study in a primary school in Queensland, Australia, and its implications for policy makers worldwide. Dezuanni, a Senior Lecturer of Film and Media Curriculum in the Faculty at Queensland University of Technology, uses Latour's (2007) actor-network theory to focus on young learners' material practices and how those developed over time. Specifically, he uses a building-block metaphor to capture how the children he studies deploy technology and media concepts to participate materially in digital-networked culture not unlike that of older students.

That the children in Dezuanni's research are part of a larger participatory culture should not be lost on those who are responsible for policies governing the ever-changing requirements of copyright law for media literacy education. In point of fact, he and his colleagues (Dezuanni, Kapitzke, & Iyer, 2010) argue that copyright literacy be required for preservice teachers who will be charged with helping young people participate successfully in digital learning networks that have economic significance for both media content and connections.

CONCLUSION

In summary, digital media's economic impact is a bit like winning the lottery. There are many changes that are easily anticipated. One can count how many relations ask for a cut, how much each one expects. However, there's really no way to quantify far more important and economically significant shifts. People relate differently. Everyday actions take on economic significance in ways that may only be recognized in hindsight.

In our chapter, we have steered away from the hundreds of studies commissioned and carried out around the world that counted up the money that changed hands as a result of digital media, the increased tax revenue collected as a result of broadband penetration in a region, and the per capita income comparisons between technological haves and have nots. Instead, we have attempted to listen and understand the economics of digital media in a way that provokes much needed conversation among researchers.

Too often, economic questions are boiled down too far as we question whether some enterprises are worth the risk. The stakes are far too high—and the changes to education, policy, civic engagement, and

social practice too far reaching—merely to rate digital media's gains and losses. Instead, two outcomes are most needed: first, that we think about what we are doing to ourselves by means of digital media; and second, we begin to inquire into the economic meaning of the conveniences we love, the challenges we endure, and the discoveries we make.

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KEY TERMS AND DEFINITIONS

Actant: A term used to denote an entity whether human or nonhuman that modifies the actions of another entity (e.g., pouring vinegar on baking soda).

Agency: A human's capacity to make choices; typically contrasted to natural forces or nonhuman elements.

Digital Media: A term given to the tools for communicating that involve conversion into machine-readable formats within human networks.

Economy: Production, distribution, and consumption of goods and services by agents, at times involving intermediaries for exchange known as money.

Global Economy: Combinations of the economies of countries *or* economic interactions that cross geopolitical boundaries overland, by air, by sea, and virtually.

Memes: Phrases, images, videos, sound effects, songs, etc. that are copied and spread rapidly by Internet users—typically without regard for whether the message or intended meaning is clear or not.

Modality: The vehicle/way in which meaning is made through text, speech, or gestures.

Mode: A resource through which people communicate that are socially and culturally determined.

Multimodality: Refers to multiple forms of communication that include language but do not privilege it over other modes such as still and moving images, sounds, gestures, icons, and performances.

New Materialists: 21st century scholars who claim that agency is not strictly a human capacity.

Transformativeness: The state of having been repurposed by a user of copyrighted materials to make them more amenable to fair use criteria.

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Chapter 58
Diversification and Nuanced Inequities in Digital Media Use in the United States

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ABSTRACT

This chapter explores access to, and engagement with, digital media by United States' (U.S.) by non-mainstream populations. Framing the issue from a sociotechnical standpoint, the authors explore how engagement with digital media is shaped by socioeconomic status (taking into account confounding factors, such as race and ethnicity, and social and geographical ecologies). The authors highlight studies that focus on the robust digital practices with which nonmainstream populations already engage, and to which they contribute. One example is how some black Twitter users engage in signifyin'–a culturally specific linguistic practice—as a means of performing racial identity online. The authors also problematize concepts such as the new digital divide and digital exclusion, and finally, reiterate that a universal roll-out of high speed broadband alone will not necessarily lead to further engagement with digital media for ALL populations. In fact, the authors claim that providing more or faster access is likely not enough to prevent the entrenchment of a global digital underclass.

This chapter explores the ways in which nonmainstream populations in the United States (U.S.) access and engage with ICT and digital media. For the purpose of this chapter, the term nonmainstream population refers to racial/ethnic and linguistic minority groups, who are also low-income or poor (i.e., hovering on or below the poverty line), and/or infrequent Internet users. The authors also problematize two related concepts of *digital divide* and *digital exclusion*.

Although the term digital media has been used and described across the literature for over a decade, its definition remains nebulous. Digital media cannot be defined solely as digitized content, but rather must include a discussion its salient features—namely its interactivity and ability to foster collaboration

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and "group forming" networks (Smith, 2013). Rather than explicitly defining digital media, scholars often refer to it by providing a parenthetical lists of examples, such as "blogging, digital comics, digital photography, digital videos, video game design, information visualization, etc." (Sims, 2014, p. 673). Such lists, however, are ever-changing, as new types of digital media are constantly appearing on the scene. *The John Hopkins Guide to Digital Media* (Ryan et. al, 2014) for example, has over 150 entries, which range from the familiar (social networking sites, wikis) to the more obscure (e.g., digital installation art and machinima). Due to the dynamic nature of digital media, therefore, our definition remains broad and inclusive, encompassing most media that require a broadband connection and, at least for now, hardware such as desktops or laptops, smartphones or tablets to access it.

Currently, the most salient features of digital media include its affordance to access a global audience, providing individuals or groups the opportunity to: (1) create/produce, (2) congregate and share interests and ideas, (3) swap and sell information and goods, and (4) express one's individual/community voice through a social platform. An important and exciting aspect of digital media (viewed as dangerous by some) is that it allows anyone with a fast broadband connection to engage actively in, and even help shape, current political, cultural, social, and economic scenes. Thus, as digital media becomes increasingly influential for all aspects of public life, its equitable access becomes ever more vital. To put it succinctly, our chapter focuses on the intersection between race/ethnicity and social economic status (SES) and with access to and engagement with ICT (Information and Communication Technology) and digital media.

Since the international exploration of this topic is beyond the scope of our chapter, we therefore restricted our search to scholarship conducted in U.S. contexts. To retrieve relevant sources across several growing bodies of literature, we searched various academic databases using keywords such as: *digital media, information and computer technology (ICT), digital divide,* combined with terms such as *access*, *use*, and *engagement*. We then cross-referenced the sources we retrieved with keywords that relate to nonmainstream populations (i.e., *Hispanics, Latinas/Latinos, Blacks, African Americans, Native Americans, American Indians, Indigenous,* and *poor/ low-income* (including whites). This process yielded a range of sources that included academic journal articles, research reports and chapters in academic books.

WHAT IS THE SUCCINCT OVERVIEW OF THE RESEARCH?

Nonmainstream Populations Access to (ICT): An Incidental Predecessor to Digital Media

In the early 2000s the phrase 'digital divide' referred to a binary notion of access, or lack of access, that various demographic groups had to the Internet (Rubinstein-Avila, 2011). However, as access, per se, has become less of an issue, especially compared to the issue of speed, software, and advanced multiliteracies, the term 'digital divide' has become more nuanced. Although scholars from different disciplines have contributed to our understanding of the ways in which digital media is used across race/ethnic groups, and especially socioeconomic lines, ICT access and engagement among the most vulnerable groups (e.g., the poor, elderly, and disabled) have by no means been resolved.

Because the use of digital media is reliant upon ICT, and because such a large portion of the extant research focuses on the digital divide, we find it is essential to explore ICT use among nonmainstream populations as a foreground into a more detailed discussion about the ways in which nonmainstream

populations are using digital media. Therefore, in this section, we explore the digital divide as it is conceptualized both in terms of access to the Internet in general, and to broadband and mobile technology specifically. After presenting the demographic trends, we reflect on the limitations of quantitative results that are not contextualized in social theory, and attempt to frame the issue from a sociotechnical standpoint, exploring how engagement with ICT and digital media is shaped by socioeconomic status in the U.S. (with obvious confounding factors, such as race and ethnicity).

Factors Affecting Access

Predictably, overall ICT use by adults in every racial group and income bracket has increased astronomically since the 1990's. Based on the telephone survey by the Pew Internet & American Life Project conducted by Princeton Survey Research Associates International (PSRAI) of a representative sample of 1,006 adults, a full 87% of adults were online in 2014, versus just 14% in 1995 (Fox & Rainie, 2014). Gaps in access continue to persist, however, given multiple demographic factors (Zickhur & Smith 2012). According to the U.S. Census Bureau (2012), Internet use varies dramatically by race, 82.9% for Asians (25 and older), 80.3% for whites, 68.2% for blacks, 64% for Latinos/as. Native Americans currently have the lowest rate of Internet use, with 49.36% of all households having home access, and 59.69% accessing the Internet at all (NTIA 2013).

Some scholars have found that amongst the Latino/a population, language barriers may impact online rate and use (Livingston, Parker, & Fox 2009; Warschauer & Matuchniak 2010). A report issued by the Pew Internet and American Life Project describes the extent to which English literacy correlates to higher levels of Internet use for Latino/a adults in the U.S. The research for the report relied on three datasets derived from landline surveys conducted by International Communications Research: (1) 2006 National Survey of Latinas/os – 2,000, (2) 2006 Hispanic Religion Survey – 4,016, and (3) 2008 Post-Election Survey – 1,540. According to the report, all three surveys used similar methodologies, targeting Latinas/os ages 18 and older who were given the option of responding in English, Spanish or a combination of the two languages. The report's findings showed that the majority (81%) of adult Latinos/as who could read English very well used the Internet in 2008. Approximately half of those (52%) who reported not being able to read English well went online, compared to 24% of those who reported being unable to read English at all (Livingston et al., 2009). Spanish reading proficiency, however, does not seem to play as important of a role to Internet access; 62% of those who reported being able to read in Spanish very well reported going online, compared to 67% who read it pretty well, 62% who claimed not to read it well, and 66% who claimed did not read Spanish at all. Based on this data, the report noted that literacy levels per se did not appear to impact Internet use for Latinas; however, low English literacy seemed to be a hindrance (Livingston et al., 2009, figure 5, section 2).

Overall, gaps in access seem to be narrowing but still exist (Livingston et al. 2009; Lopez et al. 2013; Zickuhr & Smith 2012). The use of ICT seems to fluctuate depending on variables such as race (Smith 2014), age (Zickhur & Smith 2012), level of educational attainment (Livingston, Parker, & Fox 2009), English language fluency (Fairlie et al., 2006), and income (Warschauer & Matuchniak 2010). Social economic status (SES) seems to be a major factor. When variables such as income and educational levels are controlled for, differences in Internet use between racial groups all but disappear (NTIA 2013). Rates of internet usage amongst Latinas/os, African Americans, and whites with similar income and education levels are virtually the same (Livingston 2010; Smith 2014). The strongest negative predictors for internet

use are not being a member of a certain racial or ethnic group, but rather having a low household income (under $20,000 per year), being over 65 years old, and not having completed high school (Zickhur & Smith 2012). There is little doubt that Internet use is most positively correlated with income: 97% of those earning $75,000 or more use the internet, while only 60% of those living in household earning less than $30,000 annually are internet users (Zickhur & Smith 2012). At the higher income levels, regular Internet access and usage becomes the norm (Livingston, Parker, and Fox 2009).

Types of Access and Connections

Internet access, however, occurs across a broad spectrum, and under widely varying technological and social conditions. Substantial differences exist between connecting through dial-up, high and higher-speed broadband, and using public computers at a library or community centers. As Warschauer and Matuchniak (2010) suggest, the types of connections to which people have access shape their engagement. As an example, the authors cite research reporting that while 62% of adults with broadband went online to look up information about the 2008 election, only 37% of those with a dial-up connection did so (Warschauer & Matuchniak, 2010). Not surprisingly, access to high-speed (broadband) varies considerably along the lines of race/ethnicity, income, location, and level of education (NTIA 2013). Whites generally have higher rates of access (65%), followed by blacks (52%), and Latinas/os (45%) (Livingston, 2010). Since race/ethnicity and SES are highly confounded among households earning less than $25,000 annually, 45% had a broadband connection, compared to 94% of those making $100,000 or more (NTIA 2013). Rural households also have lower rates of broadband access (58%) compared to their urban counterparts (72%). Not surprisingly, research highlighting educational attainment follows a similar pattern (NTIA 2013).

The rise of mobile technology, however, has provided yet another route to connect to and partake in digital media. In fact, the use of cell phones has reached near-parity across all racial groups. As of 2010, 85% of whites owned a cell phone while 79% of blacks and 76% of Latinas/os reported owning a cell phone (Livingston 2010). Basing its findings on a telephone survey of 2,252 adults in 2013, PSRAI found that 91% of all Americans now own a cell phone; in fact, they found that the percentage of cell phone owners that use their phones to access the Internet is around 63%--doubled since 2009 (Duggan & Smith, 2013). With the advent of smartphones and the capacity to connect from almost anywhere, primarily reliance on less expensive phones, rather than computers, to access the Internet has become a noticeable phenomenon—not only in the U.S., but also world-wide. This group of "cell-mostly" Internet users is comprised primarily of younger individuals who are under 30, non-whites, and those with relatively low incomes and lower education levels (Duggan & Smith, 2013). The researchers found that among this group, 60% of respondents were Hispanics, 43% were African Americans, compared with 27% of whites. Level of education seems to be negatively correlated to "cell-mostly" users. In other words, those with higher educational attainments are less likely to connect primarily via their phones; 45% of cell-mostly users had earned a high school diploma or less, and only 21% were college graduates (Duggan & Smith, 2013). On the other hand, the trend in computer ownership provides almost the opposite scenario. According to the 2011 U.S. Census, 76% of all households had a computer; African American and Latino/a households, however, were less likely to have computers (62% and 63%, respectively), as were households with incomes lower than $25,000 (52%) (NTIA 2013).

A Matter of Social Justice

Why is Internet access a matter of social justice? It has been widely acknowledged that access to the Internet is a useful tool in people's lives (Fox & Rainie 2014), but why, *exactly*, is the issue of the digital divide so important? Beyond the fact that so many functions are constantly relocating to the digital realm (e.g., healthcare, taxes, education), we are also in the process of shifting from an industrial to an informational economy, making digital literacy an increasingly invaluable set of skills for employment (Warschauer & Matuchniak 2010, citing Castells, 1996). According to the U.S. Bureau of Labor Statistics, the demand for manual labor is steadily decreasing, as industries such as manufacturing and construction are two of the most rapidly shrinking businesses in terms of net employment (Watson, 2012). Occupations that require the use of information technology, on the other hand, continue to grow; this increase seems impervious even to widespread economic recessions (Csorny, 2013).

In a study conducted as part of the Children and Technology Project, in which ICT use was defined as "computer and internet use, videogame playing, and cell-phone use" (Jackson et al. 2008, p. 438), the authors examined race and gender differences across the nature of use. The authors also explored the extent to which the intensity of engagement in particular activities could predict academic performance. For example, levels of ICT use were found to be significantly lower in general among African American male youth than among other groups. The study was based on a survey of 515 children (172 African Americans and 343 whites) with an average age of 12. The authors found ICT use, in general, to be positively correlated to academic performance (Jackson et al. 2008). With regards to intensity of use, survey results revealed that white students had been engaging with ICT for a longer period of time compared to African American students. Overall, the authors found that males had been using computers longer than females. A race by gender interaction revealed that African American males engaged in fewer activities, with one exception—playing videogames, the only activity that was the linked to lower academic performance in their study (Jackson et al. 2008).

Thus, the new, more nuanced digital divide can be seen as a major obstacle to equal opportunity in future employment. The full benefits afforded by ICT are constantly changing and widespread, and beyond the scope of our chapter. Scholarship on this topic ranges from how engagement with digital media is imperative for social and economic participation in a networked public culture (Ito et al., 2009) to the role of online social media in the cultivation of pro-democratic behaviors (Monforti & Marichal 2014). Based on a cursory glance of occupational patterns and current educational trends, it seems safe to assert that equitable access to ICT is indeed a matter of social justice. Analyzing how such nuanced factors shape the digital divide on a larger scale, however, requires sizable resources. The Digital Youth Project (DYP) is one notable example of such a project. A seminal three-year ethnographic study, the DYP investigated how youth participate in the "new media ecology," a term used to highlight the extent to which digital media is embedded in the lives of youth in a world where technologies, infrastructure, and everyday practices of young people are interrelated (Ito et al, 2009). The project, part of a $50 million initiative funded by the MacArthur Foundation to study learning and digital media, was unique both in terms of its large scale and in terms of its adherence to qualitative methodologies. Drawing upon extensive data collected in 23 different case studies completed by 28 researchers/collaborators, the DYP describes the new media practices of a wide range of diverse populations of youth, spanning from middle-class families in suburban Silicon Valley, to poor teens living in urban LA. The focus of the project, however, was to document practices that were observed broadly, across multiple case studies. The specificities of each research site were largely glazed over in the attempt to provide a more generalizable portrait of

youth engagement with digital media. For this reason, while some of the individual case studies that comprise the Digital Youth Project are highly relevant to the focus of this chapter, the conclusions as a whole are too general to really depict any specific trends regarding how low-income and minority populations interact with digital media.

That being said, there are some underlying points made about the importance of certain *types* of access to digital media that have far-reaching implications when considering how socioeconomic status may shape one's use of technology. Having consistent "lightweight" access to digital tools, for example, was determined by the researchers to be a necessary precondition for participating in networked public spaces (Ito et al. 2009). The researchers concluded that "[w]hen kids lack access to the Internet at home, and public libraries and schools block sites that are central to their social communication, they are doubly handicapped in their efforts to participate in common culture and sociability" (2009, p. 74). The authors assert that engaging in social and recreational activities online, not just accessing "serious" (p. 75) information, is an important aspect of participating in public life in the digital age, in addition to being a crucial starting point for self-expression and digital media creation (Ito et al., 2009).

CURRENT ISSUES IN THE FIELD RAISED BY THESE STUDIES

U.S. Nonmainstream Populations' Engagement With Digital Media

One of the many issues this contemporary scholarship raises is our lack of understanding of the ways in which vulnerable groups *are* accessing ICT and digital media (and for what purposes). While there is quite a substantial body of scholarship about how nonmainstream populations are *not* using digital media (see above discussion on the digital divide), there is a notable dearth of research regarding the many ways in which ethnic/racial minorities and low-income individuals are taking up digital tools actively. For example, there are relatively few studies focusing on how nonmainstream populations in the U.S. use mobile technology. One of the few is a study of Latina immigrant farmworkers by Garcia (2011). Based on the analysis of in-depth interviews with six women in southeastern Ohio, Garcia sought to document how immigrant women use ICT and digital media through their mobile phones. Text messaging was a common form of communication amongst these research participants, specifically for those who were living in the U.S. while attempting to maintain contact with family members in the home country (Garcia, 2011). Additionally, this research revealed that mobile phones connected these farmworkers to information and news relating to their current status as immigrants. Mobile phones also provided the participants a means to locate transportation, which is essential for immigrants who are unable to obtain drivers licenses. Garcia (2011) also found that in many instances, however, the men (husbands, etc.) maintained ownership of the phones and controlled access to the phones—especially when there was only one mobile phone per household. Access to mobile phones, therefore, only appeared to strengthen the hierarchical relations between men and women.

Small scale, qualitative studies such as this one provide an essential dimension to a comprehensive understanding of the state of digital media in the U.S. Rather than simply underscoring the lack of engagement with digital media, studies such as this are needed to illuminate the nuances of *how* vulnerable populations use the technology to which they have access. Information about adult populations is especially scarce, as research on this topic focuses almost entirely on youth.

Social Media: Diversification or Segmentation?

Another issue that contemporary studies have brought to a head is the idealized myth that the incorporeal nature of the web would function as the ultimate democratizing arena, making invisible most, if not all, forms of social differences. However, recent studies illustrate that this is not the case. Social networking sites (SNSs), which have virtually exploded in popularity over the past several years—a phenomenon that was aided in part by the simultaneous proliferation of mobile technology – have been a fertile arena for scholarship on social relations. According to the Pew Research Internet Project, 73% of adults who are online use some kind of social networking site (Duggan & Smith 2013b). Though Facebook remains the favorite overall, marked diversification has taken place. As of recent findings, 42% of online adult users engage in multiple social networking sites such as LinkedIn, Twitter, Pinterest, and Instagram. Which platform people choose, and why, yields surprisingly complex and layered social findings. In fact, an emerging body of scholarship is exploring the ways in which offline social divisions are being reproduced in the digital realm (Duggan & Smith 2013b).

As it stands, it turns out that the SNS people choose are not a matter of random chance, but rather a confluence of multiple demographic and social factors such as race, class, gender, and age (boyd, 2012). Drawing upon four years of ethnographic data collected in diverse communities across the country, boyd (2012) focused on the role of social media in the lives of American teens. Based on her extensive data, which included 2,000 hours of observation of online practices, 103 formal semi-structured interviews, and analyses of 10,000 randomly selected MySpace profiles, boyd offers a qualitative illustration of how the social network site adoption by teens reflects a broader discourse of race and class in the U.S. In fact, boyd's (2012) analysis of teens' perceptions of different SNSs - specifically MySpace and Facebook – focuses specifically on the classed and racialized terminology teens used to describe the sites. For example, boyd (2012) documents that white teens tended to describe MySpace in overtly classed and racialized terms, as being "for the riffraff," folks from "the other side of the tracks," and "ghetto" (boyd, 2012, p. 204 – 220). According to boyd (2012), MySpace, which preceded Facebook by several years, had evolved to embody an "urban late-night culture." Its cachet among teens was mostly derived from the site's association with the freedom and maturity of the 20- to 30-something crowd, its first adopters (p. 206). The origins of Facebook, on the other hand, created in the hallowed halls of an Ivy League college and initially restricted to use by Harvard students, imbued the network with a safer, more elite and exclusive image (boyd, 2012).

By 2006-2007, once Facebook was opened to all users, there was a definitive trend among generally white and more affluent teens to choose Facebook over MySpace. Users from less privileged backgrounds, who identified themselves as belonging to a subculture, preferred MySpace overall (boyd 2012). boyd frames this trend by drawing an intentionally provocative analogy between the movement of mainstream teens from MySpace to Facebook as "white flight," a term that refers to the historical exodus of white city dwellers to the suburbs in the 1960's. boyd (2012) asserts that teens who fled MySpace to join Facebook, were often motivated by many of the same fundamental issues (as the white suburban families fleeing the urban centers)—fear and anxiety, social networks, institutional incentives, and racism (boyd, 2012). Though boyd admits to the limitations of the metaphor, she illuminates several interesting parallels: equating the "American Dream" of the suburbs with the "teen Dream" of collegiate maturity, represented by Facebook. The urban "decay" of cities is likened to the influx of spam into MySpace ("digital graffiti"), in both cases serving as signs of disrepair or feeling unsafe (boyd 2012, p. 219).

Related to the issue of social segmentation raised by contemporary studies is the sociological concept of "homophily," referring to the tendency of individuals to befriend those who are most like themselves. boyd (2012) points out that socializing in the U.S., for both youth and adults, is organized along lines of race and ethnicity (boyd 2012). Thus, the self-segregation of youth into homophilic social groups within school spaces is replicated online, as teens connect virtually with pre-existing networks of friends, following established race and class-based social boundaries (boyd 2012). Using extensive statistical analyses, Hargittai's (2012) work also illuminates the systematic segmentation of youth into distinct social networking sites among first year college students. Harigittai (2012) administered a paper survey to two diverse cohorts of college students, reaching 1,060 students in 2007 and 1,115 in 2009. The data was collected from students at the University of Illinois in Chicago, which she cites as being one of the most ethnically diverse universities in the U.S. (according to U.S. News and World Report 2009). In fact, less than half of each cohort sampled was white, with levels of parental education varying substantially (Hargittai 2012). In addition to obtaining students' demographic information, the survey included questions about the social context of Internet use (e.g. home access, time students spent online, and their knowledge and use of social networking sites). Echoing boyd's (2012) work, Hargittai (2012) found that SNS use varied strikingly along racial and ethnic lines: Latino/a students were significantly more likely to use MySpace and less likely to use Facebook than their white counterparts. However, the opposite was true for Asian and Asian American students. African American students were also much more likely than white students to use MySpace, though most (91% in 2009) also reported having Facebook accounts (Hargittai 2012). MySpace was also significantly more popular among those students whose parents had less than a high school education (56% in 2009, compared to 26% of students whose parents held graduate degrees), a factor used as a proxy for SES (socioeconomic status) or class (Hargittai 2012). Once again, the study shows that offline social divisions are reproduced in the digital realm, the implications of which Hargittai (2012) describes in pragmatic terms: if college professors, employers, or government agencies assume that information is transmitted most effectively by using specific SNS, populations who utilize alternate sites are likely to be systematically excluded from receiving the message.

Assuming Racialized Identities

With 271 million active users, Twitter is widely considered the most popular of the microblogging sites. This genre of digital media is defined by enforcing users to conform their posts to limits of extreme brevity: 140 characters (Twitter.com; Croxall 2014). By electing to follow a given user, that individual's short posts (or "tweets") thereby appear on a continuously updated feed on one's homepage, known as a timeline. Interaction between users consists of "retweeting," (i.e., publicly copying someone's tweets or by replying to another user's tweets by using the @reply feature). The hashtag, created by using the symbol "#," marks phrases and indicates the topic of a tweet, thus allowing users to search for specific topics and follow them.

Given the severe limitations the platform places on the length of the message, one may question whether anything of importance can be communicated. However, Croxall (2014) claims that the medium lends itself to a sharing of day-to-day life that allow users to deepen relationships with each other over time—developing a sense of "ambient intimacy." In fact, Twitter has in large part transcended any indictments of triviality by its role in organizing, disseminating, and publicizing a number of well-known large-scale social acts with very real-world impact (e.g., the revolution in Egypt). The real-time updates of Twitter can function to enable "*social* proprioception" (Croxall, 2014, italics in the original). Literally,

proprioception is a term used to describe an individual's sense of the relative location of her/his body. In this sense, Twitter enables proprioception of a group of people. The platform's real-time, continuously updated feeds enable a collective awareness of a networked public. This renders the coordination of large-scale public actions possible by providing groups of people a sense of self (Croxall, 2014). This specific affordance by Twitter is especially interesting for the purposes of this chapter. It begs us to question *how* a live, continuously updated, and widely used social media platform can function to both reflect, as well as actively shape, cultural identities across an increasingly multicultural, multiracial, and multilingual world.

Of all the social media sites, Twitter has experienced a marked rise in popularity across the U.S., especially amongst African Americans; 34% of black American Internet users report having Twitter accounts, compared to only 18% of the overall population of adult Internet users (Duggan & Smith 2013b). Racialized hashtags are frequently featured in Twitter's list of "trending topics," often showcasing black American culture (Florini 2014; Sharma, 2013). The "Black Twitter" phenomenon has emerged as a much-discussed topic amongst journalists and bloggers (Florini 2014). In her study of "Black Twitter" timelines, Florini (2014) archived and analyzed the timelines of black Twitter users, examining how participants engaged in a specific Black American cultural practice – *signifyin'* – as a means of performing racial identity online. Florini defines *signifyin'* as a "genre of linguistic performance that allows for the communication of multiple levels of meaning simultaneously, most frequently involving wordplay and misdirection" (2014, p. 224). A playful and witty genre, with deep roots in Black American cultural traditions, Florini (2014) underscores signifyin' as a mode of interaction that enables Black Twitter users to "align themselves with Black oral traditions, to index Black cultural practices, to enact Black subjectivities, and to communicate shared knowledge and experiences" (p. 224). Signifyin' often incorporates Black popular culture references, requiring background knowledge and cultural competencies from those engaging in the practice to render the multiple levels of meaning comprehensible. However, Florini (2014) avoids contributing to the idea that "Black Twitter" is homogenous and monolithic, claiming that the use of signifyin' is a choice on the part of many individual users of color to perform a racial identity in a context that does not require the user to disclose race membership explicitly. The choice to invoke Black cultural traditions, therefore, can be interpreted as a means of resisting marginalization and invisibility (Florini 2014).

Florini's (2014) study reveals the ways in which engagement with social media can be used to perform a racial identity, ensuring that race remains visible online. In fact, Florini (2014) interprets the performance of a collective Black identity online as an active rejection of the prevalent "colorblindness" that is so entrenched in contemporary U.S. racial discourses. Employing modes of communication like signifyin', writing tweets in Black Vernacular English (BVE), and indexing Black cultural knowledge are all ways of asserting a racialized identity, and thereby communicating that race, as well as racial inequality, continue to shape Black people's experiences (Florini 2014).

Florini's (2014) study is not only innovative and insightful, but it also approaches research on digital media from a perspective of resource, not deficit. As the author points out, most studies about minorities and digital media tend to portray "people of color as technological outsiders" and to "obscure the many people of color who are online" (Florini, 2014, p. 224). In fact, even a brief foray into recent scholarship certainly conveys this clearly—a trend that is especially apparent in research regarding African American males (Patton, Eschmann & Butler 2013; Smith 2014; Jackson et al. 2008).

An example of academic research that frames African American males' engagement with digital media negatively is Patton, Eschmann, and Butler's study (2013). Patton et al. (2013) explored how

social media (primarily Facebook, MySpace, Twitter, and YouTube), has been repurposed by urban men—mostly African American—to function as a stage for what they call "Internet banging," defined as gang-affiliated communication. The authors claim that the intent of such posts are to promote gang affiliation, boast about or threaten violent acts, or network with other gang members (Patton et al. 2013). The authors also draw parallels between Internet banging and "hip hop identity," which the authors define as a collective urban masculine identity that is "rebellious," "assertive," and "antagonistic toward many other aspects of American culture" (p. A57). In addition, the authors claimed that hip-hop identity, "along with unemployment and poor educational opportunities … fuels the behavior we currently see among African American men on the Internet" (p. A57). The problem with such research is that it fails to contextualize the "Internet banging" phenomenon as only one (uncommon) use out of the *many* ways in which African American men engage with digital media. Because research that focuses on African Americans' digital media use is so scant, it seems particularly troubling that the few extant studies seem to focus on topics already sensationalized in popular media.

GAPS IN THE EXTANT RESEARCH AND DIRECTIONS FOR FUTURE RESEARCH

Engagement of Low-Income Youth With Digital Media (in Classrooms and After-School Contexts)

Much of the research on nonmainstream populations and digital media focuses on youth within educational settings. It is important, however, that such research not be conducted using deficit models, but instead, from a lens that takes into account the robust digital practices with which youth already engage and to which they contribute. For example, descriptive studies (e.g., Tripp & Herr-Stephenson, 2009) seek to document how low-income and minority youth are currently using digital media both in school and out of school, highlighting the unexpected obstacles youth often face at home and at school, as well as the youths' own resourcefulness. Another area of scholarly focus that would add to the gaps in our knowledge are data-driven classroom-based studies, analyzing how instructors of under-funded, urban schools are using digital media production projects to make schooling more relevant for marginalized populations and as a way to engage students as critical, socially aware citizens (e.g., Turner, 2012; and Schmier, 2014). In addition to classroom-based approaches, we need more studies that analyze how extracurricular programs have attempted to cultivate digital literacy skills in low-income and minority populations by supplementing instruction in formal educational settings with academic summer camps (Baker, Staiano, & Calvert, 2011), after-school clubs (Vickery, 2014), and youth development agencies (Soep, 2011).

Despite widely varying degrees of access, many youth seem to be finding ways to interact with digital media in diverse and interesting ways. In their case studies of two low-income Latino middle school students, Tripp and Herr-Stephenson (2009) illustrate the participants' nuanced engagement with digital media (in and out of school) despite economic barriers. The case studies sought to examine how youth who do not have easy access to computers, Internet, and media production software, still manage to interact with digital media in ways that are both creative and personally meaningful. Drawing from ethnographic research from the 2005-2006 academic school year, and informed by *genres of participation* - defined as modes of engagement that shape how technology is framed, understood, and operated within

mediated spaces (Tripp & Herr-Stephenson, 2009, citing Ito et al., forthcoming) - the study highlighted how youth approached technology differently within and across diverse settings. A great distinction lay between youth-driven genres of participation, which were voluntary, self-directed, and motivated by youths' interests, and adult-driven genres of participation, which were organized around adults' goals for young people (e.g., academic educational software) (Tripp & Herr-Stephenson, 2009). How this 'second digital divide' (Tripp & Herr-Stephenson, 2009, citing Buckingham, 2007) is navigated by both young people and parents, teachers, and other figures of authority is an increasingly salient issue and frames much of the research on youth and digital media (e.g., Ito et al, 2009).

Though they would be lumped together demographically, the two participants studied by Tripp and Herr-Stephenson (2009) illustrate the extent to which youths' personal use of digital media is unique, driven by highly individualized interests, experiences, and skills. The subject of the first case study, James, displayed a tendency of disengagement with the adult-driven new media-related school assignments. James utilized his limited access to digital media at school to listen to music, find information on bands, and also maintain a social networking page. While James' home was not equipped with Internet access (his parents citing both economic obstacles and a desire to keep their son out of trouble), he was able to gain access at friends' homes to support his music interests and engage in social networking. The second research participant, Michelle, had a computer and Internet access at home. Unlike James, her time at home—and especially her whereabouts online—were rigorously regulated and monitored by her mother. Also unlike James, Michelle was more engaged with school assignments that utilized new media. Michelle was able to maintain a social networking page to communicate with her friends, despite her mother's concerns.

Interestingly, significant barriers to access experienced by both James and Michelle were sociocultural, rather than physical or economic obstacles. As documented in similar studies of technology and family dynamics (see Tripp, 2011), the parents of both participants attempted to firmly regulate their children's internet use, maintaining that it be restricted to mostly academic pursuits and limiting online activities that were perceived as somehow "risky," such as exploring social media sites (Tripp & Herr-Stephenson, 2009). The school's approach to engagement with digital media also provided limited opportunities for students to connect in-school assignments with out-of-school interests, and primarily involved students in adult-driven genres of participation. The researchers thus conclude that the incorporation digital media into academic settings does not alone make schooling more relevant or interesting to students (Tripp & Herr-Stephenson, 2009). Young peoples' existing knowledge and interests need to be taken into account, as do sociocultural and institutional constraints (Tripp & Herr-Stephenson, 2009).

How student interests and out-of-school literacy practices can be incorporated into classroom pursuits is precisely the focus of Turner's (2012) year-long ethnographic study of an urban middle school's multimodal media production (MMP) class. Focusing on the experiences of 'Gina,' a female African-American student in the MMP class, Turner analyzed the how the class structure encouraged students to reframe their out of school literacy practices as tools for knowledge production and learning in an academic setting. The school that was the site of the MMP class was attended primarily by students whose families lived below the poverty line and had highly variable access to technology at home. Most students were African American and Latino (Turner 2012).

Significantly, Turner notes that the class instructor's ultimate objective was to foster critical thinking – specifically a critical perspective on popular media - through the use of new technologies. The class's principal assignment involved students working together to conduct community research projects. These projects incited students to investigate important issues in their community and then use MMPs – which

included "documentaries, digital stories, Hip Hop music, digital video poetry, music videos, multi-user digital environments (MUVEs), public service announcements, youth radio, Web sites, blogs, wikis, and other emergent technologies used in multimodal designs" – to express and analyze their findings (Turner, 2012, p. 498). Grounded in a theoretical framework that included critical media literacies, Turner's (2012) study draws connections between multimodal literacy learning and issues of social justice, thus directly impacting the lives of youth. As a pedagogical approach framing the MMP class, critical media literacies entailed enabling students to critique media as text, becoming increasingly aware of their own patterns of media consumption, and ultimately having students create their own narratives (Goodman, 2003; Turner, 2012). Turner (2012) identified students' engagement with social justice issues (such as inequality in urban education and racial justice) through the production of their MMPs, which served to indicate the burgeoning critical literacies that the students developed while researching, analyzing, and documenting community issues. This progression is clearly illustrated in the media produced by Gina (the focal participant), whose early work largely consisted of love songs and music videos heavily influenced by commercial Hip Hop and only moderately critical of how the genre portrayed females (Turner 2012). By the semester's end, however, after completing a community research project on homeless youth, Turner (2012) describes Gina's songs "We Strugglin'" and "My Community" as critically addressing heavy issues such as inequality in urban education, racial justice, traumatic life experiences, and popular culture as resistance.

By analyzing the students' MMPs created over the course of a year, Turner was able to track how students engaged with texts differently over time, and observe how the course fostered the development of social consciousness. MMPs allowed students to use the "stylistics of modern youth culture" to cultivate new and traditional literacy skills, providing the students with an avenue for participating in their own "socially, culturally, historically, and politically situated practices that may have been unavailable in previous curricular frameworks" (Turner, 2012, p. 504). As in Tripp and Herr-Stephenson's (2009) study, Turner similarly illustrated that merely incorporating technology and media production into a course does not alone translate to increased student interest and course relevance. In this case, the instructor's own pedagogical stance and incorporation of critical social justice issues were essential factors shaping student experiences in the media production class.

In other words, the research literature would benefit from more studies that value nonmainstream students' media practices outside of school settings. Formal school settings too often marginalize students' interests in favor of focusing on adult-driven genres of participation. This limited focus and enactment of restrictive policies regarding technology use and digital media in school disproportionately impacts low-income students, who may not have consistent, super-fast, and autonomous use of high-speed Internet outside of school.

For example, Schmier's (2014) 18-month ethnography of a single classroom documented how the instructor of a digital media studies class in an urban public middle school incorporated student interests - namely, popular culture - into the curriculum. Building upon studies by Morrell and Duncan-Andrade (2006) and Marsh (2005), Schmier's work contributes to the body of evidence that supports bringing popular culture into the classroom as an effective means of empowering youth as critical media consumers and strengthening students' academic literacy skills (Schmier, 2014). Schmier (2014) also incorporated the concept of "connected learning" (Ito et al., 2013), which proposes fusing student interests and passions with the curriculum as a way to create new educational, economic, and political opportunities for traditionally marginalized populations of learners. Collaboration and networking also play an important role in the connected learning framework as skills necessary to be literate in the 21st century (Schmier,

2104; citing the New London Group, 1996), and making supportive learning communities a central aspect of Schmier's (2014) study.

The class studied by Schmier (2014) was principally engaged in exploring both traditional and new media journalistic practices, such as podcasting. The researcher focused on three students who were immigrants or children of immigrants, with origins in Nigeria, El Salvador, and Honduras. Schmier observed these students' literacy practices in various contexts - online, in the classroom, and in spaces outside of school. Other data collection included focus group discussions, interviews, and the collection of texts produced by the students. Significantly, each of the three focal students maintained highly active online presences outside of school, consistently updating their personal blogs and participating in social media as forms of recreation.

As in Turner's (2012) study, the transformational affordances of digital media emerged when students were permitted to draw upon their interests, skills, and personal experiences in the classroom. Encouraged by their instructor to report on topics that were personally meaningful to them, Schmier describes how the students were able to leverage their out-of-school literacy practices to reposition themselves as "successful author[s], designer[s], and leader[s] in the classroom," and as experts within specific online communities (Schmier, 2014, p. 43). For those youth who were failing their core classes and generally regarded as struggling students, this repositioning as competent and insightful authors and activists was especially significant (Schmier, 2014). Two of the female students in particular became deeply engaged in documenting instances of inequity in their community, and were inspired to produce texts such as an anti-drug public service announcement, a podcast regarding the school's understaffing, and a documentary about a community mural project orchestrated to cover graffiti (Schmier, 2014).

When digital media studies incorporate student interests they serve as an important bridge for students to leverage their community cultural knowledge and out-of-school literacy practices within an academic setting. Digital media production in schools can also function as a creative outlet for expression and a platform for the cultivation of critical social awareness. Through the digital media studies class, the students "honed their ability to publish for multiple audiences," (Schmier, 2014, p. 45), bringing in popular culture artifacts and practices to design multimodal texts that persuasively addressed a wide range of locally relevant topics and positioned the students as community activists. The researcher's concluding suggestions for teachers include allowing for student choice in writing topics and modes of presentation, making peer feedback more rewarding (as in online forums) rather than an "artificial step in linear writing process," and having students work together to create texts that reflect the needs of their communities (Schmier, 2014, p. 46).

Extracurricular Digital Media Programs

There is little doubt that mobile devices, high-speed internet, and personal computers all transform how, why, when, and what students learn, but to what degree schools should support (or restrict) media practices and engagement remains a contentious issue (Vickery 2014). Because of the often limited and heavily monitored nature of technology access in schools, programs offered during the summer, after school, and by youth development agencies play an especially important role in providing marginalized youth with the resources and support necessary to develop digital literacy skills. The academic summer program studied by Baker, Staiano, and Calvert (2011) is one example of how a supplementary program can successfully combine digital media production skills with an environment that reaffirms youths' commitment to and positive perceptions of school.

The study followed 24 low-income, urban African American adolescents who attended the summer program, focusing on how the adolescents expressed themselves through digital media, and analyzing both the form and content of their digital productions (Baker, Staiano, & Calvert 2011). The researchers preface their study with a description of the various challenges confronted by low-income urban African American students, such as high drop-out rates (citing Chapman, Laird, & Kewal Ramani 2010), under-resourced schools that fostered negative academic self-concepts (citing Baker 1998), inadequate programs for high-achieving academic students (citing Ford & Webb, 1994), and exposure to deviant peers due to a lack of supervised settings for peer interaction (citing Brody et al., 2001).

The 24 students, all between the ages of 12 and 18, were randomly selected from a summer camp college-preparatory program that recruited students from a low-income neighborhood in a large metropolitan city. Held at a local university, the summer program provided academic and family mentoring support with the goal of fostering the skills and motivation necessary to graduate high school and pursue further education (Baker, Staiano, & Calvert 2011). The 24 youth who participated in the study were assigned to a digital production course as part of their daily summer camp schedule. The course was led by a professional filmmaker and editor who instructed students to create digital films about their summer experience, encouraging the participants to include whatever content they liked, though filming was restricted to the campus area. The students used digital cameras, mini digital video cameras, and iMovie editing software to create their digital productions (Baker et al., 2011).

The researchers found that the students' digital productions expressed overwhelmingly positive academic views, which was attributed to the supportive academic environment and positive peer relationships fostered by the program (Baker, et al., 2011). The productions also featured montage styles, foregrounded music, and other design features that mimicked much of the media consumed by the students (Baker, et al., 2011). In this sense, the use of digital media here is fundamentally distinct from its position studied by Turner (2012) and Schmier (2014). Without the emphasis on *critical* media literacy described by Turner (2012), the digital media productions of the summer academic program served more as a direct reflection of the media consumed by the youth, as well as an expression of how peer relationships and perceptions of school were correlated in the lives of the participants. While research like Turner's (2012) and Schmier's (2014) demonstrate how digital media production can function as a platform for consideration of social justice issues and inciting students to become more critically aware, the digital productions created in the summer program studied by Baker et al. (2011) functioned more as unmediated modes of communication and expression, surely made more interesting because of their association with forms of popular media consumed by youth recreationally.

The context in which learning takes place has an obvious impact on the modes of participation taken up by students as they interact with digital media. Informal learning environments like after-school clubs, precisely because of their less regulated structure, can serve as vital resources to support students as they develop new digital skills and learn to navigate social networks online and offline (Vickery 2014). Significantly, these affordances can also lead to the expansion of youth's social capital, which plays a vital role in enabling economic upward mobility, particularly for minority youth (Vickery, 2014, citing Hargittai, 2011; Laureau, 2003). In addition to the accumulation of social capital, digital literacies are also cited as enhancing political participation, and in general encompassing a set of skills and ways of interacting with technology that create more equitable futures for young people (Vickery, 2014, citing DiMaggio, Hargittai, Celeste, & Shafer, 2004).

As part of the Digital Edge Project—a large-scale research project designed to analyze teens' media ecologies in both formal and informal learning environments –Vickery (2014) studied Texas City

High School's (TCHS) after-school digital media club for eight months. The researcher observed and interviewed participants from three formal technology courses and two informal after-school clubs at TCHS, which was described as "a large, low-performing, economically challenged, and ethnically diverse, Hispanic-majority, public high school" (Vickery, 2014, p. 82). Vickery's focal participants were a multiracial group of 9 female and 9 male participants, all of whom had unreliable access to computers and the internet in their homes. The after-school digital media club (DMC), therefore, was a particularly vital resource for these students, who otherwise would not have had sufficient access to technology in order to develop digital literacy skills beyond what was available to them in school.

Within the DMC, students were free to engage in low-stakes, interest-driven participation in an environment that facilitated experimentation and a trial-and-error approach to learning (Vickery, 2014). The learning environment of the DMC was distinct from the formal technology classes not only in that the work was ungraded, but also in that it encouraged students to work more collaboratively, teaching each other and cooperatively organizing large-scale projects like scripting, shooting, and editing short films (Vickery, 2014). The club's adult mentor also reached out to nonprofit and community organizations, creating opportunities for youth to work on projects like PSAs for local organizations and thereby expanding students' offline social networks to include professionals in the local community (Vickery, 2014). This networking feature of the club's activities additionally led the adult mentor to provide the students with instruction on how to communicate professionally with the press and potential donors (Vickery, 2014).

RECOMMENDATIONS/IMPLICATIONS FOR EDUCATION, CIVIC ENGAGEMENT (GLOBAL AND LOCAL), SOCIAL PRACTICE, AND POLICY

Overall, the informal learning environment provided by the digital studies club was crucial to the development of students' digital literacies because it allowed for the freedom to collaborate, explore, and creatively experiment with digital media in a way that formal, curriculum-based, teacher-as-expert technology courses did not (Vickery, 2014). The researcher writes that spaces like the DMC "help bridge students' out-of-school and in-school learning by providing a space that students can explore, look up online tutorials, and help each other, but in a space that also offers adult guidance and support." (Vickery, 2014, p. 91).

Beyond underscoring the importance of after-school technology clubs, Vickery's (2014) study touches on the more fundamental issue of how digital media and networked technology are regarded by educational institutions at large, and how to support students' digital skills whilst retaining some control over how those skills are used and to what end. Throughout the study, a noticeable gap became increasingly apparent between how technology was regarded in the informal DMC and the school's official policies, which mandated that social media sites and video sharing sites remained blocked on all school computers (Vickery, 2014). The school's restrictive policies primarily affected those students with no or precarious home Internet access, the consequence of which was that these students were unable to distribute their work online, thereby preventing them from obtaining valuable feedback from the online community. The blocking of social media also inhibited the development of students' network literacies and stymied their opportunities to fully understand how intellectual property functions in the digital realm (Vickery 2014).

Vickery's study demonstrates how the participation gap is constantly evolving as online networks become more complex and new skills are increasingly necessary. After-school clubs can function to

help minimize these gaps by providing the kind of access necessary to cultivate digital literacies. However, students who do not have the time to participate in extracurricular programs, because of financial constraints, jobs, and familial obligations, are still excluded (Rubinstein-Avila, 2006). For this reason, Vickery (2014) asserts that formal education environments need to provide opportunities for youth to engage with digital media in meaningful ways.

Programs that partner with schools and incorporate services for out-of-school youth and recent high school graduates are therefore an important piece of the puzzle. One such program that provides minority and low-income youth with opportunities to study, explore, and create digital media is Youth Radio, a transmedia production company and youth development agency with headquarters in Oakland, California (Soep, 2011). Youth Radio, which has bureaus in L.A., Washington D.C., and Atlanta, involves young people all over the country in producing a weekly live radio show entitled *Youth in Control*. The show features stories written by youth, who also create associated playlists, videos, photos, and online posts on a weekly basis (Soep, 2011). The organization primarily recruits low-income youth and young people of color to participate in the program, seeking to provide a viable and empowering educational alternative to students who attend "economically abandoned schools" in urban areas (Soep, 2011, p. 9). Youth Radio participants progress through specialized courses in digital media and production, taking part in workshops, presentations, and professional development opportunities and eventually becoming eligible for paid positions as peer educators, media makers, and engineers (Soep 2011). As program participants, youth receive individualized education and career counseling, as well as community college credit for some courses. With 1,200 participants and over 30 million weekly listeners, Youth Radio has expanded extensively since its inception in 1992; *Youth in Control* is broadcast via commercial, public, and community-supported radio stations, and is also available on various social media sites, blogs, and iTunes (Soep 2011).

In addition to the radio show and associated media, Youth Radio has several side projects that involve youth in more advanced collaborative technological projects. Perhaps the most impressive of these is the Mobile Action Lab, which pairs students with experts to create locally-relevant apps for mobile devices (Soep, 2011). One app that is currently being created by the Lab, for example, addresses issues of food justice, using crowdsourcing to harvest excess, unused fruit from neighborhood yards and then redistribute the produce to local community members in need (Soep, 2011).

Soep, who is the senior producer and research director at Youth Radio writes that "with the right mix of supportive peers, professional colleagues, and nimble institutions, [young people] can, and do, translate their digital media activities into acts of citizenship and collective work toward public good" (Soep, 2011, p. 11). She argues that digital and mobile tools are increasingly vital for directing the flow of resources and enacting social change. Engaging young people—especially those who would otherwise lack access to digital networked technology—in such types of projects, provides crucial opportunities to take an active part in "democratic life" (Soep, 2011, p. 8). Supportive educational environments that incorporate crucial twenty-first century literacies relevant to youth, and encourage them to engage critically into their lived realities, not only result in relevant learning experiences, but are also likely to render education more equitable for nonmainstream youth.

Beyond Access: Social, Political, Economic, and Cultural Issues

It is clear that as we near the middle of the second decade of the 21st century, the digital divide is more than a simplistic binary issue of access. Providing public infrastructure to improve rates of broadband

adoption is an important measure, but only scratches the surface. The issue of digital disparity is more complex and must consider how technology is taken up and used by individuals and communities, and how different forms of inequity intersect. In an article focusing on digital inequality, Halford and Savage (2010) articulate that: "… the transformational potential of ICT requires capacity building to overcome the effects of other, independent, structural sources of disadvantage" (p. 940). The writers point out that recent research underscores the notion that mere access does not afford the same advantages to all users (Halford & Savage, 2010, citing DiMaggio & Hargittai, 2001; Hargittai, 2008). Thus, the digital divide implies not only differential access to digital technology, but also differential use, affordances, advantages, and outcomes. The authors' recommendations for further research involve deconstructing predetermined ideas of social categories and moving toward a more nuanced understanding of how lines of knowledge/power interact with technology within specific contexts (Halford & Savage, 2010).

Similarly, Gilbert (2010) argued that digital and urban inequalities are mutually constituted, and that research into the "digital divide" needs to take into account social complexities, which include relations of power, scale, and an analysis of place (Gilbert, 2010). Focusing on the daily lives of individuals, Gilbert (2010) proposed that future research ought to examine how social networks and digital capacities do or do not develop, and how the developments of those capacities are either helped or hindered by community resources on a local, regional, national, and global scale (Gilbert, 2010). Recommending that the digital divide needs to be situated within a broader theory of inequality, she is critical of the fact that most research on the digital divide remains merely descriptive, and relies on static notions of racialized/gendered social categories. Gilbert demonstrates that many (quantitative) studies lack the analytic depiction of "the have-nots" as differentiated individuals that possess agency (Gilbert, 2010).

Discerning how to investigate the sociocultural nature of technology, however, is a somewhat ambiguous task. One possible framework for such a task is to use the concept of a *technology identity*, a term proposed by Goode (2010) and defined as a blend of belief systems including (1) beliefs about one's technology skills, (2) beliefs about opportunities and constraints to using technology, (3) beliefs about the importance of technology, and (4) beliefs about one's own motivation to learn more about technology. Using qualitative data from a mixed-methods study conducted at an urban West Coast research university that had a high rate of enrollment of low-income students, Goode (2010) collected data on three students from diverse backgrounds and with varying relationships with technology. Goode (2010) focused specifically on each participants' family practices and experiences, tracing how these impacted the students' technology identities. The findings illustrated that students with positive technology identities tended to thrive, while those with negative technology identities struggled, an imbalance that may impact students' future opportunities (Goode, 2010). Goode also underscored the perpetuation of the digital divide, and the role of universities in reproducing digital inequalities.

Policies to Minimize the Digital Divide and Encourage Digital (Media) Inclusion

The federal government has also acknowledged the digital divide as a troubling issue, and has responded with several large-scale policies intended to counteract disparities in access to broadband internet connections. Around 2008 – 2009, the US government officially recognized that its market-driven approach to broadband service provision, a deregulatory strategy used since 1996, had led to robust investment in the industry, but highly uneven provision of services across the country. To ameliorate this glaring disparity in broadband access nationwide, the American Recovery and Reinvestment Act (ARRA) of 2009 allotted $7.2 billion of stimulus funding to extend broadband Internet access and for broadband projects. These

funds were funneled into two programs, the Broadband Technology Opportunities Program (BTOP), to be administered by NTIA, and the Broadband Initiative Program (BIP), to be administered by the Rural Utilities Service (RUS) of the Department of Agriculture (LaRose et al., 2014). BTOP was to target groups that been empirically shown to disproportionately lack access to broadband connections, such as low-income communities and minorities, as well as those who had gotten less attention in discussions of the digital divide, such as senior citizens, children, and the differentially abled (LaRose et al., 2014). In a federal report published in 2014 analyzing the effectiveness of the programs five years after the BTOP and BIP were initiated, researchers concluded that while the BTOP was successful in expanding access to broadband overall, it did *not* succeed in increasing access to for minority groups. Moreover, the report determined that such programs did not effectively increase broadband adoption in rural areas unless public education efforts about its benefits were simultaneously undertaken (LaRose et al. 2014).

The BTOP-funded programs that were most successful, therefore, not only provided the physical infrastructure and economic subsidies for broadband, but also included initiatives to develop the technological skills of participants. San Francisco's Community Living Campaign (CLC), for example, used a grant from BTOP to provide computers with Internet access at senior and community center and housing sites across the city (Jobling 2014). The CLC found that holding intimate, focused, and nonthreatening trainings in multiple languages (English, Spanish, and Cantonese) and exposing participants to online resources that were relevant to their lives were all important aspects of facilitating digital literacy among the seniors. The three most significant features of the CLC's approach seem to be that (1) the center developed their classes based on the needs and desires of that specific community, building sessions around student goals like learning how to video conference with relatives in another county, or how to see photos of grandchildren on Facebook; (2) the trainings were limited in scope, often focusing on a single skill, and allowing for extensive time to practice that skill; and (3) the CLC integrated technology into other activities, such as healthy aging workshops (Jobling, 2014). Clearly, simply providing the technology would not have been enough to induce seniors to become tech-savvy. Instead, the endeavor required a comprehensive approach, one that was contextually specific, accessible, and tailored to the needs of the target community.

Is a Global Digital Underclass Emerging?

Although our discussion about nonmainstream populations' access to, and engagement with, ICT and digital media was focused on the U.S., we found a U.K.-based site, the LSE Media Policy Project: http://www.lse.ac.uk/media%40lse/documents/MPP/LSEMPPBrief3.pdf that focuses on similar issues to the ones we raise throughout this chapter. For example, a media policy brief, titled "The Emergence of a Digital Underclass" by Ellen Helsper underscored important global issues, not only relevant to the U.K. or the E.U., but also to the U.S., and the rest of the global community. While Helsper and other scholars and researchers point out that infrastructure policies and improved access are necessary, they also raise essential questions, such as: Are these policies sufficient to achieve digital inclusion? Are there particular groups of individuals who are likely to be left behind in this race for ever-increasing broadband speeds?

Currently the healthy, young, well-educated professionals with higher incomes are the ones who are more likely to engage with, and contribute to digital media, through high-speed broadband. Those with health problems, the elderly, low income ethnic/racial minority groups, in manual labor occupations or those with few educational qualifications tend to incorporate the Internet into fewer aspects of their everyday lives (even if their use and engagement has increased). They are becoming relatively more

disadvantaged compared to mainstream Internet users. In other words, the information rich are made richer while the digital poor become, comparatively, poorer. This group's message is extremely relevant to our chapter; they claim that universal roll-out of high speed broadband will not automatically lead to increased Internet use nor encourage digital critical skills or deeper engagement with ICTs and digital media for all. To conclude our discussion and pose a direction for future work, we end with the question: what can, or should, be done to avoid the entrenchment of a global digital underclass?

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KEY TERMS AND DEFINITIONS

Cell-Mostly Users: Internet users who connect primarily or only through their cellphones. Cell-mostly users tend to be younger and low-income.

Digital Underclass: Vulnerable populations who are infrequent (or non) Internet users. Despite improvement in infrastructure policy and greater access, digital inclusion is not likely to include all groups, and even create an additional barrier to social mobility.

Homophily: The idea that similarity leads to connectivity. In other words, the tendency of individuals to bond with each other who are similar in regards to social factors such as: age, class, ethnicity, gender, and/or organizational roles.

New Media Ecology: The study of complex communication technologies and systems as cultural environments.

Nonmainstream Populations: Language or ethnic groups that are not a part of the white, abled, middle class population in power.

Racialized (Online) Identities: Are often conveyed actively by members of minoritized groups, from a position of social and political resistance to their marginalization by mainstream society.

'Second' Digital Divide: White the initial (first) digital divide revealed a gap between the "haves and the have nots" (those who had access to Internet connectivity and those who did not, the 'second' reveals a gap between those with more or less ICT skills.

Social Proprioception: Awareness of the spatial positioning of a group in order to organize/coordinate themselves.

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Chapter 59
Digital Media and Cosmopolitan Critical Literacy: Research and Practice

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ABSTRACT

In this chapter I consider contemporary global conditions pointing to what some scholars term "a global risk society" where digital media and Cosmopolitan Critical Literacy offer a counterpoint to human rights, health, climate, and terrorist threats. By examining current research in global youth communication across nation-state boundaries via the Internet, existing research suggests that tapping into digital media literacy and critical media literacy will be crucial for developing an informed and critical citizenry. At present, studies of transnational youth navigating old and new affiliations across national borders are in their infancy. Nevertheless, the existing research holds promise for developing global world citizens who can realize an ethos of cosmopolitan, critical citizenship through the affordances of digital media.

INTRODUCTION

Digital media permeate nearly all aspects of our lives from the connectedness of our families and communities through cell phones, tablets, computers at home, on the road, in the kitchen, and at work. The present chapter considers the impact of digital media and Cosmopolitan Critical Literacy (CCL) (Dunkerly-Bean, Bean, & Alnajjar, 2014) on the development of an astute citizenry capable of critiquing public policies, human rights, and elements of a "risk society" (Beck & Sznaider, 2010; Delanty, 2006). I begin by providing an overview of ongoing scholarly work aimed at defining the interplay of the three elements (risk society, digital media, and CCL) by first considering what it means to live in a global, risk society (see Figure 1).

Following this section, critical literacy is considered along with an expanded notion of cosmopolitan theory and Cosmopolitan Critical Literacy (CCL). Critical literacy is often confused with its older sibling, critical reading, making it imperative that the very different stances underpinning critical reading

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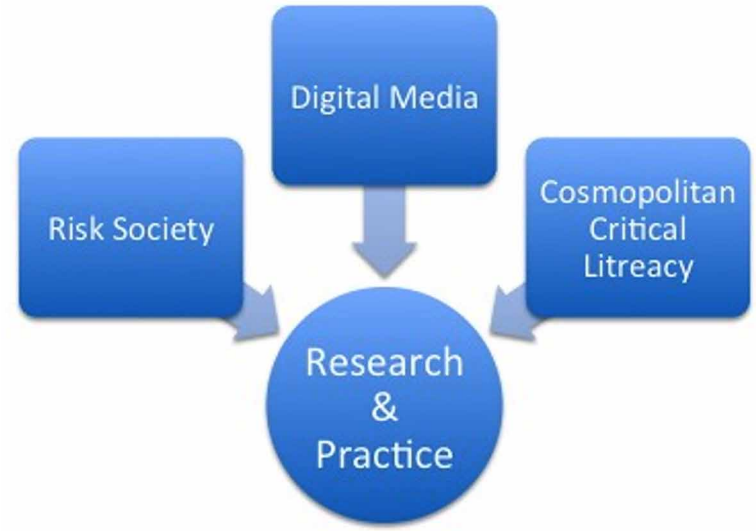
Figure 1. Risk society, digital media, critical cosmopolitan literacy, research and practice



and critical literacy are clearly defined (Cervetti, Pardales, & Damico, 2001; Stevens & Bean, 2007). Research incorporating these elements and digital media is reviewed with an eye toward how this work might guide our practice in a global context.

In essence, I argue that a global risk society overlaps with a need to develop an astute global citizenry able to collaborate and solve serious problems including war, climate change, racism, sexism, identity theft, and a host of other issues facing the planet. Figure 1 shows the three major elements considered in this chapter.

BACKGROUND

Defining a Global Risk Society

Globalization involves the increasingly fluid and borderless movement of people, ideas, information, and capital that position the global and local as mutually interdependent (Beck & Sznaider, 2010). In this environment the Internet affords an increasingly connected, transnational youth culture (Hull & Stornaiulo, 2010). This increasingly interconnected world society supports positive elements in the form of cultural exchange, as well as negative dimensions including terrorism, disease, and climate change (Trepanier & Habib, 2011) Sociologist Ulrich Beck (2012) argues that our successes and hubris in harnessing nuclear energy, developing advanced weaponry, and producing global warming place us at risk. Beck and other European scholars (Strydom, 2002) note that we now live in a global "risk society" where it will be crucial to develop an informed, critical citizenry. Because of the increasingly powerful Internet, individuals and groups of citizens can examine, deconstruct, and critique geopolitical and local policies.

To get a sense of how profound a change in communication technologies the Internet is, consider that every two years computer power doubles, rendering our cell phones more powerful than all of NASA when it placed two men on the moon in 1969 (Kaku, 2014).

Machio Kaku is a professor of theoretical physics at the City College and City University of New York. He is the co-founder of string theory and conducted interviews with over 166 prominent scientists to explore the future of Artificial Intelligence (AI), the Internet, expert systems, robotics, and new directions in brain research. In the 1900's, the differences in our current lives and those of our ancestors' lives are even more profound. Kaku notes:

To appreciate how technology reduces, rather than accentuates, societal fault lines, consider the lives of our ancestors around 1900. Life expectancy in the United States back then was forty-nine years. Many children died in infancy. Communicating with a neighbor involved yelling out the window. The mail was delivered by horse, if it came at all. Medicine was largely snake oil. The only treatments that actually worked were amputations (without anesthetics) and morphine to deaden the pain. Food rotted within days. Plumbing was nonexistent. Disease was a constant threat. And the economy could support only a handful of the rich and a tiny middle class. (p. 321)

Yet there are places on the planet that look very much like the description in Dr. Kaku's account of life in the United States during the 1900's. South African scholar Hilary Janks (2014) notes that while wealthier countries promote citizens' access to and use of Internet technologies, poorer countries may suffer from high illiteracy rates, and absence of flush toilets, and hunger. Thus, the notion of a risk society applies both on a local, village level in developing countries and on a global level. The essential difference is the degree to which parts of the globe are creating entirely new cities that are avoiding the creaking wired infrastructure of our own urban areas. For example, China and India have embraced wireless technologies and the Internet "to leapfrog past other, more developed nations that have laboriously wired their cities" (Kaku, p. 321).

Despite the escalation of wireless technology around the globe, a digital divide will likely continue to plague isolated and unplugged areas of the planet. Nevertheless, for many youth, digital media are second nature vehicles to keep up with pop culture, gaming, political issues, and families scattered around the globe through voluntary and involuntary diasporas. The point here is that this is complex terrain, a kind of disparate moving target of haves and have-nots.

Defining Digital Media

Digital media scholars struggle to generate a straightforward definition of the field, largely due to its robust and ephemeral nature. For example, Golumbia (2014) noted that: "The field of digital media can be arguably understood to be so wide as to encompass virtually everything" (p. 54). Nevertheless, Golumbia listed the following characteristics in an effort to define, and momentarily "freeze" this dynamic field:

- Digital media are *nonlinear*. That is, the temporal order of texts are largely fluid with authors able to collaborate and easily add to pre-existing texts. In addition, this nonlinearity is a characteristic of e-book readers and bookmarking websites.
- Digital media embrace and capitalize on *multimedia*. Texts can be embellished with elements that go beyond the written word to include hyperlinks and URL's that let the reader branch to multiple sites for additional information on a topic.
- Digital media supports *collaboration* across distant boundaries through the use of applications like Dropbox and others where multiple authors can confer on a project.

In addition to these characteristics, digital media are highly portable, easily archived and preserved electronically. A host of studies exploring multimodal forms in diverse fields including advertising images and angles, green corporate marketing, digital home design and decoration, and computer animation suggest that this is a rich field for research (O'Halloran & Smith, 2011). For example, a German researcher explored the impact of popular social networking sites including Facebook to evaluate the impact of representational qualities (Esenlauer, 2011). Something as seemingly simple as a profile page and adding friends on Facebook may engender a variety of responses in viewers based on the positioning of one's profile. For example, the direct gaze where a potential "friend" is looking directly into the camera is an image that demands an action on the part of the viewer. By contrast, a more neutral profile photo where a person depicted in a grainy image is balancing on a sidewalk curb with his back to the viewer is more innocuous. Esenlauer found that despite the predetermined linguistic profile categories on Facebook, personal images serve to modulate these templates, allowing for personal expression and varying how a viewer is likely to respond. Thus, multimodal images in social network sites, advertisements, and contemporary design methods call for analysis and critique.

The implications these characteristics hold for developing informed citizens able to navigate and critique this unwieldy and vast collection of information are huge. For example, early on, noted new literacies scholar Gunther Kress (2003) observed that the nonlinearity and idiosyncratic nature of reading in digital environments poses new challenges for functioning as literate citizens. For example, paying attention to visual clues to meaning including salience, color, spatial configurations, font changes, and other nonlinear elements constitutes new demands on readers and what it means to be literate.

Multimodal scholars note that studies in this area now cut across a wide array of fields (O'Halloran & Smith, 2011) including personal publishing and design issues (e.g. FaceBook), education, business, advertising, home design, and discipline specific applications (e.g. biology, history, mathematics). O'Halloran and Smith argue that in the 21st Century we are moving away from the age of the disciplines toward technology uses devoted to problem solving applications that are interdisciplinary (e.g. climate change).

In addition, the ability to successfully engage in multimodal composing has already moved well beyond writing the linear print-based texts of the past century (Miller & McVee, 2012). Design issues predominate now and are crucial for active civic, personal, and workplace activities. For example, the creation of visually appealing flyers, signs, social network pages, and videos revolve around design decisions about color, size, font, spacing, white space, movement, music, and other media. Aesthetics become ever more important in creating appealing and attractive digital media (Miller & McVee, 2012).

To gain a sense of what these new digital literacy demands might mean for careers by the year 2025, the *Pew Research Center Report* (2014) charted jobs that could be eliminated in the not too distant future. The list centered on jobs that are repetitive, rote, and easily automated, including:

- Proofreaders,
- Motion-picture projectionists,
- Meter readers,
- Butchers and meat cutters,
- Secretaries and stenographers,
- Payroll and timekeeping clerks,
- Bank tellers
- File clerks,

- Cashiers,
- Typists,
- Bookkeepers and accounting clerks.

In contrast, careers least likely to be eliminated generally involve significant educational preparation and the ability to navigate and use digital media and technology. These positions include:

- Teachers,
- Foresters and conservation scientists,
- Engineers,
- Software designers,
- Artists,
- Archivists and curators,
- Airline pilots and navigators,
- Actors, directors, and producers.

Similarly, the International Society for Technology Education (ITSE) (2007) standards for students proposes that 21st Century professions call for creativity and innovation, communication and collaboration, research and information fluency, critical thinking, problem solving, decision making, and digital citizenship.

In essence, the dispositions and skills needed for today and into tomorrow call for a critical citizenry able to cull through a vast array of digital media material and able to critique both local and global geopolitical risks. To get a sense of the ways in which globalization and cosmopolitanism interact, I turn briefly to recent work in these areas and compare the two views, noting that both conceptions of society are in flux, and, to a great extent, interdependent.

The term, "cosmopolitanism" has a long and contested history. Dating from the Greek kosmopolites, it refers to citizens of the world (Harper, Bean, & Dunkerly, 2010).

Indeed, theorists Beck and Sznaider (2010) argue that:

Cosmpolitanization thus includes the proliferation of multiple cultures (as with cuisines from around the world), the growth of many transnational forms of life, the emergence of various non-state political actors (from Amnesty International to the World Trade Organization), the paradoxical emergence of global protest movements, the hesitant formation of multi-national states (like the European Union) etc. There is simply no way of turning the clock back to a world of sovereign nation states and national societies. (p. 390)

The philosopher, Kwame Anthony Appiah (2006) takes a more critical view of the term "globalization," contending that this moniker has shape shifted from a global marketing strategy to a macroeconomic notion that is largely meaningless. Rather, Appiah sees two major strands of cosmopolitanism:

- The belief that we have obligations to others on the planet beyond our families and members of a shared citizenship, and,
- The belief that we should take seriously the value of human life generally, as well as particular human lives

Acknowledging the pitfalls of cosmopolitanism where cultural imperialists ride into town with their own new order akin to any colonizing entity, Appiah argues for human variety. "A tenable cosmopolitanism tempers a respect for difference with a respect for actual human beings" (p. 113).

The impact of globalization introduces both positive elements for some people (e.g. economic growth) while simultaneously reducing opportunities for others experiencing terrorism, disease, and the effects of climate change. Globalization may reduce geographic isolation from each other through the exchange of ideas, commodities, people, culture, and institutions through a worldwide economy (Trepanier & Habib, 2011). The process of globalization may diminish the sovereignty of the state with a greater interdependence of global citizens across geopolitical landscapes. Thus contemporary postmodern cosmopolitanism offers a philosophical position that invites social difference and values social justice (Appiah, 2006; Trepanier, 2011). Nevertheless, as Trepanier notes, no single school of thought is adequate for defining the various permutations of cosmopolitanism but it offers a way to address some of the complex issues that globalization entails. For example, given the ease with which digital images can be doctored and used as a vehicle for misinformation and propaganda, media scholars argue that the time is ripe for schools and society to embrace critical literacy theories and practices (Lim, Nekmat, & Nahar, 2011).

COSMOPOLITAN CRITICAL LITERACY

In the following section I introduce the notion of Cosmopolitan Critical Literacy (CCL) and situate this concept within critical media literacy. Subsequent sections provide an overview of relevant research and future research directions.

Defining Cosmopolitan Critical Literacy

Critical Literacy

At its most basic level, critical literacy can be defined as an emancipatory endeavor centered on interrogating issues of power, representation, and marginalization (Stevens & Bean, 2007). Its genesis is related to critical social theory and the Frankfurt School (Habermas, 1975) where scholars undertook an interdisciplinary, neo-Marxist critique of society that supported a strong interest in social justice (Borsheim-Black, Macaluso, & Petrone, 2014).

To get a sense of critical literacy as a stance it is helpful to distinguish this position from critical thinking. South African scholar, Hilary Janks (2010) notes that unlike critical thinking or critical reading with its emphasis on textual analysis, critical literacy is centered on deconstructing a message in terms of how it positions the reader or viewer, who benefits from the message, and who is disenfranchised or silenced by the message.

Applying this stance to digital literacies is crucial as the Internet is an open access network where virtually anyone can step on board and publish whatever they want (Leu, Kinzer, Coiro, Castek, & Henry, 2013). The potential for political, economic, and ideological posturing is significant and calls for readers to be critical consumers of virtual texts.

Critical Media Literacy

Critical literacy practices are increasingly applied to digital media under the banner of Critical Media Literacy (Hobbs, 2007; Morrell, Duenas, Garcia, & Lopez, 2013). Growing out of diverse disciplines in the 1990's including literary theory, cultural studies, film studies, semiotics, media studies and other disciplines, critical media literacy centers on the following precepts (Hobbs, 2007):

- All media represent constructions.
- Media messages are shaped by semiotic signs and design conventions.
- Media messages are imbued with particular values and points of view.
- People are likely to interpret the same media message differently.
- Media messages are typically constructed to advance profit and/or power.

Thus, Critical Media Literacy centers on critiquing how diverse people are portrayed and positioned in digital media including films, advertisements, video games, songs, popular culture, Facebook, YouTube, and other social media sites (Stevens & Bean, 2007). Questions aimed at guiding their critique may include:

- What is represented?
- Who is the intended audience?
- Who stands to benefit from the use of this media?
- Who is left out, marginalized, or silenced in this media?
- How are you positioned as a viewer of this media?

For example, one of the activities I do with my graduate students in a New Literacies class involves critiquing the popular Kenny Chesney song, "The Boys of Fall" (Chesney, 2010) chronicling high school football players. In particular, students note who is left out of this picture. Students who are not football players but may do more non-mainstream sports like swimming, tennis, and golf, as well as a host of others including handicapped student athletes, girls, the school band members, and so on.

Thus, digital media including music, YouTube advertisement clips, cartoons, video games, and other Internet content offer available sites where critical media literacy can be used to deconstruct and reconstruct ideological messages. For example, African American ballet dancer Misty Copeland, a ballerina with the prestigious American Ballet Theater is featured in an Under Armour advertisement that juxtaposes her stunning dance performance with the background voice of a teenage girl reading aloud from one of Misty Copeland's actual Ballet school rejection letters (YouTube, 2014). The letter reads: "Thank you for your application to our Ballet Academy. Unfortunately, you have not been accepted. You have the wrong body type for ballet. And, at 13 you are too old to be considered."

This advertisement has garnered over four million viewers worldwide. The ad provides a powerful counterpoint to Under Armour's male football oriented ads and is aimed at empowering women to move past perceived barriers to career choices. Thus, digital critical media literacy can serve to expose discriminatory positions and help reconstruct who has agency, voice, and possible futures.

Cosmopolitan Critical Literacy

While both critical literacy and critical media literacy undoubtedly help create a discerning questioning stance on the part of a reader, these practices remain tied to nation state standards rather than global issues (Bean, & Dunkerly-Bean, in press). Youth are living at the nexus of the local and global. They are the generation that currently studies in educational settings that are striving to become relevant amidst high stakes assessments that often narrow the curriculum to what Australian scholar Allan Luke (2013) calls "first wave" literacy. In contrast, a "second wave" curriculum would address local and global problems impinging on students' lives including water quality, immigration, and other pressing issues.

As I noted earlier, the term, "cosmopolitan" has a long and contested history. Diogenes, a Greek philosopher in the 4th century BCE, used the term to make known his political allegiance to the world (Harper, Bean, & Dunkerly, 2010; Trepanier & Habib, 2011). In the eighteenth century, cosmopolitanism has been associated with Kant's (1795/1972) notions of "Perpetual Peace," and more recently with globalization and mass migrations across various borders that call for intercultural communication (Hansen, 2014).

Although critical literacy and critical media literacy address and critique instances of social inequality and injustice, a cosmopolitan stance focuses on human rights and the reverberations of actions in one part of the world on other areas around the globe (Bean & Dunkerly-Bean, in press). Digital media connect the local and the global in ways that reveal injustices, sometimes in stark ways with respect to war, civil unrest, immigration, and the distant outfall from pollution in one part of the planet on disparate areas thousands of miles away from the original site of the problem. Indeed, critical literacy scholars like Hilary Jenks (2010) argue that critical literacy must be agile enough to address local and global issues. Cosmopolitan Critical Literacy (CCL) moves youth conversations into a larger sphere where they may find common ground centered on basic human rights issues (Dunkerly-Bean, Bean, & Alnajjar, 2014).

The succinct overview of research that follows encompasses the interrelated forms of critical literacy, critical media literacy, and CCL with a focus on refereed studies published in major journals, books, and book chapters. Additional criteria applied to the selection of particular studies centered on research involving digital media and transnational youth at both local, United States settings (e.g. Morrell et al., 2013), as well as globally situated contexts (e.g. Hull & Stornaiulo, 2014) where intercultural communication is considered (Sorrells, 2013).

Overview of Current Research

Social networks can serve to bridge vast distances, as well as ethnic and cultural differences. As cosmopolitan theorist David Hansen (2014) notes:

Education is a transformative experience of becoming aware of one's skills or lack thereof, of grasping their significance or their triviality, of discovering (often with surprise) that knowledge is a many-sided concept, or experience than merely having information. (p. 10)

When youth communicate across national and international boundaries via the Internet, they begin to find common ground around human rights issues and collaborate to generate solutions to problems. For example, in a study using a social media site called Space2Cre8, youth from the United States, South Africa, India, and Norway carried on a three-year collaboration (Hull & Stornaiulo, 2010; 2014).

Embracing cosmopolitan practices, they created and shared digital stories, digital music, stop animation videos, digitized artwork, and critical dialogues about their everyday lives and diverse cultures. Their dialogues discussed human rights issues encompassing discrimination, school stresses, and poverty. For example, when the Norwegian students created a movie on drug and alcohol abuse, one of the students in the United States site resonated with this issue. He lived with parents who regularly got drunk and beat him and his siblings. Although this is a challenging situation, the U. S. student was able to discuss something hidden with a peer thousands of miles away, potentially reducing some of the isolation and despair accompanying their daily lives.

In a follow-up analysis of the Space2Cre8 data, 13 young women from Locknow, India and 12 young men and women from New York City rallied around a video developed by the India students aimed at halting domestic violence against women in their community (Hull & Stornaiulo, 2014). When the video was completed, the India students shared it with the New York City students and this inspired the New York City group to create a 6-minute video showing gang violence and being "jumped into" a street gang. The India students were mystified as to why anyone would elect to join a street gang and urged the New York City students to develop a community action group aimed at resisting gang intimidation.

Thus, the transformative power of digital media afforded these students an opportunity to critique their respective worlds as well as the worlds of others, ultimately proposing and creating solutions to gang violence, drug and alcohol abuse, and other problems. Over the three years, Hull and Stornaiulo (2014) noted: "Participants gradually become more reflexive, achieving enough distance from themselves to move closer to distant others" (p. 25).

Other transnational studies of youth maintaining contact with their homelands and balancing the stresses of being a new student in the United States, suggest that digital media play an important role in quelling some of the anxiety that youth experience in a new social setting. For example, in a case study of a 10th grade girl from Trinidad, Cheryl McClean (2010) investigated how Zeek was able to adopt her digital world as a virtual home while she transitioned into a new high school in the United States. Zeek was able to preserve her Trinidad identity by using her home dialect, "Trini" to communicate with friends back in Trinidad, Tobago. In contrast, in her new high school students mocked her dialect and made her feel self- conscious. The Internet provided a way to maintain her native language while simultaneously taking up the more homogenized, and at times stressful American school setting where students made fun of her.

Clearly, if Zeek were in a school setting that adopted cosmopolitanism with its emphasis on funds of knowledge the Other brings to a new setting, there would at least be potential for what sociologist Elijah Anderson (2011) terms the cosmopolitan "canopy." Although not specifically encompassing digital media, Anderson chronicles urban Philadelphia where people gather across social difference in diners as a counterpoint to views of the Other in a city where de facto segregation is the norm. Similarly, educational philosopher David Hansen (2008) sees a cosmopolitan disposition as "a sustained readiness to learn from the new and different while being heedful of the known and familiar" (p. 289). It is not hard to reconstruct Zeek's experiences that might have been quite different in a high school where her Trinidad-based funds of knowledge were respected and valued. Indeed, the lens of cosmopolitan critical literacy (CCL) suggests that it might well be possible to find ways to reconstitute and reduce educational anxiety and stress for transnational learners trying to bridge homeland and immigration to another country, in this case, the United States.

In another study of two sisters whose family voluntarily immigrated to the United States, McClean's (2013) qualitative case study illustrated the pressure to assimilate in both language and dress. The girls,

Sade age 17 and Kai, 14 attended school in a metropolitan city in the south. Both used digital technology and online social networks to maintain membership in various affinity groups and take up new identities in the U. S. context. They produced content on their blogs, podcasts, and iMovies. Digital media afforded a means to bridge the gap between the social mores of their native and adopted homes.

In McClean's (2013) interviews with Sade, she noted that the girls in her school mocked her style of dress and tried to pick fights with her. In her native Jamaica, Sade wore uniforms to school and now, in the United States, she felt compelled to assimilate and change her style of dress to conform to the normative pressures of her classmates. Indeed, her Facebook profile shifted to indicate that she shopped at fashionable stores like Nordstrom. In essence, Sade's U. S. classmates did little to embrace and appreciate social difference and learn from the Other.

In contrast, Kai elected a different approach to enculturation in the new U. S. setting. She resisted her female classmates' criticism of how she talked (with a Jamaican intonation pattern), by using her digital literacy prowess to create a blog site for diverse youth. This site offered Kai and other diverse bloggers a space to share multiple points of view and world-views, as well as open discussion with local and global audiences regarding racism and other hot button topics for youth.

In addition, Kai resisted dominant ways of naming race (e.g. African American) by proclaiming she was part of the "human race" (p. 70). McClean noted that: "Digital literacies became the multimodal approach through which the girls resisted and re-presented traditional definitions of who they were as girls, racial/ethnic, and immigrants" (p. 71). Although Kai was not invited by her classmates to share her cultural experiences in Jamaica, her blog site provided a forum for these conversations with other youth locally and globally.

In a related study, Skerrett (2012) conducted a case study of Vanessa, a 15-year old Mexican girl who immigrated to the United States but continued to participate in life in Mexico where her father remained to run a business. Vanessa successfully navigated and used Internet social media to traverse online permeable borders. Skerrett completed detailed in and out of school observations, field notes, and artifact analysis. Vanessa kept a diary to chronicle her life in the United States. In addition, she sent regular text messages to her friends in Mexico. Vanessa code shifted from Spanish to English in her communications and she was comfortable enough to take up a transnational, cosmopolitan perspective. She embraced African American vernacular and hip-hop dance. Unlike Zeek who struggled with homesickness and deeply missed her Trinidad friends, Vanessa managed to use her social media savvy to ease the transition to the United States.

Despite the promising trends in these studies, Skerrett (2012) cautioned that studies of transnational youth constitute an underrepresented research area within digital literacies. Nevertheless, the existing body of research suggests that transnational youth have much to teach us about intercultural understanding and the unique skills and dispositions afforded by this nomadic lifestyle. Vanessa, accustomed to very few reading and writing resources in her native Mexico, enthusiastically read books recommended by her teachers. Similar to a cosmopolitan disposition, Skerrett concluded that transnational proficiencies "include multilingual repertoires and consciousness, cultural flexibility, a sense of global citizenship, and nomadic awareness" (p. 388). Thus, in this study the potential for cosmopolitan literacy was realized and exemplified by Venessa's online and school based communication where she took up art and dance, in particular learning about African American dialect and hip hop. In essence Vanessa managed to border cross dimensions of race, ethnicity, culture, and language.

Cosmopolitan Critical Literacy (CCL) was the theoretical foundation for a year-long study exploring middle grade students' multiple identities as global and local citizens creating a short film on the chal-

lenges of immigrants and refugees (Dunkerly-Bean, Bean, & Alnajjar, 2014). Students wrote and acted out scenes following their reading of global young adult literature (Bean, Dunkerly-Bean, & Harper, 2014), multimedia texts, YouTube video clip simulations, and other selections related to immigration, citizenship education, and human rights.

The study was located in a diverse urban international charter school offering afternoon electives by student choice. Nine middle grade students were involved in this global elective entitled: Project *iFLICK*, an acronym for *Integrating Film and Literature for Intercultural Knowledge*. Students had access to a global/international array of young adult literature provided by the researchers. In addition, students also explored Internet sites including Youth for Human Rights as it could be accessed at www.youthforhumanrights.org.

The charter school where this study took place had few material resources. There were no computers, a functioning library, Smart Boards, or other digital media. Thus, the researchers supplied laptops and their smartphones and iPads so that students could create a short iMovie on Article Fourteen of the Universal Declaration of Human Rights. This article states: "Everyone has the right to seek and to enjoy in other countries asylum from persecution." This human right resonated with these students as their personal experiences as Latina/o and the immediate experiences of their families centered on issues related to immigration. The short digital movie entitled: *Asylum: Seeking a Safe Place to Live* may be viewed at: https://www.youthtube.com/watch?v=Qgo7P-f5ba4.

The students' film was set in the year 3033 where war breaks out in a fictional poverty-stricken country called Chinaka. The war was related to a long- standing rivalry between the Jermians and the Evins over a Romeo and Juliette like scenario between two young lovers. The two groups clash violently and a young Jermian named "Ydoc" is killed. A group of refugees decide to flee war-torn Chinaka for the peaceful and prosperous country of Niwaka. They confront government corruption when the ruler of Niwaka bribes their guide for information on the refugees before he decides to close the border to prevent their passing into his country. Only after the intercession of the human rights minded (female) Vice President, does the president give in and grant asylum to the refugees.

It is important to note that the film features a blend of serious, tragic scenes interspersed with comedic elements. Although students drew from their readings of print and multimedia texts where poverty, war, oppression, and deportation where daily events, they gave the film their own creative spin.

Findings from this study revealed that students' understanding of the global and local elements at play became more complex, and at times contradictory to immigrants assimilating into a new culture. The film served as a way to deconstruct and critique the status quo of immigration while questioning exclusionary policies, bribery, and corruption. In the tradition of Cosmopolitan Critical Literacy (CCL), these students learned how to deconstruct a local reality in their lives, along with thinking about how, through a forced diaspora from their native counties, they could reconstruct a better life in their new homeland.

Consistent with the intent of CCL to move from deconstruction to advocacy and reconstruction, scholars in social studies have created a model based on "relational cosmopolitanism" (Baildon & Damico, 2011; Damico & Baildon, 2013). This research points to the interdependence of people across the globe as they attempt to manage pollution and other risk society problems that span national boundaries. These researchers see a profound need for interdisciplinary digital collaboration to address global risk factors including: climate change, pollution, disease, war, terrorism, financial crisis, public health, and poverty.

Toward that end, Baildon and Damico (2011) created the *Critical Web Reader*: http://cwr.indiana.edu/ to help learners engage critically with digital, web-based texts. This work has resulted in a number

of research publications including those in international settings and offers users a powerful template to organize competing texts on various topics, many specific to social studies content.

Other researchers focus on issues of civic engagement and democracy for disenfranchised populations. For example, Ernest Morrell and colleagues engage youth in regularly filming, editing, producing, and distributing high quality digital videos that take up challenging issues including gang violence, immigration, animal cruelty, tagging, budget cuts and other topics (Morrell, Duenas, Garcia, & Lopez, 2013).

These researchers argue that we need to view critical media literacy as a core literacy practice and as a civic tool in the pursuit of democracy. For example, in Ms. Garcia's 9th and 10th grade English class, students created a one minute public service announcement on Arizona's SB1070 which allowed law enforcement to require identification papers proving citizenship for anyone suspected of being an undocumented immigrant. The actors in the video were harassed when they tried to purchase sodas in a convenience store, despite armbands identifying their "legal" status. By writing and producing this counterpoint video these students were able to challenge an untenable position and transform their thoughts into action using digital media. Indeed, this form of communication is rapidly surpassing print based, formal school approaches to civic engagement.

In a study that examined 90 youth civic engagement web sites in terms of the affordances for political action these sites provided, researchers Bennett, Freelon, and Wells, (2010) found that:

Young social media users are increasingly comfortable with replacing old gatekeepers such as journalists, teachers, and officials with crowd-sourced information flows developed through information aggregation technologies, (e.g. Google news) wikis, (e.g. Wikipedia), trusted friends networks, (e.g. Facebook, LinkedIn, Move On) and recommendation engines (e.g. Amazon, iTunes. (p. 397)

In their analysis of the 90 sites they observed, Bennett et al. used a two level taxonomy to name the impact of these sites. At the lowest level of impact, "Dutiful Citizenship" (p. 397) characterized civic engagements as a matter of nation state duty and obligation., with print-based government, newscast, and policy discussions at the center of this model. In contrast, they termed advocacy models as "Actualizing Citizenship" (p. 397) because they were more likely to rely on digital media and social action networks. These participatory cultures are potentially powerful sites for political involvement and organization because of the following five characteristics (Bennett, et al., 2010, p. 401):

1. Low barriers to artistic expression and civic engagement.
2. Support for creating and sharing one's creations with others.
3. Informal mentorship with experienced users helping novices.
4. The feeling that members contributions to the greater good matter.
5. A feeling of belonging and social connection to one another.

Examples of digital media embracing these dispositions include (Bennett, et al., 2010).

- Streaming online video content that is political in nature (e.g. immigration reform videos on YouTube.
- International coalitions that are able to avoid censorship.

- Civic gaming where youth can learn and practice civic engagement.
- Virtual summer camps for discussing issues via *Second Life* (e.g. World Without Oil).

Although these characteristics and examples of the potential digital media holds for youth civic engagement, in the analysis of 90 of North America's most visited civic engagement sites (e.g. TakingIT Global), the researchers found that only 23 percent of online only sites offered participants opportunities to join public and take action projects with only 9 percent providing actual take action possibilities (Bennett, et al., 2010). The researchers noted that the online sites often mirrored the age-old school emphasis on the Dutiful Citizen model of civic engagement (i.e. vote, be a law abiding citizen). Thus, in this study of 90 popular online sites for citizenship, the affordances and potential impact of digital media on social action was quite limited.

Reconceptualizing the extant research on digital media considered through the lens of Cosmopolitan Critical Literacy (CCL), with its potential to disrupt and problematize narrow interpretations of youth, it may be possible to use digital media to improve intercultural communication. For example, in McClean's (2010) study of Zeek, her Trinidad roots were mocked in her new high school but she was able to cope by talking with her friends in Trinidad using her preferred dialect, "Trini."

Similarly, McClean's (2013) study of Sade and Kai from Jamaica found that, although they were mocked by their respective classmates and reacted to this exclusion in different ways, digital literacies offered a space, at least in Kai's approach, to resist and comment on racist attitudes. The unfortunate missing element was a cosmopolitan disposition that invited dialogue around social and cultural difference. Zeek's Trinidad roots and Sade and Kai's Jamaican homeland could offer United States classmates a larger look at the world versus an insular, isolationist stance.

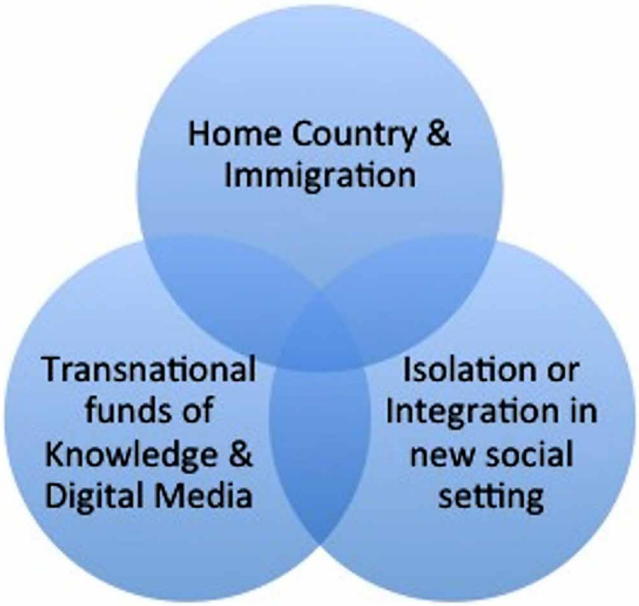
In Skerrett's (2012) study, Vanessa maintained her connection to her homeland, Mexico via the Internet. While Vanessa also assimilated cultural practices taken up in her new school (e.g. dance and hip hop), she would have much to offer in terms of transnational funds of knowledge and intercultural communication. Sorrells (2013) notes that: Intercultural communication is an embodied experience" (p. 51). Social difference is marked by language, dialects, nonverbal gestures, register, eye contact, clothes and other embodied elements in face-to-face contact or via media images.

The use of digital media exemplified by the Asylum research study considered earlier (Dunkerly-Bean, Bean, & Alnajjar, 2014), represents citizen media or participatory media aimed at challenging a political position through "culture jamming" (Sorrells, 2013). Culture jamming is a form of remixing visual and textual elements to challenge taken-for-granted notions advanced in advertising and other media (e.g. fast food ads), by creating counterpoint or alternative versions this material (Knobel & Lankshear, 2014).

Given that one out of every 35 people in the world reside outside their home country; it seems imperative to develop a more cosmopolitan perspective in schools and community settings. Figure 2 offers a useful framework for examining the current issues raised in the studies reviewed.

In the studies considered, youth were engaged in forming new identities and imagined futures, very much in the spirit of cosmopolitan critical literacy (CCL). Delanty (2006) argued that: "Cosmopolitanism concerns processes of self-transformation in which new cultural forms take shape and where new spaces of discourse open up leading to a transformation in the social world" (p. 44). While this is an optimistic view of the effects of globalization, I want to apply the ideas in Figure 2 to an analysis of extant studies of youth in fluid, transnational spaces like those inhabited by Zeek and Venessa.

Figure 2. Creating cosmopolitan critical literacy spaces



SOLUTIONS AND RECOMMENDATIONS

Although focusing on studies that highlight the tensions that exist between a United States nation-state based school curriculum and students' transnational funds of knowledge may seem overly narrow, Williamson (2013) noted that: The curriculum is a microcosm of the wider society outside school" (p. 2).

The reality of living in a risk society (Beck & Sznaider, 2010) suggests that our current school curriculum may be out of alignment with the need to develop a creative, astute citizenry able to address challenging global issues (Williamson, 2013). In a series of case studies located internationally (e.g. New Basics in Australia), Williamson found that:

The visions for the future of society imagined by the various prototypical examples of the curriculum of the future all challenge the idea that a single, central, and official version of the curriculum is possible. Instead, they promote a much more centrifugal and decentralized vision of schooling. Centrifugal schooling, as the collective name given to the prototype curriculum projects, represents an emergent and unofficial vision of the curriculum of the future—a style of thought for the curriculum of the digital age. (p. 121)

Toward that end critical media literacy (Hobbs, 2007) and Cosmopolitan Critical Literacy (Dunkerly-Bean, et al., 2014) take on particular importance in the transnational flows of people and ideas via the Internet. Research reviewed earlier in the chapter reveals the transformative power of digital media. For example, the three-year international collaborative project, Space2cre8 (Hull & Stornaiulo, 2014) engaged youth from the United States, Africa, India, and Norway in media projects on discrimination, poverty, and other topics. Students' intercultural communication barriers were reduced as the project progressed

over time. Thus integration rather than isolation in disparate locales of the globe was a positive outcome for the youth involved in this international project.

In contrast, McClean's (2010) study of Zeek and her difficult transition to a United States high school showed the pain of isolation when U. S. students mocked her Trinidad dialect. Digital media helped preserve her identity by providing a space where she could communicate with her homeland friends using "Trini" and maintaining her home identity even a she attempted to negotiate her new transnational identity. Sade and Kai in McClean's (3013) study of these Jamaican immigrant students revealed their very different ways of coping with having their culture and language mocked by classmates. While Sade assimilated by changing her style of dress to conform to her classmates' norms, Kai resisted peer pressure by using her digital literacies to create a blog site aimed at discussing transnational issues.

Skerrett's (2012) study of Vanessa's navigation of her new home in the United States after moving from Mexico revealed her approach to integrating into the new culture through expressive dance and hip-hop, as well as embracing African-American vernacular. She was able to maintain contact with her family in Mexico via digital media while taking up a new identity in American teen culture. However, it is less clear that Vanessa's culture and language were seen as transnational funds of knowledge. Rather, she seemed to do what many immigrant families have done for ages, assimilate the mainstream cultural mores while trying to maintain her native culture as well.

In the middle school iFLICK asylum study, the researchers found students' understanding of the global and local elements at play became more complex, and at times contradictory to immigrants assimilating into a new culture (Dunkerly-Bean, Bean, & Alnajjar, in press). Writing and acting in the short iMovie film "Asylum" served as a way to deconstruct and critique the status quo of immigration while questioning exclusionary policies, bribery, and corruption. In the tradition of Cosmopolitan Critical Literacy (CCL), the students in this study learned how to deconstruct a local reality in their lives, along with thinking about how, through a forced diaspora from their native counties, they could reconstruct a better life in their new homeland. Thus, their transnational funds of knowledge were respected and invited into the global period where they felt welcomed.

Baildon and Damico's (2011) software aimed at critiquing issues offers a useful tool for critical literacy practices. Similarly, the production of counterpoint high quality videos provided students in various classrooms a vehicle for the critique of immigration policies and a host of other important issues (Morrell, et al., 2013).

Although each of these studies show promise for engaging youth in political critique and potential action projects aimed at transforming social injustices across a range of issues, research by Bennett et al. (2010) shows that the majority of citizenship education is mired in older models of the "Dutiful Citizen."

In their analysis of 90 of North America's most visited civic engagement sites (e.g. TakingIT Global), the researchers found that only 23 percent of online only sites offered participants opportunities to join public advocacy projects with only 9 percent providing actual take action possibilities.

The main issue raised by these studies suggests that intercultural communication and capitalizing on transnational youth's global experiences will be a long-term journey with starts and stops along the way (Hansen, 2014). As Hansen noted in a themed issue on cosmopolitanism in *Curriculum Inquiry*, "People necessarily speak from who or what they have become up to that moment. Their prejudices or presumptions take from through the course of socialization and life experience" (p.9). At times when I have offered a graduate diversity and literacy seminar, this has become readily apparent. That is, the ideals and dispositions of cosmopolitanism go well beyond merely respecting difference. This positioning

means one is able to walk in the Other's shoes and see multiple perspectives expressed in transnational encounters like those of Zeek, Vanessa, and the students in the Asylum production. This is not easy work or easy scholarship and research. As Hull and Stornaiuolo, 2014) concluded:

Yet, we are still a distance away for knowing how to foster a cosmopolitan citizenry, being yet at the beginning of imagining conceptions of imagining conceptions of education, schools, and curricula that produce the globally alert, linguistically versatile, ethically turned, and geographically nimble, or individuals able to converse, understand, identify, and act, not locally but beyond. (p. 40)

With that caveat in mind, I turn to a consideration of the gaps in the extant research and possible directions for future study.

FUTURE RESEARCH DIRECTIONS

It seems to me that the most glaring gap in the existing research on digital media and CCL relates to exemplar settings (e.g. classrooms) where youth from diverse transnational settings have a chance to share their unique funds of knowledge rather than simply assimilate. Although the concept of funds of knowledge is certainly not new (Moll, 1992), we have very few examples of classrooms and other sites where students are, in the best sense of cosmpolitanism, seeing their diverse cultural mores and artifacts acknowledged (Jimenez, Smith, & Teague, 2009).

These researchers noted that: "We believe that the act of embracing and implementing transnational and community literacies is one way for teachers to begin to build productive relationships with students who are English Language Learners" (p. 16). For example, barrio neighborhoods in Nashville where their exploration occurred often feature advertisements for a host of instrumental tasks such as transmitting funds to Mexico, China, and Nigeria. Additional documents explain how to open a banking account in Spanish, as well as informational material on how to apply for a mortgage. These researchers compiled a collection of over 30 digital photos of these "texts" that could be used in the classroom.

In addition, the researchers took photos of foods (e.g. tomatillos) that might not be known outside the local context. Learning the cultural history of these foods would help all students appreciate the diversity in their classrooms and the powerful funds of knowledge students bring from their home countries. Digital media including YouTube clips can be used to further orient students to far flung villages in their home countries, whether in Mexico or elsewhere.

In the Luis Moll (1992) account, Tucson's Latino community possessed a wealth of knowledge about agriculture, mining, economics, household management, science, medicine, folk medicine, ranching, mechanics, carpentry, masonry, electrical wiring, biology and math. Working with teachers to revamp lessons so that students' diverse funds of knowledge were included meant developing units on building and construction where students read, researched, and finally created model buildings. Enroute to this culminating project, students were learning the language of construction as they created streets, parks, and other buildings.

Moll (1992) listed a number of key questions aimed at evaluating the degree to which a school site takes up a multicultural, cosmopolitan curriculum likely to engage transnational students:

1. How well does a school link student learning to families and communities?
2. Have teachers had professional development to learn how they can incorporate their students' unique funds of knowledge?
3. In what way do teachers use students' informal language as a way to bridge to the curriculum (e.g. dialects, hip hop, and so on)?

Given the studies I reviewed in this chapter, there is a pressing need for new studies that explore how these changes might create a cosmopolitan canopy (Anderson, 2011) and a two-way exchange of cultural resources. At present, studies suggest that transnational students assimilate as best they can, or outright resist the hegemonic, conformist pressures to leave their native ways behind. Thus, in this light, even the questions posed by Moll may be too restrictive. A CCL perspective would marshal students' questioning stance to critique policies that limit their voice and agency. Rather, a study aimed at creating the kind of interchange across global boundaries in the fashion of Hull and Stornaiulo's Space2Cre8 (2010/2014) would help the field further understand the potential for moving beyond cultural communication toward intercultural communication.

Other areas within the digital media realm that need further study include how youth might go about critiquing global risk issues (e.g. immigration and human rights). The study where students created a film on Asylum (Dunkerly-Bean, Bean, & Alnajjar, 2014) provides an example of a promising research direction. Additional studies that cut close to home for students (e.g. discrimination, bullying, sexual harassment, cyberbullying, and so on) are hot button topics in many school districts and amenable to CCL practices.

Cross cultural civic engagement studies where youth reach out to tutor younger students in literacy offer yet another venue for intercultural communication and research. For example a study exploring an afterschool program in Los Angeles sought to reduce the digital divide for students of poverty (Felt, Vartabedian, Literat, & Mehta, 2012). Because schools often block social media sites that have the potential for participatory cultures where there are few impediments to creativity, artistic expression, and civic engagement, the researchers sought to change this situation. They noted that participatory cultures are characterized by (p. 214):

- Creative original works;
- Circulating in knowledge exchange by disseminating products across networks;
- Collaborative efforts aimed at problem solving or community engagement;
- Connecting with affinity groups around a common interest.

In this study, set in a high density Pico Union Latino area of Los Angeles where 84 percent of the students were Latino and low income with 50 percent ELL, students had access to a state-of-the art digital media lab, archive, and community center focused on social justice and digital media. Eight participants (6 male and 2 female) age 15 participated. As the 15-week program progressed, these students became more adept at working with digital cameras, video composition, and numerous sites and applications (e.g. YouTube). Their school was located on the site of the former Ambassador Hotel where Robert F. Kennedy was assassinated in 1968. Students developed a video production entitled "This is my L.A." that

was presented to a large audience of family members, administrators, teachers, researchers, and peers. The project reviewed existing schools in their community with an eye toward successful elements and social barriers needing improvement. At the close of the project, students earned Digital Citizenship Certificates.

CONCLUSION

At this relatively early stage of extant research at the intersection of CCL and digital media, this body of work points to needed changes in how curriculum can become responsive to transnational and immigrant youth, as well as how digital media can be instrumental in this transformation. As Ben Williamson argued based on international case studies of curriculum designs (e.g. New Basics in Australia):

A very cosmopolitan vision of curriculum is required. Cosmopolitanism represents the sharing of values on a global scale that transcend local and parochial interests. Such concerns are linked to the diversity of multiculturalism, changes in traditional family structure and everyday life; to the expansion of notions of community and civic participation, powered by digital media, and its effect on the individual's capacity for belonging; as well as to global economic and political forces. (p .90)

Thus, digital media and cosmopolitan critical literacy hold great promise for transforming the lives of youth. As the youth in the studies reviewed for this chapter demonstrate, it is no small accomplishment to immigrate from one's home country and its familiar culture and language to a new land, a new school, a new neighborhood that may, or may not be welcoming. Clearly, one of the ways these youth bridged barriers to active participation as citizens in a new land was through digital media and related practices. Indeed, to be literate now and in the future implies that one can manage a fairly lengthy set of competencies that alter the once lauded basic skills related to reading and understanding print based texts. New Literacies competencies include (Simsek & Simsek, 2013, p. 129):

- *Sharing* via communal bookmarking, photo/video sharing, social networks, writer's workshops, fanfiction
- *Thinkin*g via blogs, podcasts, online discussion forums
- *Co-creating* through wikis, collaborative file creation, mashups, collective media creation, collaborative social change communities

In addition to these competencies, contemporary citizens must be able to navigate multimodal material that includes visual, aural, and media based content while respecting social difference in viewpoints and multiple perspectives (Simsek & Simsek, 2013). While embracing this vision it is important to keep in mind that, as Hansen (2014) noted, we are in the very early stages of fieldwork aimed at placing cosmopolitanism practices, and CCL on the ground. The studies I reviewed in this chapter suggest that alternative and more inclusive curriculum designs that tap local and global funds of knowledge hold the potential to create citizens who respect each other and are able to use digital media successfully to transform theirs and others' life trajectories.

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KEY TERMS AND DEFINITIONS

Cosmopolitan Critical Literacy: This framework moves beyond nation-state boundaries and interests to critically address a host of global human rights issues (e.g. immigration) via digital media as a vehicle for discussion and transformation.

Cosmopolitanism: At times a contested term referring to the framing of self and other in relation to the world rather than a nation-state, and a concomitant ethical obligation to others beyond local and national borders and citizenry.

Critical Literacy: An emancipatory endeavor centered on interrogating issues of power, representation, and marginalization. Who is acknowledged and who is silenced in a text becomes crucial, along with the understanding that no text is neutral.

Critical Media Literacy: Critiques how diverse people are portrayed and positioned in digital media including films, advertisements, video games, songs, popular culture, and social media sites.

Digital Media: Digital Media is a highly dynamic category that includes multimodal elements (e.g. visual images and sound). Digital Media are portable, searchable, and able to be digitally preserved.

Globalization: The increasingly fluid and borderless movement of people, ideas, information, and capital that position the global and local as mutually interdependent.

Risk Society: Globalization, while at times treated as an economic element, renders nations interdependent such that events in one part of the globe spill over into other parts, sometimes with dire consequences (e.g. terrorism, climate change, pollution, involuntary diasporas, economic problems).

Transnationalism: The increasing diversity of people immigrating voluntarily and involuntarily to new home countries argues for an appreciation of cosmopolitan cultural funds of knowledge that values social difference in languages and cultural beliefs.

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APPENDIX: ADDITIONAL READING

Digital Resources

The following web-based digital resources are provided to guide Cosmopolitan Critical Literacy discussion of many of the global risk society issues explored in this chapter. As this is an evolving area of study, the list is not meant to be exhaustive.

Canadian Museum for Human Rights

Established in 2014 in Winnipeg, Manitoba, Canada this resource includes a website offering a virtual exploration of the museum at:

http://museumforhumanrights.ca

Centre for Human Rights and Civic Engagement

Developed by St. Patrick's College in Dublin, Ireland the following two websites include global exemplars of human rights education in the classroom.

http://www.spd.dcu.ie/site/chrce/index.shtml
http://www.hrea.org/pubs/Compendium.pdf

Choices Program

Sponsored by Brown University, this virtual collection engages youth with international issues and discussion.

www.choices.edu

Research by Columbia Teachers College scholar Earnest Morrell in urban settings with African-American youth engaged in multimedia critique of issues can be found at:

http://earnestmorrell.com

Me to We and *Free the Children* features a wealth of examples aimed at interesting students in issues of global civic engagement.

http://www.metowe.com/speakers-bureau/view-all-speakers/craig-kielburger
http://www.freethechildren.com/about-us/our-story/

United Nations Children's Emergency Fund

This well-known resource includes issues lessons on global issues.

Youth for Human Rights

Video clips running 1 to 2 minutes are centered on specific human rights and offer a rich resource for discussion.

www.youthforhumanrights.org

Chapter 60
Economic Impact of Digital Media:
Growing Nuance, Critique, and Direction for Education Research

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ABSTRACT

Digitization by computers, like steam power and internal combustion, is widely recognized as a pervasive, disruptive engine powering new ways of living and affecting all aspects of economic life. Research on its economic impact cannot be entirely disentangled from powerful cultural stories connecting technological, educational, and economic progress. As cracks appear in the narratives of constant progress through technology, science, civilization, and economic prosperity, research on the economic impact of digital media develops nuance. This review of literature examines a wide range of perspectives on the economic impact of digital media as a basis for suggesting areas of further research and implications for education, civic, engagement, and policy.

INTRODUCTION

The breadth and depth of research on the economics of digital media point to a view shared across academic disciplines and governments that the production of machine-readable information is affecting how humans provide for their needs (Dobson & Willinsky, 2009); in other words, digital media is affecting the economy. "The economy" is often an opaque package of ideology, often exchanged without acknowledgement of which economy, whose economy, what parts matter, and why. The combination of ubiquity and lack of clarity in lay political and educational discourse about the economy complicates efforts to conduct and share research. Equally challenging is researching and discussing the set of materials, texts, and social practices that make up digital media. Assessing the relation between economies and digital media(s) often involves unpacking cultural myths or overarching stories linking the two.

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Digitization by computers, like steam power and internal combustion, is widely recognized as a pervasive, disruptive engine powering new ways of living (Carlsson, 2004; McQuivey, 2013). Economic growth and, therefore, digital media access are routinely equated with national or global stability (e.g., European Commission, 2014; Yu, 2002). Economic prosperity is often absolutely linked to digital literacy (e.g., Graff, 1979, 2011). These master narratives answer research questions so forcefully that it can be difficult to imagine disconfirmation. However, as cracks appear in the narratives of constant progress through technology, science, civilization, and economic prosperity, research on the economic impact of digital media develops nuance. Under emerging conditions of economic research across numerous academic fields, poverty is less likely to be viewed as a condition of privation to be alleviated by the actions of fiscally and politically powerful groups. Digital media is less likely to be viewed as a static set of tools to be 'rolled out' for others to access. Large-scale formal governing bodies are less likely to be viewed as unproblematic benefactors of struggling villages, regions, and countries.

Powerful stories, old and new, continue to inform research and discussion of the economic impact of digital media. These stories express belief in or suspicion of intrinsic benefits of market economics, global commerce, and privatization. They consequently shape digital media education, policy, and research. As a result, readers approaching the topic of digital media and the economy are likely to encounter a fragmented array of studies verifying and contesting causal links between digital media phenomena and economic life (e.g., Atkinson & McKay, 2007; Brynjolfsson & McAfee, 2012). Projects offer heterogeneous policy recommendations and reports for governments, corporations, and development and educational organizations, whose fragmented missions call for concerted action to steer economic development through digital media education, access, and use.

In order to review the literature comprehensively, digital media is defined broadly to encompass broadband networks, the physically wired infrastructure that supports them, information and communication technologies (henceforth, ICTs) that they support, and the merging of social and economic life into these digital spaces.

WHAT IS A SUCCINCT OVERVIEW OF THE RESEARCH?

Economic Impact of Digital Media in the New Economy

Prior to the Great Recession, research across multiple fields pointed to an emerging "New Economy" explicitly driven by machine-readable information as a "General Purpose Technology" comparable to steam power and the internal combustion engine (Carlsson, 2004). Two studies of the decade prior to the economic downturn found Broadband infrastructure and ICTs to affect national economic growth in Europe (Czernich, Falck, Kretschmer, & Woessmann, 2011; Vu, 2011). The New Economy was shown to depend fundamentally on digital media for increasing productivity, making markets more efficient, improving the quality of goods and services, and creating new or innovative products (Atkinson & McKay, 2007). This influence was "not likely to run out of gas anytime soon and should power robust growth [globally]." These studies before and after the Great Recession provided empirical backing for the "growth" imperative seemingly intrinsic to the Internet and cellular phone technology. In many cases, research explicitly claimed that the "lion's share" of economic growth belonged to digital media (p. 1).

After an initial boom and bust of dot-com industry had passed, yet before the financial crises of the mid-2000s, digital media's true believers trumpeted the narrative linking digital media with economic

growth (Litan & Rivlin, 2001). Research teams carried these growth imperatives into international development settings (Galperin & Rojas, 2013), where technological and market determinism would fix a temporary digital, and therefore economic, divide (Guillen & Suarez, 2005). Skeptics questioned the effect of the Internet on productivity (Gordon, 2000) or connected the dot-com bubble with exaggerated projections regarding the Internet's economic impact (Gadrey 2003). Many more studies, however, strongly correlated changes in Gross Domestic Product with a region or country's degree of access to broadband technology or Internet Communication Tools in order to argue that they drive growth (Chambers, 2013).

The widespread view that digital media was linked fundamentally with economic prosperity spurred attention to the problem of a digital divide reinforcing traditional economic access issues. Digital divides were defined as unequal access to information and communication technologies based on wealth (Mun-Cho & Jong-Kil, 2001). Research on access to digital media in rural North America and Europe, and in numerous regions outside comparatively wealthy cities and countries worldwide was predicated on the assumption that lack of access to digital media was a serious threat to economic and political security, while access to digital media represented an opportunity to "leapfrog" historical developmental obstacles (Dunn, 2013; Faye, 2000). The digital divide has become an important part of research on the economic impact of digital media: It has developed over time, and it demonstrates characteristics of combining factors, zooming in, and critically reflecting found in research not geared toward the digital divide in particular.

Questioning simple causal connections between economic growth and digital media on the basis on historical productivity paradoxes, technology-rich environments have not always demonstrated increased output (Eliasson, Johansson, & Taymaz, 2004; Solow, 1987). Such studies suggest a category of research on the economics of digital media in which scholars have argued that realizing economic opportunities digitally depends upon organization of multiple factors, not just the existence of or access to digital tools. Chambers (2013), for instance, questions the ability to isolate ICTs' impact in the presence of other major factors like recession and war, plus rapid technological changes make longitudinal studies difficult. He notes a shift in research from measuring access to measuring particular economic effects of ICTs in specific developing regions that impede simple comparisons. Among the most important additional factors that may have been overlooked in early projections of the Internet's economic power are social practices and cultural norms that shape how Internet Communication Tools are used.

Another category of research follows in the wake of the global economic downturn beginning in 2007, embracing a mixed picture of economic effects of digital media. Zooming in on particular economic effects allows research to account for economic recession and constriction of markets whose across-the-board growth had previously been used to point up the advantages of digitization before 2007. In this category, the recognition remains that economies are more flexible and adaptable when networked digitally, yet growth claims are more modest (Kim, Park, Kim, & Hwang, 2013). Brynjolfsson and McAfee's report (2012) argued that digital media drives growth despite many signs of economic calamity such as collapse of job sectors and persistent unemployment. Destruction in the New Economy, they argued, makes room for innovative combinations, new products, and new markets, but research increasingly acknowledges that economic benefits may be fragmented:

Technological progress does not automatically benefit everyone in a society. In particular, incomes have become more uneven, as have employment opportunities. . . . The problem is that our skills and institutions have not kept up with the rapid changes in technology (p. 2).

While grand narratives of technology-driven economic growth are still being produced that tout the 'natural' connection between digital media and the economy, a great deal of research has zoomed in to see particular effects.

Research on the economic impact of digital media is *combining* digital media with other factors to understand a more complex economic significance, on one hand. On the other, *zooming in* on smaller scale economic questions, much research seeks a less coherent, but more accurate assessment of digital media's impact. A third major research development involves reflecting critically on the epistemological, political, and social consequences of digital media. Thus, in addition to combining digital media with other factors and zooming in for finer-grained analysis of economic effects, critically reflective research adds further nuance to the economic impact once attributed to digital media by noting the way economic research on literacy, media, and digital access plays into powerful cultural myths. These myths, such research argues, affect global, national, and regional media and educational policies, and they underwrite the massive financial commitments driving universal broadband access and literacy campaigns. Decentering literacy in relation to economics may be essential for making appropriate recommendations for education and digital media policy.

Combining. As early as 1993, studies combined digital media with changing business choices in order to measure an impact (Clemons, Reddi, & Rowe, 1993). But more recent research suggests that oscillations between social and material digital worlds have inadequately characterized the "blurred realities" of life in digital worlds. Moving beyond binaries requires recognition of the complex existence of digital media in the economy (Ettlinger, 2008).

The human and economic networking potential of digital media are closely intertwined, and research on the combined economic and political effects of digitization has shown that authoritarian regimes only withstand the economic and political pressure of digital networks at great cost (Kalathil & Boas, 2003). Related research examined governments' ability to filter available entertainment and found that perceptions of domestic versus foreign entertainment quality played a major role (Cheng, Feng, Koehler, & Marston, 2010). A related study drew similar conclusions by comparatively examining legal and illegal digital content downloading occurring during and after a corporation pulled popular content (Danaher, Danasobhon, Smith, & Telang, 2010). Other studies have examined the intersection of digital media, intellectual property, and government intervention: Chambers (2013) correlated vibrant intellectual property rights policy in European countries with large scale economic growth; MacQueen (2007) sought explicitly to balance the goals of economic growth with copyright protection; Van den Bulck (2014) addressed the pressure on governments to develop new regulatory frameworks to respond to rapidly changing industrial boundaries, such as between media producers and media outlets.

Research on the regulatory responsibilities of government foreshadow new possibilities for "completely digital entrepreneurship" (Asghari & Gedeon, 2010), which takes advantage of protected markets and reduces or eliminates overhead costs. The New Economy thus involves integrating the changing rules of business with responsive government policies (Oh & Larson, 2013).

Digital media spending, on the other hand represents a significant corruption problem. The increase in pork-barrel or preferential government spending on digital media projects prompted research on the messy combination of digital media expansion and undemocratic political processes (Thierer, Crews, & Pearson, 2002). In contrast to the free market goals of the former research project, Bennett and Segerberg (2011) examined how the digital forces enabling globalization also afforded forms of democratic protest and collective action.

Zooming in. Researchers zoom in past grand narratives of economic growth to test digital media's impact more accurately. The degree of mobile phone penetration was correlated with increased Gross Domestic Product (Gruber & Koutroumpis, 2011). Convergence of media devices (Alam & Prasad, 2007), convergence of databases (Janowicz & Hitzler, 2012), and cloud computing (Chambers 2013) have all been evaluated discretely in terms of their economic impact.

Zysman (2010) connected the growth of digital media with service sector expansion in US and global job markets. Much research has clustered around music, film, and entertainment industries as areas susceptible to massive change through digitization. Some have questioned whether digitization and reduced opportunity costs in producing and distributing films will loosen Hollywood's hold on the film industry (De Vinck & Lindmark, 2014; Zhu, 2001). Similar shifts in power were examined in the music industry from large US-based labels to digital community networks (Hughes & Lang, 2003). By contrast, Lee (2009) called into question the liberating possibilities of digital media in view of the complex and still-powerful industrial dynamics too easily overlooked by studies overemphasizing democratizing possibilities of digital media. Other research in this vein has recognized local synergy between university communities and arts and culture clusters (Breznitz & Noonan, 2013), where digital media is argued to play a central role in multiplying the economic impact of local resources. Similarly Morgan (2013) showed that creative media industries could have regionally significant economic impact despite their longstanding marginalization prior to the emergence of a new digital economy.

Possibilities for economic growth through new and reduced-cost outlets for digital cultural content produce economic challenges for existing outlets (Maggiolino, Montagnini, & Nuccio, 2014) in the transition away from brick-and-mortar shops (Waelbroeck, 2013). Booksellers online offer advantages for customers that translate to increased economic activity (Brynolfsson, Hu, & Smith 2003), and consumer-generated content is integrated into their business models (Ghose, 2011). The business developing around the distribution of digital content vary widely, yet the configurations and ownership of digital and non-digital content providers, such as with ebook and print text markets, themselves have measurable economic impact (Jiang & Katsamakas, 2010). At the same time, retailers' internal marketing strategies vary in terms of the way they make use of available digital information about their intended or actual clients (Ziliani & Bellini, 2003).

Critically reflecting. Historians Graff (1979, 2010, 2011) and Trigger (1976) have discussed ahistorical yet culturally important post-Enlightenment liberal social theories that tie literacy and schooling to socioeconomic development. Graff's interrogation of "literacy myths" continues to inform contemporary researchers questioning the autonomous relationship between techno-literacy and sustained economic development. Trigger (1976) used evidence from prehistoric civilizations to argue that literacy is not required to support highly complex economies, even if literacy developed to support complex economies in the Middle East. Katz & Stern (2008) argue that growth promises tied to education in the New Economy ring hollow, providing many medium-low wage jobs requiring no college degree, outsourcing many jobs, and rewarding a tiny percentage of college graduates who reap outsized rewards.

Katz and Stern's (2008) argument about college education touches on the changing value of specialized knowledge and knowledge in general in the "New Economy." Brynjolfsson and McAfee (2012) connect the economic impact of digital media with the educational need to focus on "soft skills" like leadership, team building, and creative thinking. The Partnership for 21st Century Skills (2011) represents core academic knowledge as a "base" for "21st century skills" implementation." The incorporation of educational recommendations manifests the shift in emphasis away from efficiency and cost saving as the main advantages to networked computing and communication. Researchers increasingly recognized the

potential of digital media to affect every aspect of economic life, with a "multiplier effect" (Katz, 2010). Carlsson (2004), Geyer-Schulz, Neumann, Heitmann, and Stroborn (2004), and Maull and Mulligan (2014) locate the salient feature of digital media in its capacity to convert of information to knowledge. The economic and sociopolitical consequences of datafication or "metadata" are only beginning to be realized and studied.

Chambers (2013) claims that entire functions of society (e.g., education, health, security, privacy) are being rethought as they are being translated for exchange through digital media. Accompanying this translation is a shift toward "digital epistemologies" (Lankshear, 2007), where sweeping changes in individual and community life through digital media affects what counts as knowledge. The New Economy represents a structural shift toward "networked information" (Benkler, 2006, p. 3). Because the use of digital infrastructure for networks has been enclosed economically, laws of supply and demand apply to this process of translation. To understand the human consequences of an economic metric for digitizing information electronically, Foray and Lundvall (2009) argued that the economic importance of digitizing information disrupts traditional boundaries between codified and tacit knowledge, with consequences for the social organization of institutions. Zysman, et al (2010) echoed these claims and added that digital media affects how economic value is created: "When activities are formalized and codified, they become computable. Processes with clearly defined rules for their execution can be unbundled, recombined, and automated" (p. 8).

McChesney (1999) argued that, when it comes to the relation between economics and digital media, "the market has assumed mythological status," where "all must pledge allegiance" (p. 137). In an age in which knowledge must have market value to be digitized, Carrette (2007) warned that, despite decades of critical inquiry into the role of media in shaping human thought and behavior, markets for digitized information are increasingly controlling human thought. Gee (2007) agrees, attributing the view of digital media to neo-liberal myths that lasting good is only produced by markets. "Only markets ensure quality," says Gee, to explain a relation among economics, digital media, and human knowledge. Knowledge only counts when it has survived the test of the commodification of knowledge digitally.

Critically reflective research notes the importance of powerful cultural myths at work when people make sense of changes in communication, economy, and knowledge. Selfe (1999) saw the promise of technology as a savior as a uniquely American phenomenon, now being exported globally. Warnick (2001) characterized this view as a form of economic manifest destiny; Berland (2000) found techno-evolutionism at work in the view that technology was a key factor in realizing human potential for freedom, democracy, culture, intelligence, and progress (p. 243). *The new work order* (Gee, Hull, & Lankshear, 1996) argues that changes ascribed to the new economy parrot neoliberal myths of market driven progress, which actually spell increased inequality and oppression for the world's workers despite promises of great work satisfaction, autonomy, and teamwork. Other social criticisms of the rise of digital media (Carrington & Luke, 1997; Luke, 2008) draw on complex concepts of class, lifestyle, and capital found in the work of Bourdieu (1993). Brandt and Clinton (2002) argued that the notion of using literacy to manipulate one's environment overlooks a crucial economic feature of literacy, that using literacy means being used by literacy as well for potentially economic purposes beyond the view of researchers and participants. Similarly, court decisions and other structural factors play a role in the preservation of cultural myths about literacy and media use (Prendergast, 2009).

Critical media literacy has the goal of exposing economic underpinnings of digital media. Cultural messages about economic life and literacy are important (Luke, Iyer, & Doherty, 2011). One study noted the effects of neocolonial literacy education in parts of southeast Asia, where "The dominant character-

ization of the landless peasantry in Bangladesh and elsewhere in Asia is of illiteracy" (Maddox, 2001, p. 137). Another criticized the literacy education agendas sponsored by the World Bank and UNESCO as neocolonial in nature, that is, positioning the less developed regions for a new wave of economic exploitation through digital media.

Such critiques pave the way for new ways of looking at the economic significance of digital media. Ethnographic perspectives of digital media experiences are useful in considering more nuanced economic situations (Coleman, 2010). Case studies undermined the link between economic development and digital media use among low literacy adult workers in Australia (Black & Yasukawa, 2011).

As powerful cultural stories about markets, technology, literacy, and continue to be positioned as reasons to embrace digital media's positive econiomic effects on human life, more and more studies are published questioning the links and the stories that contextualize them. At the same time, the World Bank, United Nations Educational, Scientific and Cultural Organization, and transnational development organizations profit fantastically from "over-promising" (Heeks, 2010) and "overselling" (Kenny, 2001) digital media's or other utility infrastructure potential for economic impact. Still, research on economic impact of digital media continues to draw quite explicitly on problematic myths. The Deputy Secretary-General of the UN made literacy, and even "informatics" prerequisites for "a healthy, just, and prosperous world," (Frechette, 2003 cited in Rutsch, 2003, p. n.p.; Frechette, 1999). The urgency of the "Literacy Decade" represents the intersection of multiple narratives of progress outlined above, but it focuses on the question of a digital divide ostensibly intensifying inequalities between former colonial powers of the Global North, comprising Europe, North America, and parts of Asia, and the formerly colonized regions of the Global South, comprising wealthy regions in Asia, Africa, and South America.

DIGITAL DIVIDE

Research on the Digital Divide flows out of concerns that the ostensibly vast benefits of the New Economy will not be realized apart from access to the Internet. Recent research has therefore either forwarded or confronted the philosophy and policy reinforcing the view that digital media holds a key to development in rural areas of the Global North and both rural and urban regions in the Global South. The World Bank funded research that purported to isolate access as the controlling factor in economic growth in poor countries (Dasgupta, Lall, & Wheeler, 2001), in spite of numerous studies arguing for an approach to increasing access that accounts for social practices shaping use (Warschauer, 2002). Compaine (2000) argued that decreasing cost of use and increasing ease of use would further isolate access alone as the key determiner of economic development through digital media. Bolt & Crawford (2000) neatly equated the economic *have-nots* with information *have-nots*. These research projects bear the marks of a global economy flexing its muscles, yet, even after the economic downturn of 2007, UNESCO-backed research by Katz (2010) still assumed economic growth as the norm despite numerous indicators otherwise. Katz' research supported the view that systematic, that is, top-down, internet access policy was a key global development priority. Global broadband access was recommended as a core step in alleviating the inequalities of the digital divide (Williams, 2013). A study reaching from the end of the dot-com crisis to before the economic downturn correlated broadband access with a broad set of economic growth factors (Lehr, 2005). Similarly, Mainardi (2013) connected Internet Communication Tools, "and specifically digitization," with the assumed need for countries to effectively compete as economic engines: Digital media is a "fundamental driver of economic growth" that holds the key to "the potential development

and maintenance of absolute advantage" (p. vii). Despite the nationalistic zeal inherent in this research funded by Booz & Company, Mainardi's report identifies specific economic impact of digital media despite "continued sluggishness" of "financial crisis" (p. vii). Finally, the report's top down approach to development frames governments as chiefly responsible for building digital infrastructure, since increased digitization beyond basic broadband access produces increasing economic returns on digital infrastructure investment. This top-down view echoes in the pursuit of an inclusive information society (Guerrieri, Bentivegna, & Elgar, 2011).

Digital divide research does not unanimously endorse the top down approach to responding to the digital divide. Projects designed to increase access alone have been critiqued for their inefficiency. Heeks (2010) characterized projects designed to boost economies through networking centers as "heavy over-promising followed by noticeable under-delivery" (p. 629). One review of research (Chambers, 2013) found that economic growth in many regions that had *progressed* along the digitization spectrum had stagnated or even retreated. Recognizing the complexities of economic and cultural life in the Global South and in rural areas of the Global North has resulted, as it did with economic research not geared toward the digital divide, in projects that combine digital media with other factors and zoom in on more discrete economic effects.

Combining. Mansell (2001) found institutional foundations to be important coordinating factors for predicting growth from ICT use through uptake of digital media in business. That study argued that the notion of leapfrogging, by which ICTs enable overcoming developmental obstacles, must move beyond one-dimensional views of access to technology. The same author argued in a later study that ICTs had to be deployed in ways that afforded people making authentic choices about their own lives. Access alone is not enough (Selwyn, 2004). In spite of massive fiscal and political support for global broadband initiatives, a study of a rural broadband access program showed no economic growth (LaRose, Strover, Gregg, & Straubhaar, 2011). Far from denying the economic impact of digital media, research in this vein echoes the view that

ICTs alone cannot improve peoples' lives; the use of ICTs needs to occur within broader strategies that are tailored to make the most use of these tools and techniques in order to reap their potential benefits for human development (Hamel, 2010, p. 59).

Responding to critiques of top-down approaches, much research on the digital divide has oriented on participatory design and implementation of ICTs. When "conceived and accommodated in locally meaningful ways," argued Maive & McGrath (2010), ICTs "can provide a platform for advancing development agendas in ways that are sustainable in the longer term" (p.2). Perhaps the most important combining effort in this vein of research is the recognition that the notion of a digital divide as distinct from issues of poverty is a fallacy. A study by Blake and Quiros (2012) following reviews of digital divide research (van Dijk, 2006; Wersch, 2009) attempted to address numerous reductionist tendencies both in looking at economic impact of digital media and discussing the nature of poverty.

Using a complex view of poverty (Alkire & Foster, 2009) and more grassroots action approach, Blake and Quiros (2012) recommend recasting poverty in terms of capability goals rather than privation, thereby supporting locally relevant strategies for integrated digital media. They argued that community participation was essential to the design of effective responses to the digital divide, and that "efforts aimed at bridging the digital divide therefore need to be refocused as strategies to address the multiple divides within which poverty has been fostered" (p. 8). Research in this vein invests local communities

with agency for digital innovation around their own needs. Contrasting with the agenda of developing universal Internet and broadband policies, von Braun (2010) argues that the perceptions of the target population, rather than the supposed power of the new tools, are of paramount importance if development through digital media is to occur.

Language and gender play a role as well (O'Byrne, 2011; Looker & Thiessen, 2003; Bryson, Petrina, Braundy, & de Castell, 2003), as does race, and class (Mossberger, Tolbert, & Stansbury, 2003).

Combining environmental sustainability and economic issues has resulted in critical comparisons of environmental with economic impact (Cox, May, Kroder, & Franklin (2010). Other studies of environmental economic impact include assessment of "green broadband" (Valley Vision, 2012), energy consumption (Alonso, Hamdoun, Mangeni, & Dwivedi, 2013). At the same time, ICTs are enabling intensive environmental measurement, too, with complicated economic results, where economic growth depends upon public response to environemtnal sustainability imperatives regarding city water quality (Sitzenfrei & Rauch (2011), watersheds (Mishra, 2011), and urban sprawl (Shalaby, Ali, & Gad, 2012). These studies concur on the need for "technology that is suitable for the environmental, cultural and economic conditions in which the technology is intended to be used" (van Reijswoud, 2009, p.3).

Many concerned with a digital divide view education as a natural factor to be combined with economic growth (Borovoy & Cronin, 2011/2014). The combination of economic change and digital media has resulted in numerous recommendations for major educational changes to accommodate new digital literacies (Leu, 2000). Complex changes in the New Economy are said to underwrite a "transdisciplinary" approach to education (Lélé & Norgaard, 2005; Mollinga, 2010) that values academic specializations as it moves among them and to require "transliteracy," or the ability to respect norms of multiple communication environments (Selfe, 1999). At the same time, digital media is also supporting the creation of digital content for schools and digital tools for writing assessment, and educational technology is increasingly recognized as a site of struggle as academic labor is valued through its technological availability, distribution, and marketability (Hall, 2013). An emerging concern merges environmental stability with education. Gomes (2011) made the connection: "If education and development make an irreducible binomial and that development must be sustainable, then we need an education for sustainability" (p. 205).

Zooming in. Challenges to top-down, access-oriented, government-sponsored digital media development projects come from research that zooms in on specific economic effects. One critique rests on the notion that economic projections are made based on what might be possible through digital media when research does not strongly support the idea that economically beneficial activities will form a significant portion of internet use. One study found that digital media available in the home is a vehicle for reaching a region's elite, with poorer consumers' behaviors remaining largely unchanged (Reich, 1992]). Kenny (2011) criticizes the overzealous aims of UNESCO's Broadband Commission for Digital Development and their policy brief *Broadband inclusion for all*. Kenny skeptically cited universalist claims in the report: "international estimates suggest that for every 10 per cent increase in broadband penetration we can expect an average of 1.3 per cent additional growth in national gross domestic product" (cited in Kenny, 2011, p. 1). The critique pointed to numerous areas in which claims linking digital media access to economic growth rested on dubious assumptions, and that the actual margins of growth attributable to digital media rollout are very small.

In the report, partially titled "Overselling broadband," Kenny reveals a suspicion that the large scale of the recommended projects will disproportionately benefit those who will handle the development contracts, rather than a country's taxpayers. The author concludes by zooming in on numerous finer-grained approaches to supporting economic development through broadband rollout:

This is not to say that nothing can or should be done by policymakers to speed broadband rollout in the developing world. McKinsey [& Co. (2009)] estimates that a combination of adding to available spectrum for mobile broadband, encouraging infrastructure- and spectrum-sharing, reducing coverage obligation, reducing competition, and eliminating spectrum fees could reduce wireless broadband costs by as much as 75 percent. If one is less sanguine about the impact of reduced competition and prefer to see spectrum rights auctioned rather than given away, the impact of the remaining measures could still surpass a 50 percent cost reduction. This suggests there are powerful tools that governments could use prior to diverting scarce revenues towards broadband subsidies.

Zooming in on the digital divide led to inquiry into the significance of digital money in Uruguay (Cassoni & Ramada, 2012). Digitized geographies in Europe are consistently presented as domains of economic growth and impact (Mossberger, Tolbert, & Franco, 2012; Misuraca & Broster, 2010). Technological infrastructure is often isolated and its effects studied on particular regions: US states (Lloyd; Hohlfield, 2008), US rural versus urban areas (Whitacre, Gallardo, & Strover (2014), and sub-regions of Africa (Fuchs & Horak, 2006). Research also zooms in on the technological devices themselves. Mobile phones in India (Moz & Tanz) were shown to benefit higher status groups most and marginalized groups least. Varian (2006) saw considerable potential for emerging low cost laptop manufacturing. Brazil's low cost laptop computer program was evaluated (Amiel, 2006, less favorably by Warschauer, 2003).

Critically reflective. The notion that rural regions in the Global North and areas in the Global South can overcome development obstacles through acquisition and use of digital media has been called into question from a range of perspectives for its many assumptions about development, literacy, technology, and globalization (Fuchs & Horak, 2006). Most obvious is the ahistorical assumption that ICT and broadband development funded by outside investors might differ in their economic intent and effect from well-documented exploitive colonial and neocolonial policies. A study conducted in Egypt cautioned against an ahistorical reading of changes in global communication and that digital divide research risked recapitulating the great literacy divide (Warschauer (2002), in which modes of communication were equated with the intelligence and civilization. Providing similar historical context for research in the Global South, others have argued that the digital divide masks exploitive economic imperatives driving outside investment in digital media. The Digital slavery, it is argued, results from bridging the digital divide, where

… the claim that our personal data and electronic interactions are owned by others is tantamount to accepting that we, as digital beings, can be owned by others. . . . With ownership comes the right to use, trade and dispose. Existing legislation such as data protection is concerned with the legitimate use of data items. It does not consider data items to be the organs of a digital being and so is not concerned with the welfare of digital beings protecting them against servitude and slavery" (Rogerson & Rogerson, 2007, p. 1).

Further developing the historical critique, Ogunsola (2005) noted that leapfrogging the industrial stage of development is not a straightforward move for most countries because past economic struggles have resulted in "tighter imperialist control of the continent" by lender countries, the International Monetary Fund, and the World Bank (n.p.).

Alzouma (2005) argued that advocates for development in the Global South assume that help must come from outside, and that ICT and broadband policies magically invest technology with power to solve

entrenched human problems. The digital divide is itself a problem not likely to be eliminated, even if widespread access occurs (Lopez-Sintas, Filimon, & Garcia-Alvarez, 2012), confirming findings in a study of school and home ICT use nearly a decade before (Sunderland-Smith, Snyder, & Angus, 2003). Researchers have also questioned the environmental consequences of e-waste in the Global South, which already receives much of the world's electronic waste (Bjorn, Vanden Eynde, Viaene 2013).

WHAT ARE THE CURRENT ISSUES IN THE FIELD RAISED BY THESE STUDIES?

Educational policy is being affected globally by recognition that digital media and economic growth are entangled, if not always causally linked in an absolute sense. Research intended to inform corporate, industrial, economic, and educational speaks with many voices, without clear consensus. A lack of consensus does not mean a lack of important issues, however. On the contrary, research on economic impact in general and the divide in particular raises an important collage of issues, which provide an increasingly variegated or fragmented backdrop for action. That backdrop was once monochromatic: ICTs and broadband boost GDP, suggest the need to rethink education around watershed changes in human interaction, and demand heavy investment in less-development regions around the world. In the monochrome, social practices mattered less than material technological access, income alone defined poverty, and technology was environmentally clean and politically neutral. The evolution of the digital divide debate, the effects of the economic downturn on attitudes toward global economic progress, increasing attention to global climate change, as well as persistent critical reflections on cultural myths of technology and literacy have given researchers a far more diverse palette. Irreconcilable views among large-scale global anti-poverty groups (Denny, 2011) illustrate how colors may clash.

There is widespread agreement, however, that divisions between digital content, digital infrastructure, and digital practices are not easy to maintain. Digital media are widely regarded as critical elements of 21st century economic growth across scales and stakeholder groups, and the existence of a meaningful digital divide is widely confirmed, but current efforts seek more nuanced approaches that attend to digital media practices—the combination of digital media with cultural, material, and economically oriented practices. Additionally, studies have combined economic growth goals with questions of environmental sustainability in the recognition that limited resources, changing living conditions, and reliance on nonrenewable resources cannot be separated ultimately from digital media, despite the myth of clean technology. Studies have raised similar concerns about the role of digital in globalization, and the need to balance complex national and international interests with equally complex local and regional situations. The balance imperative stems from efforts to place the trendy in context.

The issue of balance and responding to rapid technological change is particularly important for literacy education and research. On one hand, notions of education and economic access as fundamental rights have placed schools on the education technology bandwagon. The technology imperative flows from the seeming urgency of technological and economic change: Schools must act as a stopgap bridge across the digital divide; teachers can hardly integrate enough current technology; and technology is well suited to schooling, because it so efficiently packages and distributes information, because students like learning with new technology, or because its use trains students entering the global workforce. Economic research on digital media potentially offers important balance to the view that schools must bridge the digital divide through digital literacy, as Brandt & Clinton (2002) argued, since the user-friendliness of digital media

is, illusory. Digital media, via literacy, uses us. Other economic research on digital copyright, piracy, and intellectual property raises similar concerns about the elision of technology access with education: Ownership of digital media and the ontological status of digitized personal information does not square well with human rights arguments about digital media access or the school as its conduit.

On the other hand, documentation of specific, varied, and conditional economic impact of digital media is important in literacy research, where monochromatic notions of economic change have limited engagement with the particularities of growth sectors, malleable ICTs, economic meaning-making, and environmental impact such e-waste. These issues present significant opportunities to integrate economic particularities, questions, and problems where only grand narratives existed before. Among the most important issues raised by current research is confirmation of existing concerns about automation, outsourcing, and workforce development. The review of literature reflects a shift from nationally and internationally scaled economic impact studies (even though such studies continue to be produced) to more narrowly defined industrial, local, and personal economic effects of digital media. As the picture of economic impact of digitization comes to life, critical reflection upon techno-evolutionary myths continues to be crucial for literacy research. Educational policies conceived on the basis of the older pre-Recession grand narratives can be revised to support local concerns and practices where they have been ignored or effaced in monochromatic narratives of globalization and national competitiveness.

At the same time, it must be recognized that the issues to which literacy education and research should respond are themselves fragmented. The digital divide, for instance, is hailed as an opportunity for reducing inequality through leapfrogging the glacial process of industrialization in the Global South, yet the too comfortable relationship of development corporations and World Bank or International Monetary Fund confirm fears that the digital divide really refers to neocolonial economic opportunity to expand markets in capitalism's last gasps as human, market, and environmental resources are exhausted. The issue of digital literacy as a set of practices embedded in the cultural life of particular groups (Lankshear, 2007) has been challenged similarly for its naïveté about how global economic forces are exploiting educational imperatives for profit. This issue further raises the questions about 21st century work, knowledge work, and the new work order. Research on digital media's economic impact has not produced a coherent picture of the 21st century worker, but has instead raised questions about "high" and "low" economic roads that preserve familiar class divisions, albeit overlaid with new literacies, new jobs, and new means of building elite social networks. The issue of workforce development in response to digitally mediated changes in the New Economy depends absolutely on economic impact research, and current research in the wake of the Great Recession is suggesting a more varied picture of digitized work.

Research suggests that monochromatic picture of economic growth driven by digital media depend on myths of autonomous or exogenous effects of digital literacy. The gaps in the logic that literacy *has* positive economic consequences are filled in (or papered over) by cultural stories linking high-status technologies with social status, progress, morality, and more. Research on the economic impact of digital media, while diverging in terms of critical and uncritical orientations toward these stories, point together to the importance of underlying literacy myths in shaping local, regional, national, and global policy. Graff (2011) points out that the core issue is not the expulsion of the stories so commonly told about literacy and economic development, but a need to gain some control over them and direct them.

The idea of using cultural myths about literacy strategically raises the important issue that little effort has been given to understanding economic factors affecting literacy outside the work of critical theorists of literacy (e.g., Gee, Hull, & Schultz, 2007; McLaren, 1998; Rose, 2010). Even with these

broad critiques, knowledge of the relation between real schooling practices and local economic history is "pitifully thin" (Rose, 2014, para. 4).

Separating economic from literacy and cognition issues has been an explicit goal of a branch of literacy studies most apt to tackle the problem of linking literacy and economic life beyond the grand myths (see Scribner & Cole, 1981, introduction). Literature published in media studies, by contrast, has maintained a robust critical agenda linking economic goals with digital tools and literacy. So now, the research points up the issue of synchronizing the government, business, and philanthropic economic imperatives with local economic and educational settings, of working across scales, in other words. So far, the synchronization process has been trapped by the politics and economics of scale that produced it: National and transnational governing bodies, in partnership with large national and transnational corporations, have sought to reform educational practices to produce a workforce for the new millennium. But understandings of the nature of literacies constrained by national and transnational scales decreasingly answer to issues raised in the literature. One important feature of this synchronization and scale problem is the failure to reconcile reform goals internally. Indeed, Au (2011) argued that reforms in assessment, driven by digital economies of scale and enabling new forms and levels of teacher, student, and curriculum surveillance, cannot be reconciled with curricular reform goals developed around the notion of disciplinary literacy practices and problem solving. In this study, the economic concept of alienation from work has been realized in the context of the educational reform for the digital age.

Alienation, poverty, and environmental consciousness are issues raised in the literature that demand reconceptualization for designing instruction and educational research. The digital divide debate presses the issue that definitions of poverty have implications for the kinds of economic activity and growth that can be projected upon a research site. Theories of poverty based on capabilities, agency, and freedom rather than "lack" have significant advantages in terms of predicting the way digital technologies may affect lived conditions. Although no consensus exists, digital divide research raises the issue of transdisciplinary approaches to questions of digital media development among underrepresented populations, which may significantly shape kinds of positions on digital literacy and technology integration in schools. A potential explosive conclusion from this research is that teachers, administrators, and educational researchers, as important stakeholders in the digital divide discussion, should or could cultivate transdisciplinary knowledge of digital media. Such knowledge would mean a holistic approach to questions of poverty, technology, literacy, and economics informed and clarified by disciplinary concepts (Mollinga, 2010).

The idea that education professionals should approach the digital divide or other questions of digital media and the economy holistically is an obviously tall order, yet it underlines a persistent problem raised in the literature, that a mythical relationship between economy and digital media has stunted or stood in the way of applied problem-solving about the needs of teaching practitioners, studies, and communities (Brown & Grant, 2010). But this issue applies to educational research as well, where "overly utopian and zealous belief in the role that ICTs play in development" is accompanied by a "lack of linkage" between ICT and poverty alleviation (Blake & Quiros, 2012, p. 3).

Finally, the literature confirms the issue in literacy research and schooling that instrumental and technocentric approaches to digital media should give way to pluralistic and participatory models "determined locally, according to local choices" (Chapman & Slaymaker, 2002, p. 25). In other words, schools, teachers, families, and researchers need pluralistic tools for connecting digital media, literacy, and economic life, for understanding poverty in the digital age, digital participation, possibilities for meaningful change, and possibilities for digital exploitation (Schimmel, 2009). All too familiar in literacy research, this review of literature underscores the problem of deficit models driving acquisition of

digital tools and participation in digital spaces. In a review of digital divide literature, Vaughan (2011) distinguished "ICT programs which demonstrably and explicitly contribute to community well-being aspirations through the contribution they make to capabilities" as "being sustained by communities," while a lack of such meaningful connections result in failed programs and waste (p. 7). Lack of consciousness about the development goals being incorporated in contemporary education are specifically implicated in such indictments of digital media development programs (Maye and McGrath 2010). This tension between top down and bottom up or grassroots digital media acquisition represents a crucial issue present in the literature (Harris, 2004), where functionalist rationales, "What is and what can be achieved" meet moral challenges, "What should be done and how should we do it?" (Unwin, 2009, p.33). Further, participatory development efforts, should they be conceived and deployed in schools may still "hide or widen existing divides," hence a need for balance between meaningful participation and "reinforcement of existing power hierarchies and exclusionary practices" (Grimshaw & Gudza, 2010, p.10; Blake & Quiros, 2012). The question has been raised by combining factors and zooming in on particulars, as well as by critically reflecting upon the stories told about literacy, technology, and growth: Whose economy matters, and why?

WHAT ARE THE GAPS IN THE EXTANT RESEARCH AND DIRECTIONS FOR FUTURE RESEARCH?

Position statements on digital media education pay scant attention to the economic significance of literacy, digital media, and adolescent digital media practices. References to economic impact rarely go deeper than mere mention of economic significance. Educational reform initiatives seeking to restructure schooling in Asia, Europe, and North America treat the New Economy as a form of progress for those who remain competitive (Asia-Pacific Economic Cooperation, 2014; Common Core State Standards Initiative, 2014). The idea of a set of "skills and competencies young people will be required to have in order to be effective workers and citizens" (Ananiadou & Claro, 2009) masks the diversity of use, meaning, and real economic significance of informational capitalism (Castells, 2010). It also reinforces a monochromatic view of the economic and political meaning of digital media. The idea of global skills for global competition (Partnership for 21st century skills, 2013; (US Chamber of Commerce Foundation, n.d.) justifies large scale co-option of education. In the US, many are crying foul, but widespread resistance across stakeholder groups to national and state standards initiatives has challenged almost everything about educational reform except its simplistic economic promises. In Florida, a leader in educational reform, the Career and professional Education Act (2013) is intended, to "lash our education system to the knowledge-based economy" (Florida Senate, President Office, 2013).

The literature does not univocally support the competition imperative. Global competition has resulted in significant job losses and even whole job sectors in the US and elsewhere. Other factors not related to the skill of the workforce shape economic life, and yet a persistent gap exists between research on the economics of digitization and narratives of educational reform, "which subsume educational attainment and social justice inside agendas for commodification, marketisation, employability and enclosure" (Hall, Atkins, & Fraser, 2014, p. 2).

The major gap has consequences for research on teaching and learning, since economics-minded research currently consists of recommendations based on the imaginary 21st century worker: her team spirit, critical thinking ability, ability to communicate, and adapt. Research has not yet connected what is

known about economic impact of digital media with teaching. Instead, teaching is being connected with reductive literacy myths as proxies for knowledge about how digital media is integrated into economic life at multiple levels. Although popular and useful for guiding instruction away from more didactic, fact-based approaches, crosswalks that help teachers, families, and policy makers think between schooling and economics are much needed.

As research begins to responds to this gap, existing literature emphasizes the importance of participatory models of economic impact research that combine material and social dimensions of digital media, carefully evaluate how and why economic impact matters, and critically reflect upon potentially exploitive relationships. While international development fields increasingly embrace these characteristics of economic impact research, as markers of quality inquiry, they delineate a gap in digital media and literacy research attributable to longstanding disciplinary boundaries. The "funds of knowledge" project and approach (Gonzalez, Moll, & Amanti, 2005) illustrate the troubled past of integrating literacy participation, economic considerations, and exploitation. In that landmark study, local economic structures and struggles were centrally important to researchers, who understood the precariousness of immigrant Latino economic participation and recognized the false promises of a literacy myth, in which poor kids could change their economic future by doing well in school. They observed the profound disconnect between vanishing funds of labor knowledge and alienating and evanescent labor opportunities. And yet the implication of their research and the heart of the funds of knowledge approach is to ignore the economic well-being of actual communities in favor of leveraging what funds are left for school success. In the end, the literacy myth won out against less coherent and perhaps less palatable alternatives. Scribner's concern that her predecessor Luria's (1976) interests in literacy, conceptual, and economic development together were too broad has, in a way, come home to roost. Sociocultural and cultural-historical literacy research is theoretically equipped to engage the economic question, to do so locally and beyond, and to do so in a way that attends to human experience.

Critical media literacy has contributed significantly to the discussion of economic impact of digital media, yet economic critique is less robust and distributed less across the field compared with other critical platforms. In some cases, economic critiques may even make it more difficult to interpret the economic impact of digital media for purposes of education, particularly when research implicitly and explicitly positions people as proactive or empowered *consumers*. Framing people as consumers participates in neoliberal systems of social change, in which markets, supported vigorously by strong states, become exclusive arbiters of human experience.

Economic research on the social impact of digital media seeks to refine educational and government policies regarding literacy education and digital media infrastructure. Efforts to link digital media with dramatic changes in the domestic and global economy, along with critiques of those efforts, are warranted in the wake of the most political and economic developments. Among the most relevant phenomena to economics and digital media are the global recession, state collapse in the Middle East, independence movements worldwide, surveillance practices tied to economic activity, and digitally-mediated antisocial behavior. Besides the gaps in research created by ongoing change, even structural change, in economic, political, and technological structures, there is need for focused attention on combined effects of digital media and state control of the Internet. Existing hierarchical structures (e.g., coding language, ownership of wired infrastructure, and data providers) by which digital content are produced are not absolute. Studying the economic impact of different regulatory and commercialization models is needed. In education, the push to digitize instruction has only just begun to be analyzed (Hall, Atkins, & Fraser, 2014). The enclosure of economic labor through educational technology represents a significant area

for future research, given current imperatives to create and distribute digital records of scholarship, instruction, and student work.

These areas for additional research share an emphasis on the production of digital social space and educational responses. It is difficult to overestimate the significance, politically, economically, educationally, and civically, of digital media and digitization in the contemporary production of space. Because that production is regulated politically, economically, socially, and culturally, the politics of space as outlined by Lefebvre (1992) can be a way to interpret the meaning of new arrangements of space (Butler, 2012; Elden, 2004). In sum, the production of new forms of social space represents a crucial area for research relating economic life and digital media. However, issues of scale are everywhere in research on economic impact of digital media, and recognizing scale as a political and ideological construct (Delaney & Leitner, 1997) in defining problems and opportunities with digital media can lead to awareness of whose interests are likely to receive attention. Scale is an important yet unrealized tool for interpreting the significance of digital media development in educational research, too, although arguments drawing on the political and economic significance of scale are rare. Acknowledging scale and the production of social space as political and economic questions can be useful in suggesting alternatives to existing economic imperatives for digital media access and education (McKenzie, 2012).

WHAT ARE THE RECOMMENDATIONS/IMPLICATIONS FOR EDUCATION, CIVIC ENGAGEMENT (GLOBAL AND LOCAL), SOCIAL PRACTICE, AND POLICY?

Research on digital ecologies, digital economies, and their interlocking systems of knowledge and value should continue to demand better articulation of the economic significance of digital media. Despite generations of glib projections of economic growth, a "triple crunch" of financial crisis, climate change, and energy production (Wallis, 2008, para. 1) threatens almost every possible conception of economic life. Far from constructing a crisis narrative to motivate an unmeasured response, the message of the economic triple crunch should tell literacy and civic education that there is real, possible, meaningful work to be done for which existing conceptions of cultural relevance and equality are inadequate.

Education

Better articulation of the economic significance of digital media in education cannot remain, as it is now, "pitifully thin" (Rose, 2014, para. 4), if educational goals of preparing people for personal, civic, and economic life are to ring true. This current situation is especially precarious given drastic economic changes and erosion of myths of permanent economic progress. At the same time the politicization of educational reform threatens to move the discussion out of the realm of academic argument into demagoguery. Still, current pressure on education to respond to economic needs signals a crucial opportunity, to incorporate economics as a feature of culture in culturally responsive pedagogy (Ladson-Billings, 1995). Slavish acceptance of monochrome cartoons of digitally driven economic progress should give way, as has much research outside the field of education, to a kaleidoscope in which multiple economic histories, theories of technology, and literacy pedagogies apply.

A shift away from a mythical, linear, and large-scale view of economic change in the digital economy depends upon dynamic rather than static views of culture. Cultural and economic responsiveness in

pedagogy depend upon participatory research that frames problems of poverty, access, and practice in terms of capabilities and goals rather than privation.

For academic disciplines and teaching in particular, working between economic imperatives and instructional design is crucial. Research has not yet attempted to connect the dots between literacy instruction and economic impact, hence reliance on the literacy myth to fill in the gap (Graff, 2011). Rather than only exposing the myth, Graff recommends using it strategically to foster the development of literacies among researchers, teachers, and students that resist racism, classism, and violence inherent in the hollow promises of literacy for economic gain (Stuckey, 1990).

Civic Engagement

Research on the economic significance of digital media is growing more critical of techno-centric, exogenous solutions to digital divides across multiple scales from the classroom and neighborhood to continents. This shift toward participation and fragmentation coincides with increased recognition that the promises of global, digitally-networked economies require careful consideration, especially regarding the scale of prosperity and the social, civic, and environmental consequences. Global economic change, regional political change, and environmental sustainability issues will continue to decenter literacy and technology from their prominent, yet mythical, role in safeguarding economic success. In civic life, as with education, such decentering sets the stage for exciting new research on the role of digital communication tools in economic development, which plays a dominant role in formal, national and international political arrangements. Changes projected for schools, teachers, students, families, and literacy research place these stakeholders in important positions of civic agency, with the likely outcome of increased accountability of government, philanthropic, and other agencies to this nuanced picture of economic aspects of digital media.

Managing the myths of literacy education and economic life requires critical civic consciousness. The development of critical digital literacies (Author and Colleague, 2014) by teachers and others produce digital media communication and spaces less as domains for consumption and more as boundary spaces in which alternative political and economic agency and arrangements may be explored. Thus the New Economy and its neoliberal underpinnings evoke responses constructed through new literacies (New London Group, 1996), and the new civics (Zuckerman, 2014). The "new" in the economy, literacy, and civics has less to do with time and more to do with space, participation, and multiple possibilities.

Social Practice

Everyday life is being digitized in ways that constantly defy the imagination. Musicians, news outlets, and artists thrive on virtual attention and approval. Digitized smiley faces and thumbs-up stand in for physical gestures. The "on demand" economy brings three dimensional printing, dry cleaners, restaurants, chauffeurs, programmers, and writers to our doors, promising to destabilize and reorganize the above and many other service and industrial sectors. In many ways, these innovations represent significant economic enclosures shaping social practice. Enclosure is an important economic concept of particular relevance as social life merges into digital spaces.

Enclosure refers to conversion of a thing, such as food or a word, from one economic status to another. An individual might enclose land formerly shared freely among neighbors, for instance, in order to convert the resource into personal wealth more efficiently. Digital media works the same way upon

social practices. Social media platforms enclose everyday speech, emoticons enclose human gesture, and so on through music sharing tools, stock market trading aids, online instruction, and so forth.

The idea is that information is only digitized if it has value, if the process of digitization creates a stream of revenue for the parties responsible for the digital programming and infrastructure. Meetings once held in spaces occupied by a single business may allow third party companies to facilitate digital audio and/or videoconferences for which they will be compensated. So one or more brokers of digital media may enclose communication at work that was already monetized through wage labor. For contemporary work, such conveniences may be welcome, but what about indigenous knowledge encoded in unknown languages? Information and practical wisdom specific to particular places, such as highly sensitive ecological zones, is unlikely to be preserved digitally if current investors are not able to envision a timely return on investment. By the same token, the economic factor acts as a mediating influence on the information itself, not only acting as a gatekeeper for information, but inevitably changing it. This reordering knowledge (Author, 2011; Carrette, 2007) obviously shapes social practices as well. Online recipes are a familiar example. Their accessibility and variety change how people cook, think about cooking, interact with elders, and value existing compendia of cultural knowledge. And they exist as economic ventures with very few exceptions.

Digital enclosure is important because, in addition to the economic conversion of hypothetically monetized information and practice, the practices change as they are translated. Cyber-bullying and human sex trafficking are troubling examples of how the translation of social practices into digital spaces brings about new challenges for law enforcement, families, and communities. Further, economic and political fallout from high profile instances of computer hacking and executions point to digital media as a potential catalyst for antisocial behaviors.

Policy

Much research on digital media and economics is explicitly oriented toward shaping Internet and digital media policy at the state, national, and multinational level. As research tends toward finer grained and more cautious analysis of digital media's effect on economic growth, policymakers continue to grapple with contradictory imperatives from established and new economic interests. The thrust of recommendations is to invest in telecommunication expansion, but questions and concerns in the research are proliferating. Intellectual property protection and enforcement have been serious concerns for policymakers for years. Imperatives of growth and copyright protection are seldom in agreement, however.

Contemporary developments in research directed at policy makers stress the importance of nuanced views of digital media access, poverty, and digital media use. Implications for educational policy include adjustment away from cherished literacy goals accompanied by myths of economic attainment to more adaptive views of literacy and economic opportunity.

The "triple crunch" of energy cost, financial instability, and climate change (Wallis, 2008) place educational and other policy makers in a precarious position. Established economic interests who profit from core factors in global insecurity make progressive policy development difficult. A particularly poignant conflict of interest in this context has to do with workforce development as a matter of local, regional, national, and international policy. The idea of developing a workforce for as yet unknown oc-

cupations (Frey & Osborne, 2013) tests the resolve of policymakers who are simultaneously asked to help businesses succeed in increasingly difficult and competitive circumstances. The result is a policy trap, where forward thinking becomes the only solution to decreasing profit margins in existing economic arrangements but established economic interests must be protected by increasingly outdated policy.

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KEY TERMS AND DEFINITIONS

Digital Divide: A term patterned after 'achievement gaps' among demographic groups, digital divides refer to different outcomes for learning and economic participation based on access to information and communication technologies.

Digital Media: In contrast to analog media, which involve inscription with ink, carving, and the like, digital media use electronic switches to encode information. Programming involves arranging thousands of electronic switches to produce, receive, and exchange data. Digital media includes the physical hardware used in the encoding process, the digital "content" itself, and the mediating software.

Enclosure: A term in economic and agricultural history referring to the termination of shared rights (to land, especially) in favor of an owner, who subsequently uses a resource exclusively. The expansion of economic markets often involves changes in the way a natural or social resource is treated. Because digital spaces serve economic purposes, exchanges among users occurring there can involve economic enclosure. Social media provides numerous examples, in which creators of a networking site own and profit from the everyday communication of users.

Global North/South: Terms that denote the generic geographic, historical, economic, educational, and political division between North and South. North America, Europe, and developed parts of East Asia disproportionately control global resources. Disparities of wealth, housing, education, digital media access and numerous other factors underscore the power and privilege enjoyed by the Global North, while the Global South, home to the majority of natural resources and population, is excluded.

Knowledge Economy: A term denoting an economic shift toward knowledge as a chief commodity. A knowledge economy, unlike agriculture- or labor-intensive economies, places emphasis on expertise and other forms of human capital as opposed to material products. As nonrenewable resources dwindle, economic advantage shifts toward knowledge products—innovation and reorganization of existing frameworks.

Literacy Myth: Coined by educational historian Harvey Graff, literacy myths fuse the ability to read and write with economic and even moral progress. Graff and others, such as Stuckey (1990), argue that myths of economic progress through literacy obscure and oversimplify economic and political factors affecting prosperity, especially with regards to populations placed at risk because of race, socioeconomic status, and/or gender.

Neocolonialism: A term referring pejoratively to the economic influence of capitalism, especially in the form of foreign investment and market expansion, on developing countries. Neocolonialism refers to new means (i.e., business, free trade) to reach familiar ends (i.e., exploitation of developing regions, political influence) without direct military force.

Neoliberalism: A term that refers pejoratively to the tendency of governments in developed regions to use their resources to support privatization, free trade, and reduction of economic regulation.

New Economy: A term referring to the shift from the manufacturing-based economy to a service economy.

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Chapter 61
Scandal Politics and Political Scandals in the Era of Digital Interactive Media

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ABSTRACT

This study focuses on scandal politics and political scandals in the era of digital interactive media. Scandals are the part of symbolic power struggles. Media is one of the main actors of these struggles. In fact, political scandals have a constructive function in democracies because they help releasing corruptions. After scandals, the public get the opportunity to discuss on the legitimacy of political-legal institutions and political system. However, this discussion is not possible in the conditions of scandal politics. This study is interested in scandal politics and political scandals in the era of digital interactive media. It evaluates the maintaining role of traditional media in the era of digital media, and the potentials of digital interactive media to utilize the constructive functions of political scandals in democracies. The cases of WikiLeaks and Ashley Madison affair are used to evaluate the scandal politics and political scandals in the era of digital interactive media.

INTRODUCTION

This study aims at clarifying the relationship between scandals and media in the era of digital interactive media in terms of scandal politics and political scandals. This study explains the difference between scandal politics and political scandals in terms of the presence or the absence of critical public discussion. The presence of critical public discussion on the legitimacy of political system after the release of a corruption is considered as essential for making political scandals functional in democratic system. This study separates the media power on political scandals as before and after the use of digital interactive media. It has critical points about the optimistic views on the role of digital interactive media on political participation and its role as an alternative media to challenge the dominancy of scandal politics.

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This study examines authoritarian responses in democratic countries towards digital interactive media. However, this study does not deny the challenges in communication and information processes realized by the development of digital media. It tries to find these challenges and understand the main characteristic of political scandals and scandal politics in the age of digital interactive media.

Scandal politics is a concept related to the power of information in politics. Participative democracy supports the access to information by the public and the active participation of citizens to political processes by the way of public discussions. Scandal politics does not comply with the participative democracy consisting of critical public debate about public issues even if it is essential for the revision of political system. However, in scandal politics, scandals are the important parts of political power struggles. Media companies characterize scandal politics using scandals for both making profit and using these struggles as a part of reputation wars. Symbolic power is useful for manipulating people's opinion in order to get their vote in elections or eliminate political rivals. Media has an important role in this manipulation process. In terms of scandal politics, media holds the power of producing information and forming opinion. Moreover, media elites corporate with power elites in this process.

Scandal wars among politicians is a part of politics. Politicians search for information about the corruptions of their rivals useful to attack or counter-attack to them. Journalists and whistle-blowers are main information sources for mainstream media. Blackmailing is a part of political struggles in the conditions of scandal politics. These struggles cause to the loss of political importance of information promoting public debate. Thus, disinformation increases and trust to media dissolves. Details and stories about corruptions are used as profitable commodities by media. In this system, the link between scandals and the unethical character of corruptions disappears. Corruptions as sensational events take the attention of audiences temporarily instead of being a part of long term public discussion as a main problem of political systems.

With the development of information and communication technologies (ICTs), digital interactive media is regarded as an alternative space and channel to challenge the dominancy of scandal politics. People tend to use new and alternative media channels (Castells, 2009). There is a respectable literature on the role of Internet, social media and multimedia systems for the establishment of a new critical public sphere (Dahlberg, 2001; van Dijk, 2006; Halpern & Gibbs, 2013). It is claimed that Internet has various information sources, and transforms the rules of traditional media and traditional journalism. It promotes investigative and participative ways for releasing information. Corruptions are becoming more and more visible by means of Internet and social media such as blogs, microblogs, wikis, or interactive online forums. In the last decade, new digital interactive media channels are used during the protests against governments accused by corruption (Rahimi, 2011). These new communication technologies are thought as a new potential to develop participative politics including critical public discussion.

This study firstly explains interconnection among political scandals, scandal politics and media. This part underlines the importance of scandals as a catalyst for public discussion focusing on the legitimacy of political institutions. Secondly, it dwells on the main characteristic of traditional media in relation to political scandals. Thirdly, it explains the role of digital interactive media in scandals, and scandal politics in digital era. This last part tries to clarify following issues: the maintaining role of traditional media in the era of digital interactive media; obstacles for digital interactive media; and changes in the nature of scandals in this new media era. The arguments of this study are discussed in terms of the cases of WikiLeaks and Ashley Madison affair affected the character of scandals in the last decade.

POLITICAL SCANDALS, SCANDAL POLITICS AND MEDIA

The term of scandal is used "to describe a broader form of moral transgression" (Thompson, 2000). Scandals are related to releasing of the transgression of moral values or norms. Scandal is briefly explained as a released corruption (Lowi, 1988). Corruption is explained as illegal or unethical actions of public authorities or political elites including the use of official positions illegally ignoring public duties (Klitgaard, 1988).Corruption occurs with the breaking of a law or moral norm by public figures or political elites. Thompson (2000, p. 29) explains that "corruption can give rise to scandal, and some of the most important and consequential scandals have been based on charges of corruption." When a corruption released, then it becomes a scandal. By the way of scandal, corruption gains a public character. Therefore, a political scandal can be called as a released corruption of public figures, politicians or officers.

Corruptions become public issues. Thus, scandals play a positive role in democratic countries informing the public about corruptions. In democratic countries, scandals help evaluating democratic system in terms of its stability, powerfulness and trustfulness. Tumber and Waisbord (2004a) explain that "scandals allow us to analyze and gauge the effectiveness of democratic process and procedure. In fact, scandals encapsulate the dynamics of accountability in liberal democracies." Even though scandals have this function in democracies, it needs to meet some conditions to operate successfully. For example, personalization of a scandal is one of the mistakes causes to decrease in the importance of the relationship between scandal and politics in a large extent. This relationship stands on the concept of legitimacy. Attitudes breaking political, social, economic or ethical norms have to be punished. However, this is not enough, the conditions of corruption have to be discussed by the public to make necessary challenges in political system. The discussion about the legitimacy of political system indicates the power of public opinion. In democratic systems, all political decisions and policies have to be debated by the public to gain legitimacy. Therefore, scandals should create an environment for realizing extensive and inclusive public discussion about the legitimacy of institutions and public figures. Legitimacy needs critical public discussion. The presence of a critical public deliberation, and freedom of press, expression and organization are essential requirements for the development of legitimacy.

Although scandals have important role in democracies making corruptions apparent for the public, the functions of scandals can only be useful in the presence of democratic conditions. Evidences about corruptions coming to light after scandals cannot be functional in dictatorships or authoritarian regimes. However, there are also obstacles in democracies to utilize the functions of scandals. The manipulation of public opinion and the commoditization of scandals by media limit the legitimacy discussion by the public. In this situation, political scandals become a part of political competition among politicians and media holds the control of politics in reputation wars. Therefore, discussion of legitimacy and the importance of released corruptions lost their importance as public issues in the conditions of scandal politics.

In terms of scandal politics, media has not the potential to be a catalyst for the development of critical public discussion. Instead, it is one of the actors in scandal wars. Media holds the power of the control of information and communication channels. It can manipulate public opinion and lead informational processes during scandals. In this position, media is a part of symbolic power struggles. It is also not an independent actor. There are political and financial control on media. Thus, media losses its critical role and scandals start to determine the political system instead of political reason. Scandal hunters, sensationalizing and tabloidization of scandals by media, damage to the potential of public debate on corruptions. Therefore, the term of scandal politics insists on the loss of critical role of media in public

issues. And it indicates the increase of the importance of political appearance on media. Thus, corruptions stay behind the presentation of corruption on media.

Media has important role in the disclosure process of corruptions and the breaking out of scandals. Thompson (2000) uses the term of "mediated scandal." Scandals are mediated events so media organizations hold the power of leading people opinion about scandals. In fact, media has the responsibility of informing people about public issues in democracies (Habermas, 1991; Bennett & Entman, 2001). With regard to this responsibility, news about scandals should not be perceived as commodities by media companies for making profit. Events should be seriously mediated in appropriate to the principles of trustfulness and the independency of media. However, when the power of media industry is considered, media companies regard political scandals as marketable products. And they write interesting stories about scandals for taking audiences' attention. These stories become more important than the principles. The next section explains to the background of the challenge on the role of media in politics.

TRADITIONAL MEDIA: THE FALL OF INVESTIGATIVE JOURNALISM AND THE RISE OF SENSATION AND SURVEILLANCE

The development of scandal politics is related to the industrialization of media. Media has lost its public role when it became an industrial power (Habermas, 1991). Media productions focus on consumption. Thus, political communication turns to an activity of political marketing and political advertising. Media conglomerations aim at maximizing their profits. Media contents are under the control of advertisers and media bosses. In this situation, media contents focus on producing enjoyable times for audiences instead of motivating them for public debates. Conglomeration and monopolization in media industry cause to the standardization of media contents (Croteu & Hoynes, 2003, p. 47). This situation damages to the plurality in media environment.

The loss of the productive role of media in public issues has a historical background. It is seen that there is a rise and fall in the public role of journalism in history. The importance of investigative journalism in scandals raised in 1960s and 70s. Investigative journalism consists of bringing truth into open. The press was responsible to inform the public to develop civic culture and political life. However, in 1980s, the importance of investigative journalism started to fall due to the high costs, the gap between costs and profits, and the problems with legal, political and financial authorities. These factors encouraged to sensational journalism instead of investigative one (Tumber & Waisbord, 2004b).

Ekström and Johansson (2008) insist that broadcasting a scandal is an activity more than bringing information into open. As mentioned before, scandals are mediated events. In terms of consumption, the role of media is not only transforming information but also dramatizing it for taking public attention. It uses story telling technics and makes news more interesting for audiences. In terms of scandal politics, sensationalizing is very important. Media uses the strategies of dramatization, sensationalizing, and shocking for attracting audiences. This situation shows that a corruption is not enough to cause to break out a scandal. As Castells (2006) claimed with the terms of scandal politics, media manages scandals and gets power in politics. Its power as an actor in the political struggles is not limited to the sensationalizing of scandals for making profit. Media power in politics causes to new relationships between media and political elites based on mutual interests. Politicians utilize media to increase their symbolic power during political campaigns. Some of politicians are also media bosses, and they use their media power to increase their political interests. For example, in 2001, Michael Bloomberg, used his media power to

become New York governor. At the same year, Silvio Berlusconi, another famous politician and media boss, used his media power in political competition (Croteu & Hoynes, 2003).

The power of media is not only owned by politicians. Public authorities also hold the media power in hand and use its power. Governments have power to control information and communication process. Also, they try to get their own media or cooperate with established private media organizations (Croteu & Hoynes, 2003). With regards to this relationship between media and politics, scandals are open to manipulation of financial and political actors due to their commercial interests or political deals with media bosses, or the control of governments. Therefore, media is not an independent or neutral actor in politics. Its contribution to public sphere and critical public debates about scandals is weak. Thus, questioning the legitimacy of public figures seems not possible. The democratic responsibility of media disappears in the conditions of scandal politics.

The position of audiences in scandal politics is insufficient to recognize them as a part of critical public debate and discussants of the legitimacy of political system. Media provides a huge amount of commodity for audiences. It provides enjoyable times, so people regards media commodities as means for enjoyment. People do not trust to media due to its commercial concerns and its close relation with politicians. Furthermore, people are aware of the government control on media. Therefore, they are unresponsive to media contents. People watch programs instead of considering the public role of media. Medium is considered as a means for passing time. The claim of McLuhan (2001), "medium is the message", is important to evaluate this situation. Content is less important for people than the medium. They are mostly interested in medium and having fun watching programs rather than thinking on messages, so they do not have real demands from media. Therefore, a scandal mediated by mainstream media with sensationalizing and dramatization cannot get enough potential to develop a public debate, and contribute to the discussion of legitimacy about political system due to the problems of value, trustfulness and perception.

Scandals mediated by mainstream media are not seen as reality by the public (Castells, 2009). Highly charged debates about scandals broadcasted on TV do not have special meaning for audiences more than TV series or talk shows. These broadcasts may mobilize some feelings for a short time but they do not continue when TV turned off. Therefore, it is hard to separate their effects from fictional entertainments. Audiences watch the conflict between prospective bride and groom on a marriage program; competition in a floor show, and a talk show about a political scandal on same screen. People watch or read news about sensationalized scandals among countless violence news. In programs about scandals, the sides of a scandal (political elites, journalists, media producers) are making highly charged discussions, they threaten each other. These are similar to competitors in show programs who always accuse each other. The main point of scandal, corruption or transgression of a moral or legal norm disappears in the noise pollution on media. The media environment does not have the capacity to develop a critical public debate and to solve the problems of political system (causing corruptions) around a legitimacy discussion.

Scandals create several public reactions limited to unorganized and discrete events. Some people follow discussions and talk about them but these reactions have not a real aim and consistency. Thompson (2000) explains that "scandals have been described as frenetic events, media and political frenzies that initially capture a great deal of attention and later, gradually or suddenly, disappear." Tumber and Waisbord (2004a) insisted that media is failed to create public reaction. This reaction is essential for critical public discussion to reinstate the legitimacy of political-legal system. In this context, legitimacy crises have no more connection to the public because of the influence of symbolic power struggles in political wars and their presentation on traditional media provides high ratings.

DIGITAL INTERACTIVE MEDIA, SCANDALS AND LEGITIMACY

Social media as an alternative media having potential to pass over the dominancy of scandal politics (Castells, 2009). It has a role in the process of diffusion of information and ideas. Lee and Lio (2016) insists that Internet helps the processes of information production and dissemination. It improves the freedom of expression and plurality in communication. These are important components of critical public discussion. A high level of public access to information improves accountability and supports the struggle against corruptions.

Williams and Delli-Carpini (2004) claims that mainstream media cannot maintain its power as a gatekeeper in the era of digital interactive media. Any actors has no central position in communication process in this new era. Williams and Delli-Carpini (2004) explains that there are so much information on Internet ready to progress. People do not only consume the contents of media but they also produce information on Internet. Consumers have more impact than before, the interaction between producers and consumers is stronger in this new media era than traditional media. Users are not only audiences on digital interactive media but they are also producers so they are called as prosumers. Prosumers produce contents besides consuming them (Dunn, 2013). For example, teacher violence against students in class can be recorded by students using mobile phones, and records can rapidly flow through users' online social networks. Bribery can be recorded and uncovered on social media. New actors (amateurs) engage in the production and dissemination process of information and communication. The users of digital interactive media have power to investigate corruptions as well as journalists, public investigators or political advisors. Also, so many people have capacity to mediate corruptions sharing information with people in their social networks. Williams and Delli-Carpini (2004) claim that the gatekeeping and issue-framing roles of mainstream media are challenged by the development of digital interactive media.

The number of scandals have been increased seriously by the use of information and communication technologies (ICTs). Since, Internet provides more accessible and interactive spaces than mainstream media. Information and news are cycling through social networks. New mobile multimedia systems (van Dijk) record videos and voices which are useful to get proofs about corruptions. The multimedia systems and social networks help releasing corruptions. The files as voices, videos or texts can be used in a combination by means of digital interactive media (Dunn, 2013). The types of the presentation of proofs as visual, audible and written forms with a combination make scandals more impressive for audiences. Also, access to these technologies is easier than to access the mainstream media channels.

Mainstream media manipulates public opinion in the conditions of scandal politics. However, new digital interactive media may increase the awareness of public about the role of scandals. People share information and news about corruptions, and they talk about scandals on Internet. Lee and Lio (2016, p.128) imply that Internet users create pressure on governments. This is important to overcome corruptions in governmental level. Reporting has become easier by means of Internet. It improves the auditing potential of people on public officers. Tumber and Waisbord (2004b) insist that digital interactive media reduces the power of official media under the control of state. Thus, corruptions in governmental level become more visible for the public. For this reason, digital interactive media is seen as an important part of democratization process especially in "authoritarian regimes" and "weak democracies". Dunn (2013) stresses that ICTs are used considerably to release concealed corruptions in the last decade. Therefore, digital interactive media technologies are seen as necessary for increasing public interests and civic culture.

Although new digital interactive media has strengths for accountability, transparency and participation, it is not totally characterized as a critical and alterative media. It also improves conditions for scandal

politics. Tumber (2004b) claims that new digital media provides additional spaces to rumor and talk about scandals. There are new actors who are desired to mention scandals and many blogs and websites make profit by this way. This new era is open to tabloidization, too. There is many information supplier and a huge amount of information on Internet. Scandals cycle on social media by means of online talk forums, rapidly, consistently, and without huge costs. For example, the sites like Drudge Report has role as a forum for spreading rumor and sensationalizing scandals. Tumber and Waisbord (2004b) insist that "by validating claims and providing the illusion of immediacy to acts of wrongdoing, video and sound tapes are important ammunition for actors involved in scandal politics."

However, scandal politics on digital interactive media is different from traditional media. Miltner and Baym (2015) imply that the control power of stories about scandals is challenged by the development of digital technologies. There are different mechanisms and actors in scandalizing process. Investigation of scandals and distribution of them are easier on digital interactive media rather than traditional media because the processes of investigation, storytelling and broadcasting are not only realized by professionals. There are many various actors having role in the investigation of scandals and in the process of information dissemination after scandals. There is not only special investigators, but also whistle-blowers or political advisors hunting scandals. All people can be a potential whistle-blower having a mobile phone and an account on social media platforms. The necessity of professionality in the processes of investigation and broadcasting are challenged by the digital interactive media. The subjects of scandals are also changed in this era. Usually, scandals mediated by traditional media are related to public figures, officers or political elites. On social media, scandals can be related to ordinary people.

The dominancy of scandal politics on digital interactive media is a contradictory issue. Literature on the role of social media in politics presents that social media is not a powerful channel to develop a public discussion challenging the current political environment (Morozov, 2009). However, events in the last decade show that people have had power using social media during protests after political scandals. Especially, in the countries called as "weak democracies" in terms of their political system, scandals caused to social and political reactions and political changes. Nevertheless, these movements have not a real effort to challenge the problems of democratic system around a discussion on legitimacy regarding the problems on the basis of scandals. Therefore, it is not certain whether these political movements are a part of public discussion or temporal reactions open to manipulation by the actors of scandal politics.

The availability of information on Internet about scandals, the rapid flow of information on social media and mentions cannot directly prevent corruptions. Accountability and transparency can only be realized in the presence of political control of the public, the presence of discussion about the legitimacy of public institutions and public figures, and the presence of sharing some common social or moral values. Scandals can only be constructive if they promote to public discussion, legitimacy crises and the revision of political-legal system. Digital interactive media cannot challenge scandal politics although it has potential. From this point, it seems that factors due to financial, political and governmental control on traditional media are important problems against political change in the era of digital interactive media, too. Moreover, there is political control on social media in liberal democracies as well as "authoritarian regimes" or "weak democracies." The control prevents the freedom of expression and damages the main conditions of public discussion. Therefore, the limits of public discussion and legitimacy debate in the era of digital interactive media makes the situation similar to the one of traditional media.

The opportunities of digital interactive media for social and political movements promise hope for people to develop critical public discussion. People may cause to change in the position of traditional media because they are reacted to its reckless and unresponsive position. Digital interactive media chan-

nels have become alternative media in these protests. However, communication on digital media is not totally independent from traditional media. Traditional media becomes a part of communication process a short time after the beginning of social movements. It leads the information flow and takes public attention. The role of taking public attention is a powerful function of mainstream media in the new media era. Digital interactive media is investigative, and information on digital media needs to some editorial assistance by media professionals. Therefore, digital interactive media actors corporate with traditional media companies, and they carry on business. Thus, they find places on the era of digital interactive media supplying their products and continue to use their strategies like storytelling and sensationalizing.

The opportunities increase with taped telephone conversations, the records of videos or secret talks are obtained by and accessible on digital interactive media. These materials are seen as the proofs of corruptions. It is claimed that communication on social media creating pressure on public figures, and it has the role to prevent corruptions. However, it is not sure whether the huge number of proofs have a real impact to overcome corruptions. Discussions on social media are similar to traditional media focusing on the subjects of scandals. However, the main issue is not public figures or politicians as subjects. The issue should be the reasons of corruptions. Scandals sometimes cause to resignation of public figures or punishment. However, scandals do not create debates on the legitimacy of political-legal system. The main reason of this situation is the absence of critical public discussion.

In terms of scandal politics, the huge number of scandals on social media cause to decrease in the importance of scandals. People consider scandals as media events in the abundance of scandals. There are many scandals on social media but they do not cause to public discussion and not resulted with decrease in the number of corruptions. Also, ordinary people becomes a potential subject of scandals in digital interactive media era. Sometimes, people share their unmoral or illegal attitudes on social media and cause to scandals about themselves in their social networks. It seems like self-whistleblowing behavior. Moreover, they become parts of unmoral activities which are accessible as well as information on the era of digital interactive media. Thus, the popularization of scandals causes to decrease in the importance of their political character. It also has impact on scandal politics. If somebody is already a subject of scandal what does a scandal about public figure mean for this person? Popularization, increase in the number of scandals, their inefficiency in political area make scandals meaningless media events for people. This situation also makes the boundaries between private and public blurred.

WIKILEAKS AND ASHLEY MADISON AFFAIR

This part evaluates the arguments of this study by means of WikiLeaks and Ashley Madison affair, famous websites related to popular scandals in the era of digital interactive media. WikiLeaks is a digital interactive media platform played an important role releasing corruptions related to the public authorities of countries in the world. The case of WikiLeaks is useful to understand the role of new digital technologies in political scandals, and it clarifies change in the role of traditional media. WikiLeaks uses digital technologies and has new methods for investigating and broadcasting corruptions. Anonymous information networks, using hacking attacks for investigation, and the online publication of documents are some of the methods used by WikiLeaks.

In the last decade, WikiLeaks has played an important role to disclosure many political scandals. It is crucial to understand scandal politics in the age of digital interactive media. Since, WikiLeaks is scandalized by traditional media by means of allegations about Julian Assange. The case of WikiLeaks

clarifies the changes in scandal politics and political scandals in the era of digital interactive media in terms of the processes of investigating and broadcasting corruptions, the role of traditional media in digital era, and surveillance in modern democratic countries.

Another digital interactive media platform is the website Ashley Madison. The website was scandalized with the disclosure of users' identities after a hacking attack. In this case, scandals were about ordinary people rather than important public figures. It seems that although this case includes unmoral relationships of many number of public officers, it cannot be seen as a classical political scandal. In fact, it has political character if its political and social consequences are regarded. The scandal was not only about the disclosure of users' identities, but also Ashley Madison website has a potential to be a scandal with regards to its service "arranging extramarital relationships." After this affair, the number of registration to website has increased surprisingly.

The cases of WikiLeaks and Ashley Madison are useful examples to understand scandal politics and political scandals in the era of digital interactive media. The main point about these digital interactive platforms is finding out the challenges of scandal politics and the change of political scandals. In this context, this study discusses the possibility of critical public discussion about the legitimacy of political-legal system after political scandals in the era of digital interactive media. Political scandals are defined as functional events in democratic systems if they can contribute to the revision of political system. In other way, corruptions can be apparent in authoritarian regimes but if it is not discussed by the public, scandals cannot realize their function in political system.

WikiLeaks

The case of WikiLeaks is evaluated in terms of the following issues: i. the maintaining role of traditional media as storyteller and gatekeeper; ii. the role of traditional media due to the weakness of investigative journalism, tabloidization and sensationalizing on social media; iii. surveillance on social media; iv. the challenge of scandal politics.

WikiLeaks (WikiLeaks, 2016) is explained as "a multi-national media organization and associated library." It was founded in 2006 by Julian Assange. It publishes "censored datasets or otherwise restricted official materials involving war, spying and corruption." WikiLeaks published more than 10 million documents and associated analyses (WikiLeaks, 2016). It is called as "a whistle-blowing organization and website that publishes materials provided by anonymous sources" (Beyer, 2014, p. 143). Volunteers in anonymous networks are important in the process of obtaining secret information about governments or corporations, and sharing documents on digital interactive era.

WikiLeaks aims at contributing to the establishment of a networked public sphere (Benkler, 2013). It is regarded as a powerful source for a real democracy. In democracies, people have the right to access true and reliable information about the policies of governments. Also, people have to be a part of policy making process in appropriate to participatory culture (Jenkins, 2009; Dunn, 2013). People in anonymous networks all around the world provide information and proofs about corruptions using digital interactive channels (Dunn, 2013). These features of WikiLeaks are compatible with the claims about the advantages of digital interactive media for revitalizing democracy.

WikiLeaks has important role in scandals releasing corruptions in international level. It became popular in 2010, after the publication of U.S. secret documents. These documents claim that U.S. army and U.S. government broke the official principle of secrecy. WikiLeaks' documents caused a couple of scandals called as Collateral Murder, The Iraq War Logs, The Afghan War Diary, and Cablegate.

The Collateral Murder is an important one of these scandals about U.S. air strike in the July, 2007 that killed Iraqi journalists working for Reuters (Brevini et al., 2013). Investigation efforts failed and a copy of the video requested by Reuters as an evidence was not launched. However, WikiLeaks obtained and launched this video, and made it available to the international public (The video on YouTube is viewed by 15.547.171 user by the June, 2016.). It clarifies the power of WikiLeaks releasing scandals. The popularity of WikiLeaks increased rapidly after the broadcasting of this video.

The Maintaining Role of Traditional Media as Storyteller and Gatekeeper

WikiLeaks uses investigative methods such as whistle-blowing and hacking activities. And it has various publication methods. It publishes secret documents on its website and/or makes contract with mainstream media for the publication of these documents. Its self-publication activity is different from traditional standards of journalism. It does not use editing procedures or arrangements like storytelling, or dramatization of news. Therefore, the form of documents in the website are regarded as investigative data rather than news. These data do not make sense for the public because they seem as raw material and need to gain a frame. Therefore, traditional media and new media collaborate. WikiLeaks has contractual relationships with more than 100 major traditional media organizations (Wikileaks, 2016). New York Times, the Guardian, Le Monde, El Cezire TV and Der Spiegel have published the documents provided by WikiLeaks. These traditional channels are functional for the dissemination of information, attracting public attention to corruptions, and providing financial support to WikiLeaks. As Rogers (2011) stressed that WikiLeaks helps journalists to obtain information, classify and analyze data, and present information to the public. Making news using data is the work of data journalists. It could be seen as intervene on the raw material (investigative documents) by traditional media.

Getting information from an organized partners instead of unknown personal sources is also an advantage for established news organizations. It is insisted that WikiLeaks has been challenged the relationship between journalists and whistle-blowers (Thorsen et al., 2013). Organizations such as Al Jazeera and New York Times get information from organizations like WikiLeaks, and collaborate them in the status of partnership to obtain leaks and to secure this process. This new collaboration challenges the sources of leaks. Organizations like WikiLeaks are more responsible and reliable than personal sources (Benkler, 2013).

The Role of Traditional Media Due to the Weakness of Investigative Journalism, Tabloidization of Social Media and Sensationalization

Traditional media helps WikiLeaks for publication and increases public attention about corruptions (Dunn, 2013). It means that even if sources are investigative documents obtained by WikiLeaks, these documents reach to the public by the stories of traditional media. The methods of the publication of documents used by mainstream media are different from WikiLeaks. Mainstream media companies need to analyze data and provide story about investigations.

Although traditional and new digital media have a cooperation, there are some contradictories. WikiLeaks is different from traditional media in terms of its non-profit nature. The main aim of WikiLeaks is revitalizing critical public debate about governments and politics lightening corruptions with documentary evidences obtained by a volunteer global information networks (Benkler, 2013). On the contrary, mainstream media aims at making more profit. Moreover, the collaboration between WikiLe-

aks and mainstream media has risks for both of them. Media players faced with economic and political risks due to the collaboration with WikiLeaks producing scandal including government agents. Media companies also strive for preserving their authenticity. It is also complicated for WikiLeaks because it aims at creating an opponent public and challenging hegemony. It is a counter-hegemonic project against both traditional media and political elites.

This collaboration has also ideological and methodological risks. Storytelling and sensation, and regarding news as commodity are not appropriate to the strategies of WikiLeaks. Another problem is the main components of the nature of traditional media that are tabloidization and sensationalization. WikiLeaks and its symbol name Assange are also marked as sensational news by mainstream media. While many corruptions in international level were scandalized by WikiLeaks, mainstream media scandalized Assange due to the allegations about sexual misconducts. Dunn (2013) stresses that there was a tension occurred between traditional media when collaborators, Guardian and New York Times, reported the allegations of sexual misconduct by Assange, denied by him. This scandal caused to the decrease in the meaning of WikiLeaks, and it caused to the tabloidization of WikiLeaks.

Surveillance on Social Media

Digital interactive media is considered as a space providing the freedom of information for people. In Arab spring, western countries claimed that Internet is a channel to challenge authoritarian regimes. However, it is seen that this declaration is not trustworthy. The power of Internet is considered as a part of struggle for freedom against authoritarian countries. However, modern democratic countries apply surveillance and control on the platforms of digital interactive media like WikiLeaks as well as authoritarian regimes (Hintz, 2013).

WikiLeaks is seen as a symbol of the freedom of information (Beyer, 2014). McCarthy (2015, p. 439) explains that groups like Anonymous and WikiLeaks are "a part of information movement against practices of information asymmetry." WikiLeaks is an example of "the use of liberation technology and experiences of individuals and movements in advancing free expression, transparency and social transformation" (Hintz, 2013, p.147). Beyer (2014), suggests that "the cross-national online norm of freedom of information" has troubles with domestic legal practices. According to Beyer (2014) this conflict is clearly seen in the U.S. government's effort to get rid of WikiLeaks from the Internet. After the scandals of Collateral Murder, The Iraq War Logs, The Afghan War Diary, Cablegate, U.S. government started to censor on web servers providing services to WikiLeaks (Assange, 2012). After this censorship, WikiLeaks supporters started to mass-mirroring to continue broadcast the website (Enriquedans, 2010).

Also, there are financial, political and legal control on digital interactive media. In this context, digital media is similar to traditional media. This control is explained as control on infrastructure, control on financial support provided by the supporters of radical online disclosure, and control on analytical labor interpreting raw material (Brevini & Murdock, 2013). Political, financial and legal control on digital media causes to the limitation of freedoms. Internet provides advantages for companies. Some of huge companies control the digital media market. Google, Facebook, YouTube hold the large part of information and communication economy. Web-sites use web services provided by these powerful companies. Service providers establish control on digital interactive media (Brevini & Murdock, 2013).

After the disclosure of U.S. embassy diplomatic cables, WikiLeaks is declared as a threat for homeland security by government. The service providers cut off their services to WikiLeaks due to the reaction of U.S. government. In terms of financial control, an unofficial pressure was applied on the banks

to prevent the transfers of donations via banking service or credit cards (Brevini & Murdock, 2013). Financial control also affected the analytic labor which needs high prices to work (Brevini & Murdock, 2013). If an Internet platform cannot pay these costs, it could not be publicly visible.

Control on digital media in democratic countries is similar to authoritarian regimes filtering the web contents and blocking access to websites during social-political movements. Governments have control on web service providers, search engines, and infrastructure. Political power collaborates with corporations in this process. Surveillance is applied on the contents of communication like emails. User's data (activist or supporters) are collected from social media sites (Hintz, 2013; Winseck, 2013) as proof for accusations. These controls were applied in the case of WikiLeaks. Moreover, Assange accused of spying; surveillance was applied on supporters, on publications of WikiLeaks and the use of WikiLeaks' documents by mainstream media, public officials or academicians (Beyer, 2014; Hintz, 2013).

Scandal Politics and Digital Interactive Media

Scandal politics consists of the manipulation of public opinion by media and political elites. However, public opinion established through public debate is very important to use scandals for democracy. In terms of WikiLeaks, Beyer (2014) explains that surveys present that the majority of U.S. citizens did not support WikiLeaks. Chaiken (2014) writes that Washington Post-ABC News poll finds that "most of those polled (68%) say the WikiLeaks' exposure of government documents about the State Department and U.S. diplomacy harms the public interest. Nearly as many (59%) say the U.S. government should arrest Assange and charge him with a crime for releasing the diplomatic cables." However, Beyer (2014) stresses that an age considering survey shows that especially young people supported both Assange and their information freedom. Also, Beyer (2014) claims that the new movement for freedom of information presents evidence for the power of Internet and political participation, especially for the participation of young people.[1] Dunn (2013) suggests that the scandals broken out by WikiLeaks contributed to public discussions. For example, politically conservative Newspaper group The Gleaner's publication in Jamaica took partner with WikiLeaks and publicized information about the U.S. Embassy cables was very important for Jamaican civic life. The Gleaner's publication of U.S. Diplomacy Cables developed public debate and deliberation in Jamaica. Dunn (2013) claims that this publication has contribution to the development of organized, connected and broadened civic culture.

The relationship between WikiLeaks and Arab Spring is important for the development of public debate and legitimacy crises in authoritarian countries. The documents of Cablegate provided many information about corruptions in administration level in MENA countries. Saleh (2013) summarizes the cables about Arab Spring released by WikiLeaks in terms of three issues. The first one is the cables related to "the diplomatic positions of Arab leaders towards Iran and Israel; the second one is related to "the US backing of dictators in the region"; the third one is "focused heavily on abuses of civil liberties particularly in Egypt" (Saleh, 2013, p. 237). These are important allegations about the political authorities in the world.

In terms of WikiLeaks' impact on Arab Spring, Saleh (2013) takes attention to the low level of information literacy, and Internet access gap in MENA countries. Saleh, also stresses the prohibition of access to social media sites, and the gap between Internet users and politically active young population. In this situation, Saleh insisted that there was an interaction between online and offline political participation in Arab Spring. WikiLeaks' cables had an important role promoting public debate and anger

against political authorities. It contributed to the development of democratic politics in Arab countries providing information about corrupt relations among governments (Saleh, 2013).

York (2013) claims that in the Arab world, demands for transparency are encouraged after the cables released by WikiLeaks, and by traditional media. For example, Al Jazeera released more than 1,600 documents about Israeli-Palestinian peace process, Palestine Papers (Aljazeera, 2016). Corruptions about the president of Tunis were released by the WikiLeaks two weeks before the protests (Bachrach, 2011). WikiLeaks partnered with Nawaat.org - an activist media site- published cables on a site called as TuniLeaks. Cables related to Morocco also released by means of similar version of TuniLeaks called as MoroLeaks (York, 2013). However, it is not certain that WikiLeaks is directly related to uprisings in Arab world. In terms of the demands for transparency, WikiLeaks can be regarded as a catalyst for the uprisings rather than as a reason.

After the releases of corruptions, demonstrations aimed at defending both the freedom of information and democracy. It shows that information freedom was a part of these movements. The problem about freedom is also one of the problems of liberal democracies because surveillance and control on digital interactive media maintain in democratic countries. The development of public debate using digital interactive media is closely related to the freedom of expression and freedom of information. This is the reason of the claim that scandals have a function in democratic countries. However, surveillance on digital interactive media like WikiLeaks is an important obstacle to characterize interactive platforms on Internet as alternative channels for disclosure (Brevini & Murdock, 2013). Although WikiLeaks documents about corruptions motivate struggles for democracy and public debate, debates on corruptions cannot cause to a real change in political system. They could create a powerful doubt about the public figures, elites and institutions resulting with the revision of political system. However, it is not certain that WikiLeaks and Assange have strong support from the global public opinion.

Ashley Madison Website

The Ashley Madison affair explains how scandals in digital interactive media are socialized events. Many ordinary people become the parts of scandals in the age of digital interactive media by this event. Interaction spaces on digital era open to act transgressing social norms. People have access to online services providing unmoral experiences. These services are mostly conflicting with social norms and public values. However, the privacy of users are not safe in digital interactive media. Hackers' attacks, leaks in companies' privacy systems, and personal information sharing for profit among companies cause to scandals. In fact, the services of companies providing unmoral relations or damaging social values are already scandalous. However; the release of personnel information makes scandals more apparent for the public. In the age of digital interactive media, political figures are no longer the single actors of political scandals. All the people have a potential to be a part of scandals. Socialization of scandals affects the political scandals including the members of the public, the main source of critical public discussion.

Ashley Madison is a digital interactive media platform the center of which is in Canada established in 2002. The running company of this website is Avid Life Media (ALM) (Mansfield-Devine, 2015). Ashley Madison is a social networking site aiming at providing extramarital relationships to its users from all around the world and its motto is "Life is short. Have an affair." (Mansfield-Devine, 2015). A group of hackers who called themselves as the Impact Team hacked this website in July, 2015. Hackers threatened ALM to uncover the identities of users. However, Ashley Madison continued its service. In August, hackers started to explain the identities of the users.

There are 39 million registration in this site from 53 countries (Mansfield-Devine, 2015). According to analysis, 34% of accounts are fake. With regard to this information the number of valid accounts is founded about 25 million (Mansfield-Devine, 2015). The broadcasting of a huge number of users' identities caused the Ashley Madison affair. This case is not seem as directly political at the first glance. However, it is related to the transgression of a modern ethical norm (faith among family members) by a huge number of people from many countries. After the hackers attack and the disclosure of personal information, many people have become a part of social scandal all around the world. The scandal become a public event including public figures politicians, priests, military members, civil servants, celebrities (Lamont, 2016).

In general, extramarital relationship is accepted as unmoral behavior in many societies. However, this digital interactive media company provides extramarital relationship to its users. It has about 25 million users. This situation means that an unmoral service is not directly create a scandal. The scandal was broken out after the release of users' identities. The company stayed calm and continued to provide its services without any restriction (Mansfield-Devine, 2015). This attack was declared by the company as a criminal attack rather than hacktivism, and it was insisted that "The criminal, or criminals, involved in this act have appointed themselves as the moral judge, juror and executioner, seeing fit to impose a personal notion of virtue on all of society" (cf. Mansfield-Devine, 2015, p.12).

This scandal affected the social status of people and their careers. However, its impact was wider than any other media scandal about popular public figures. Because many ordinary people were affected by this scandal. For example, nearly 15.000 official email addresses related to U.S. military and government (.mil and .gov) used during registration to website are released. There are many email addresses related to public institutions and private companies. People are punished according to institutional procedures. However, the effects are not only about the careers of people. Couples were divorced, families were damaged, people lost their social status, and the affair was mentioned in relation to suicides (Mansfield-Devine, 2015, p.13). This attack is considered as a crime and unmoral attack to people life (Mansfield-Devine, 2015, p.13).

In order to understand the relationship between Ashley Madison affair and political scandals in the era of digital interactive media, evaluating this service and the aim of people for using this service are necessary. According to the research of Pelucio (2015, p.45) man registered on Ashley Madison website enjoy due to the risks of using this service. They think that the service supports their masculinity. Users are taking risks like controlling information about them, they use nick names, and the risk of disclosure of personal photos. However, users claim that they have abilities to manage risks and these risks mean for them having control, power and autonomy contributing their masculinity. Any problem in the process of risk management is shown as fun, and they regard this situation as "risk adventure" rather than a trouble (Pelucio, 2015, p.45).

There is a relationship between providing an unmoral service and its use by people, and public reaction to political scandals. People are the parts of public who are responsible for the evaluation of the attitudes of public figures or political elites in public issues, and the evaluation of the transgression of socio-political norms organizing the societies. In this situation, the scandal of Ashley Madison is related to degeneration of social norms and public values. By the way of this scandal, ordinary people became the subject of a scandal besides public figures related to scandals. The subjects of Ashley Madison affair are the part of the public as the subjects of critical deliberation.

In the era of social media, many people become a part of scandals, and scandals become ordinary events. This situation causes to fall of the importance of public discussion and legitimacy debates about corruptions. The concepts of risk management and risk adventure used in terms of the risks about the extramarital relationship have connection with people's perception about public figures involved in scandals. In this situation, people cannot ask ethical questions, and they do not discuss about the reasons of corruptions. Thus, they do not try to find the ways of change. On the contrary, people consider scandals as the failures of public figures and political elites in the process of risk management.

Scandals should create public discussion about the legitimacy of political institutions, and they should cause to the revision of political-legal system. Therefore, the meaning of scandal for public is important to talk about the political character of scandals. When corruption is not considered as media event, or most people become a part of scandals, scandals loss their political meaning. If people conceive scandals as unsuccessful corruption attempts, scandals will be seen as a personal fails of the subjects. If corrupt persons can manage their corruption successfully, they can continue their social and political position. If they fail to manage this crisis, the person has to be leave his/her position. The consideration of scandals between the scale of success and fail, causes to the fall of discussion about legitimacy, and the process cannot be completed with the revision of political-legal system.

CONCLUSION

This study focused on scandal politics and political scandals in the era of digital interactive media. It supports that scandal politics is still affecting the politics in the era of digital interactive media. Although the power of traditional media is challenged by the innovations in ICTs, it has important function in the same era. The challenges mainly consist of changes in the investigation and broadcasting process. The investigation of scandals and broadcasting process include many actors different from traditional media organizations and professional journalists. The gatekeeping role of mainstream media is challenged, too. Recently, many people are a part of the whistle-blowing process. Nevertheless, traditional media has some functions in digital interactive media era. The financial cooperation and taking public attention are the maintaining roles of traditional media. The rules of scandal politics are also valid in this era. Scandalization, tabloidization, and surveillance are important problems preventing the realization of critical public discussion. These are also causes to the loss of the importance of investigative information.

The case of WikiLeaks presents that traditional media is not any more the single actor in the process of investigation and the publication of news. Governments' control on information and communication process is decreased by the way of hacking activities and anonymous networks. The communication process is not central in social media and media elite is no single power in the process of scandalizing. However, political, financial and technological control still maintain on digital era. Ashley Madison affair presents the change in the nature of scandals. Digital interactive platforms provide new spaces open to the transgression of social-moral norms. Inclusion of a variety of subjects in scandals besides public figures causes to the popularization of scandals. Scandal politics are not only about the public figures in political area but also it is about the figures of social area. It affects the families' lives, careers and relationships between ordinary people. Digital media caused to the increase of the number of scandals. The spectrum of scandal is widened. Hacktivism and leaks, or information leaks from services ignoring

their users' privacy are an important part of the releases of scandals. Even, accessible profiles on social media are useful to break out scandals about people because they share their own unmoral or illegal activities there. Although, there is an important increase in the number of scandals, there are not affective public discussions about the legitimacy of system. Because scandals are popularizing day to day. When everybody being a part of a scandal, scandals may lose their importance in politics.

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KEY TERMS AND DEFINITIONS

Ashley Madison: A digital interactive media platform services extramarital relationships to its users.

Corruption: The actions of public authorities or political elites including transgression of the social and political norms of society.

Critical Public Discussion: The base of public opinion in participative politics having potential to challenge scandal politics.

Political Scandal: Political scandal means a scandal breaking out after the releases of corruptions related to public figures and political elites.

Scandal Politics: It means the use of scandals as a component of political struggles in symbolic power wars. Media is a powerful actor in politics as holding the means of information and communication channels.

Social Media: All digital technologies and platforms provide opportunities to users for interaction. Video recording mobile phones with social media applications, social media platforms like Twitter, Facebook, YouTube, Instagram, blogs, wikis, forums and interactive website like WikiLeaks.

WikiLeaks: A digital interactive media organization aims at releasing corruptions all around the world. It investigates information about corruptions and publish on the website. Its aims at increasing public awareness and contribute to the transparency of governments.

ENDNOTES

1 http://www.ifla.org/publications/what-is-the-effect-of-wikileaks-for-freedom-of-information

2 http://www.support-julian-assange.com/tag/impact-of-wikileaks/

3 https://prezi.com/sohsmg8jpszt/the-negative-impact-of-wikileaks-in-todays-society/

4 https://read.amazon.com/?asin=B00C2RDZEC

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Chapter 62
Invest, Engage, and Win: Online Campaigns and Their Outcomes in an Israeli Election

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ABSTRACT

Though the use of social media for political campaigning has been widely studied, its correlation with electoral success has not received much attention. The current study uses the 2013 Israeli elections to examine the impact of social media on campaigns as a process. Findings indicate that parties and candidates that invest in social media are more likely to achieve social media success, which in turn increases their chances of achieving electoral success. Some may dispute the level of influence of social media; however, study findings suggest that being active in the digital arena has become a significant element in achieving ballot box success.

INTRODUCTION

One of the most challenging political communication questions concerns social media in election campaigns. These days, social media serve as a public stage for political deliberation (Bode et al., 2014; Dvir-Gvirsman et al., 2014; Kushin & Kitchener, 2009; Zhang et al., 2010). As the new media become an increasingly important part of every campaign (Dimitrova et al., 2014; Trent & Friedenberg, 2008; Trippi, 2013), researchers and practitioners have been attempting to understand whether social media

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popularity can be linked to electoral success. This study deals directly with that issue by looking at the role of Facebook in the 2013 Israeli elections.

In the U.S., the 2008 presidential campaign was considered a social media turning point. Indeed, in 2008, CNN went so far as to ask whether the presidential election would be won on Facebook (Rawlinson, 2007). In 2012, the Obama digital campaign made several significant changes, and the general impression was that these contributed to the President's re-election (Trippi, 2013).

Previous studies have examined this phenomenon from various perspectives. Some that examined political preferences and election results (Ceron et al., 2013; Lui et al., 2011) found that social media activity can be used to forecast results in Italy and France (Ceron et al., 2013). Others looked at how citizens use social media during election campaigns (Baumgartner & Morris, 2010; Fernandes et al., 2010; Kushin & Yamamoto, 2010; Robertson el al., 2010; Small, 2008), and how candidates were portrayed (Woolley et al., 2010). Some studies dealt with the impact of social media on political participation (Bakker & de Vreese, 2011; Baumgartner & Morris 2010; Conroy et al., 2012; Dimitrova et al., 2014; Vitak et al., 2011; Wolfsfeld et al., 2013; Zhang et al., 2010) and social capital (Pasek et al., 2009; Valenzuela et al., 2009; Gil de Zúñiga et al., 2012), while others focused on candidates' use of social media (Bronstein, 2013; Church, 2010; Gueorguieva, 2008; Metzgar & Maruggi, 2009; Perlmutter, 2008; Robertson et al., 2010; Wen, 2014).

The current study examines the impact of social media on election campaigns as a process, beginning with the amount of resources a political party invests in digital media, the extent to which this investment leads to greater social media success, and the extent to which this second variable can be translated into electoral success. To better understand this process, the authors took into consideration additional factors such as the parties' initial Knesset1 size and their relative success in the traditional news media. The 2013 Israeli elections were considered by many to be the first Facebook elections in Israel, since social media hosted an extensive part of the campaigns and political discussions. Using Israel as a case study provides a more international perspective (compared to most studies in the field, which were conducted in the US). The characteristics of the Israeli political system enable us to compare these variables in a multi-party parliamentary system.

INVESTING IN DIGITAL MEDIA

Early studies focused on mass media investments and their role in changing voters' attitudes. Most scholars agree that traditional media coverage of issues and events influences public opinion (de Vreese et al., 2011; Entman, 2003; McQuail, 1994), especially when dealing with political issues, such as election campaigns (Hopmann et al., 2010; van Aelst et al., 2008). For example, Norris et al. (1999) found that the media can have direct effects on political opinions. Thus, media shapes its recipients' conceptions of political reality, while setting the frames of reference that they use to interpret public events (McQuail, 1994; de Vreese et al., 2011). Previous studies have indicated a link between traditional media coverage and audience attitudes (Beck et al., 2002; de Vreese et al., 2011; Druckman, 2005; Entman, 1993; Gamson, 1992; Mazzoleni & Schulz, 1999; Mendelsohn, 1996), taking into consideration that other factors, such as personal experience and interactions with peers, also affect audience views (Neuman et al., 1992). Previous studies also found that financial investment in media campaigning provides resourceful candidates with an advantage over their rivals (Davis, 2000; Ganz, 1994, 2000).

Whereas the above studies relate mostly to traditional media, the emergence of Web campaigns sparked an important new line of research. The question was whether the lower costs of internet use provided a way for candidates and political parties to compete on a more equal basis. Proponents of the equalization hypothesis argued that creating a website requires many fewer resources than using public relations and advertising agencies (Corrado & Firestone, 1996; Gibson & Ward, 1998; Rash, 1997). Conversely, critics argued that the Web reflects the traditional power play, because candidates with better resources have better online media. Effective web campaigns are expensive, and operating professional websites requires significant resources (Margolis & Resnick, 2000).

The majority of early studies supported the normalization hypothesis and identified that the larger parties had more advanced and well-designed websites, and were able to generate a significantly greater volume of traffic (Bowers-Brown & Gunter, 2002; Gibson & Ward 1998; Gibson & Ward, 2000; Norris, 2001; Ward & Gibson, 2003). The growth of social networking services renewed the debate and led to further studies.

Indeed, the Web 2.0 era provides wider evidence for the equalization hypothesis. The 2008 US Democratic primaries, as well as Obama's victory, were widely influenced by skillful use of social media, again in favor of the candidate originally perceived as the underdog (Harfoush, 2009; Hindman, 2009; Trippi, 2013). Similar trends were found in Scandinavia (Carlson & Strandberg, 2008; Kalnes, 2009), Australia (Gibson & McAllister, 2009), and Germany (Zittel, 2009). In contrast, Schweitzer's 2011 study of German online campaigns indicated normalization, because larger parties used social media to their advantage much more efficiently. Studies in the UK and US also regularly point in the direction of normalization (Gibson, 2010; Gulati & Williams, 2013; Williams & Gulati, 2013).

Does Success With Social Media Lead to Electoral Success?

Media attention during the election campaign is seen as vital to the election outcome (Harrop, 1987; Hopmann et al., 2010; van Aelst et al., 2008), and politicians are convinced that media attention is crucial for their electoral success (van Aelst et al., 2008). Media attention was found to contribute to the electoral success of parties and candidates (Brosius & Kepplinger, 1992; Gerth & Siegert, 2011; Maddens et al., 2006; Sheafer & Weimann, 2005; van Aelst et al., 2008).

The impact of social media on election outcomes, however, has not received enough scholarly attention. A related topic that has been studied is the impact of social media on political participation and civic engagement. Social media's political use was found to correlate with civic engagement, and enhance both digital and traditional political participation (Bode et al., 2014; Gil de Zúñiga et al., 2012; Wolfsfeld et al., 2013; Xenos et al., 2014; Zhang et al., 2010). If so, it is reasonable to expect social media campaigning to affect political processes.

To date, there are only a few studies that have dealt with the impact of online campaigns on election outcomes. One of the earliest (D'Alessio, 1997) found that investing in online campaigns is linked to electoral success. Findings did not clearly indicate whether Web campaigns directly affect the election outcomes; rather, they suggested that such campaigns reflect the parties' size and power, as well as their level of campaign preparation, thus supporting the normalization hypothesis. Given the increasing use of the internet in political contexts, more studies supported this trend. Gibson and McAllister (2006; 2011) studied the impact of digital campaigning on voting in the Australian elections in a Web 1.0 environment during the 2004 elections, and in a Web 2.0 environment during the 2007 elections, generally finding that online campaigns constitute an important component of a winning election strategy, but those effects are

moderated by the party and the tools used (Gibson & McAllister, 2011). Their findings indicated that Web-based techniques are non-traditional, providing a clear advantage in election outcomes (Gibson & McAllister, 2006). Similarly, while examining the 2006 US midterm congressional elections, Wagner and Gainous (2009) found that digital campaigning and Web presence were significant predictors of the total votes candidates garnered, even when controlling for funding, incumbency, and experience. Further, Sudulich and Wall (2010) found that Web-based campaigns are more effective in areas with higher internet penetration. Apart from website presence, Rackaway (2007) emphasized the influence of blogs and "grassroots mobilizing sites" to the success of campaigns.

Investment in Web 2.0 platforms made the study of online campaign outcomes even more complex and challenging, mainly because users are able to directly engage and channel campaigns in several directions, making it harder for the candidates to control the process. Thus, Gueorguieva (2008) found that YouTube and Myspace indeed offer greater potential for new candidates to spread their messages. However, once the message is reproduced and changed by users, candidates lose control over it. Zittel (2009), reporting on the 2005 German federal elections, further found that young candidates and those running in districts with a high share of young voters were more likely to engage in and benefit from social media campaigning. Hence, the use of interactive online platforms may particularly leverage the outcomes of parties that employ them. It seems, for example, that parties that can appeal to the younger audience may benefit more from employing Web 2.0 tools in their election campaigns.

Engagement:[2] The Mediating Factor

The engagement of online audiences is therefore an important and perhaps crucial factor for evaluating the election outcomes. Park and Perry (2008) showed that online campaigns clearly influence the level of engagement and the social interaction between users, who further spread information to their friends. In recent years, social networking platforms, particularly Facebook, have been embraced by many political candidates as a platform for engaging and mobilizing their supporters. Hong and Nadler (2012) explored the relationship between presidential candidates' use of social media channels by measuring the number of mentions they received on Twitter. Their findings showed that high levels of presidential candidate Twitter activity had only minimal effects on their mentions by users in this channel. This provides another indication that investment in social media has a certain independence from both candidates' actions and election outcomes. To conclude, most studies on election campaigns conducted on the internet examine the relationship either between online investment and election success, or between online investment and audience engagement. As far as can be discerned, no previous studies have systematically explored the relationship among the three stages: investment in digital media, social media success, and electoral success.

The theoretical argument is straightforward: all other things being equal, political parties that make a significant investment in social media during an election campaign are more likely to have citizens react positively to the party and/or candidate posts on Facebook. Social media success should, in turn, lead to electoral success. Investing in digital media is the independent variable, social media success is the intervening variable, and the dependent variable is electoral success.

The underlying logic is that social media represents a powerful tool for encouraging potential voters emotionally and ideologically. The traditional electoral campaign, which is vastly different from what happens in the digital era, is based on two major communication channels: the mainstream news media and political advertisements, that is, two inherently passive types of communication that can nevertheless

attract success at the ballot box. Social media, however, enables potential supporters to become actively engaged in the campaign, which the authors believe offers major advantages. In addition, potential supporters receiving the political messages from their "friends" increases the likelihood that such communications will be read and watched. The term "potential" is critical here. The assumption is that political parties that are able to successfully exploit the social media are in a better position to reach voters who consider that party or candidate as a viable voting option. A massive investment in social media by an inherently unpopular party will not save it. In addition, in a multi-party system, most voters identify with a certain ideological camp, and few will consider voting for a party that is opposed to their core political beliefs. Thus, the authors expect strong correlations between the three variables, but do not see investment in the social media as something that always brings electoral success.

The study's hypothesis claims that the impact of social media on election campaigns is a process; the amount of resources a political party invests in digital media leads to greater levels of social media success, which in turn can lead to electoral success. Success on social media is expected to serve as a mediator variable between the parties' and candidates' investment on digital media and their electoral success.

METHOD

This study examines the 19th Israeli parliament (the Knesset) elections, held on January 22, 2013. Israel has a multi-party proportionate representation system, which has always led to coalition governments. In the 2013 elections, 32 parties ran for the Knesset (many did not have a realistic chance of being elected, due to the two-percent threshold that is required to secure any representation). The 19th Knesset's 120 seats are distributed between 12 parties. The citizens in Israel vote for their preferred party, but due to the tendency in western democratic countries to emphasize and personalize candidates (Balmas et al., 2014)—and a few changes that were made in the Israeli voting system3— – candidates (and especially party leaders) play a significant role in the election campaign. As such, the authors decided to also examine the impact of Facebook pages for both parties and certain candidates. Social media played a central role in the 2013 Israeli election campaigns, and politicians' use of new media tools is correspondingly vast. Almost all political parties had a digital campaign (including Facebook pages), and their financial investment was 50 percent of the total budget (Mann & Lev-On, 2014). The authors selected the parties and candidates for this study based on their chances to pass the two-percent threshold, as reflected in the polls before the elections. The final list included 14 parties and nine candidates.4

In keeping with the study's goals, several interviews with the parties' campaign managers and new media managers were conducted. The parties and candidates' online activity was Web-mined via monitoring their Facebook activity and mentions in prominent news websites (see below). The indicator for candidates' political success was the election result.

Investment in Digital Media

The information about the three investment variables was collected through 27 interviews with campaign staff members.5 During those post-election interviews, the campaign managers provided us with information about their parties' financial, personnel, and time investments in digital media.

To assess the parties' commitment to digital media, the authors examined three indicators:

1. Financial investment (the percentage of the total media budget invested in digital media);
2. The number of the campaign's digital media staff members; and
3. The length of the digital media campaign (measured in weeks).

These three aspects, which were presented as part of the factors of political campaigns professionalism in previous studies (Gibson & Römmele, 2001; 2009; Tenscher et al., 2012), together provided a broad, albeit imperfect, assessment of parties' investment in digital media.

Investment in Digital Media Scale

To effectively estimate the parties' investment in digital media, the authors constructed the Investment in Digital Media scale. The scale was calculated using the three indicators mentioned: the parties' financial investment in new media, the number of the campaign's digital media staff members, and the length of the digital media's campaign. The scale's range was determined by merging those three indicators' standardized scores, and confirmed using a factor analysis (with loadings of no less than 0.807 for any of the items).

Online Activity and Success

The authors chose to focus on Facebook because it is by far the most popular social network site in Israel, with 4.3 million users (more than 50 percent of the population), 95 percent of whom are over the age of 18 and considered potential voters, according to official Facebook figures (Kabir & Urbach, 2013).6 For each party and candidate, the authors collected activity data during 52 days before the elections (between December 1, 2012 and January 21, 2013).7 Specifically, the authors looked at the daily party and candidate mentions in mainstream online newspapers, and the number of likes given to their official Facebook pages. Because most online activity in Israel is conducted in Hebrew, the authors measured only Hebrew content. The authors recorded Facebook activity on the relevant official pages of the parties and the candidates, using the following measurements:

Online News

This variable consisted of the daily average number of news mentions of each party and candidate. The authors used the full names of the candidates and the official names of their parties as appeared on the official Israeli government website (The Israeli elections website, n.d.). The data on news mentions were retrieved using software called Makam (Makam, n.d.) that systematically mined thousands of Web pages using pre-selected keywords. For the news data, the authors looked at the number of items mentioning each political party or candidate in all mainstream sites in Israel including Ynet, Walla, NRG, Haaretz, The Marker, Globes, Nana10, and News1. For the purpose of this study, even when a party or a candidate was mentioned more than once in the same news item, it was counted only as one mention. Given the massive amount of content, no attempt was made to assess whether the news stories were considered "positive" or "negative." Thus, the measure is meant to convey media standing rather than legitimacy.

Facebook Data

After identifying the official Facebook pages of the parties and their candidates, the authors used three measurements to examine their success:

1. *Facebook's "talking about this" (TAT) scale*, which refers to the number of people who responded to a post in a page mainly by sharing, liking, or commenting on it during the last seven days. The authors calculated the average TAT for each party or candidate between December 1, 2012 and January 21, 2013.
2. *Facebook Likes added to the page during the campaign*. For each party or candidate, the authors calculated the number of likes added during the campaign by subtracting those in the beginning of December from the number on the day of the elections. This measurement gives us a general overview of the party or candidate's pages.
3. *Facebook Likes (daily average)* compensates for this general overview by providing the information on a daily basis.[8]

Overall Facebook Success Scale

In order to get a better estimation of the parties' and candidates' success on Facebook, the *Overall Facebook Success scale* was calculated using the three indicators noted: Facebook's TAT scale, the number of Facebook Likes added to the page during the campaign, and the daily average number of Facebook Likes. The scale was gauged by merging those three indicators' standardized scores, and confirmed using a factor analysis (with loadings of no less than 0.900 for any individual item).

Political Success

The election results were used to measure the parties and candidates' political success. Two indicators were used:

1. The *number of Knesset seats* won by the respective parties in the elections, and
2. The *change in the party's number of seat from the last elections*. This last represents the rise or decline of the parties' political power during the elections.

The examination of the absolute number of seats won provides us with a completely objective measure of electoral success, since winning seats is the ultimate goal of every political party. However, the disadvantage of this measurement is its problematic assumption that every party starts from zero, ignoring the major advantages that existing parties have in terms of resources and voter loyalty. An examination of the change in each party's number of seats compared to the last elections solves this problem. While there are many factors that affect the ability of parties to improve their Knesset representation, it is important to see whether social media is among the factors that contribute to that success.

In addition to the political success in the 2013 election, the *number of seats of each party in the previous Knesset* (according to the 2009 elections) was taken into account and served as a controlling variable in the study's analysis. An examination of the number of existing seats in the beginning of the campaign is important, because party size affects both its resources (because the state's election funding

relies on party size) and its political success in the current elections (because, as mentioned above, the party's Knesset size has an effect on its ability to attract voters). Table 1 presents the distribution of the variables used in the study.

RESULTS AND DISCUSSION

This section will examine the study's hypotheses, beginning by examining the correlation between the parties' and candidates' investment and social media success, and conclude by examining the full model, beginning with the parties' and candidates' investment in digital media, through their success on it, and on to their political success in the elections.

It is important to note that in contrast to most studies, the statistical significance of the results is less of a concern. The reason is that the authors were basically examining all the political parties with a reasonable chance of entering the Knesset. The major reason to examine statistical significance is to attempt to generalize from the sample to a more general population. In general, the authors found that the correlations were strong (Table 2), although due to the small number of cases (23) not always statistically significant.

In accordance with the hypothesis and as shown in Table 2, a relatively strong correlation was found between the parties' and candidates' investment in social media and their subsequent success. The findings indicate that an increase in the investment in digital media leads to more success in all three Facebook variables: the Overall Facebook Success scale ($r = 0.494$); and online news coverage,[9] while controlling for the number of seats in the previous elections, a variable that also tells us the amount of state funding the party received for the election campaign (the zero sum correlation between the investment and the success on the different digital media variables is presented in Table 2).[10]

Table 1. Summary of variables

Variables Distribution (Means and Standard Deviations)			
	N	**Mean**	**SD**
Facebook's Talking about this scale	23	20,545.30	22,460.61
Facebook's Likes added to page during the campaign	23	14,048.65	19,315.04
Facebook Likes (daily average)	23	464.28	597.43
Overall Facebook Success	23	0	0.72
Online News Exposure	23	50.31	45.10
Financial investment in digital media	18	19.08	14.644
Number of digital media staff members	18	6.67	3.56
Digital media's campaign length	18	25.22	25.55
Digital Investment	18	0.07	0.71
Seats in last elections	23	9.26	11.03
Number of seats in the Knesset	23	10.22	10.30
Change in the number of seats since the last elections	23	0.96	11.77

Table 2. Controlling for party size

Digital Investment, Social Media Success, and Online News Exposure					
	Overall Facebook Success	**Facebook's Talking about This Scale**	**Facebook's Likes Added to Page during the Campaign**	**Facebook Likes (Daily Average)**	**Online News Exposure**
Digital Investment - controlling for party size. (zero-order correlation)	.494* (.473*)	.424* (.364)	.623* (.641**)	.227 (.232)	.503* (.256)

Note: Entries are Pearson's R scores.
*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$, $N=23$

Table 3. Predicting overall electoral success (number of Knesset seats) using investment and social media success and existing Knesset size (regression model)

	Model 1	**Model 2**	**Model 3**	**SE**
Digital Investment	0.439*	0.224	0.390	3.112
Overall Facebook Success		0.454*	0.378*	5.461
Seats in last elections			0.432**	0.195
N	18	18	18	
Total *(adjusted)*	0.142	0.267	0.415	

Note: Entries are standardized beta coefficients and standard errors.
*$p \leq .1$. **$p \leq .05$. ***$p \leq .01$.

This relationship between investment in digital media and success on Facebook certainly makes sense, but is far from obvious, and there are surely political parties that make a major investment in social media, but either their messages or their candidates fail to resonate. These results suggest, however, that most parties do receive a return on their social media investments. Parties and candidates that invest more heavily in digital media will generally be more successful in social media, regardless of their party size.

As presented in model 1 of Tables 3 and 4, parties' and candidates' investments in digital media can predict their political success in the elections for both indicators. The more heavily a party or candidate invests in digital media, the greater their political success. Model 2 (of Tables 3 and 4) adds success in digital media (the Overall Facebook Success scale) as a predictor. Findings indicate that it explains the effect of parties' and candidates' investment in digital media on both indicators of their political success (Hayes, 2013). Investment in digital media leads to parties and candidates' popularity there, which leads to election success. Model 3 (of Tables 3 and 4) adds the number of seats in the previous elections as a control variable, and exhibits similar findings. The model in Table 3 explains more than 41 percent of the variance of the number of seats, and the model in Table 3 explains more than 60 percent of the same.

Surprisingly, the number of seats in the previous elections serves as a negative predictor for the change (Table 4). One possible explanation is that this result had to do with the particularities of this election and not any theoretical issue that can be generalized; during the 2013 elections in Israel, two small parties received a large amount of votes (*Yesh Atid,* a new party, went from zero seats to 19, and

Table 4. Predicting relative electoral success (change in the number of seats since the last elections), using investment and social media success, and existing Knesset size (regression model)

	Model 1	Model 2	Model 3	SE
Digital Investment	0.626***	0.220	0.322	3.133
Overall Facebook Success		0.522**	0.312*	5.461
Seats in last elections			-0.524***	0.195
N	18	18	18	
Total *(adjusted)*	0.354	0.430	0.603	

Note: Entries are standardized beta coefficients and standard errors.
*$p \leq .1$. **$p \leq .05$. ***$p \leq .01$.

Habayit Hayehudi went from three seats to 12). At the same time, the largest party in the previous elections, Kadima, lost 26 seats (from 28 seats to only two).

Similar to the concept of advertising and public relations (Reis & Reis, 2002), the findings suggest that while dealing with election campaigns in the Web 2.0 era, investment in digital media leads to political power. In addition, the evidence provides some support to the normalization hypothesis (Bowers-Brown & Gunter, 2002; Gibson & Ward, 2000; Norris, 2001). Table 5 gives more detail on social media success when controlling for party size.

CONCLUSION

The findings provide strong support for the hypothesis. In the Israeli election campaign of 2013, digital media investment was clearly worth every shekel spent (Israel's currency). These findings should assist both scholars and practitioners in the field of political communication.

Table 5. Digital investment (the different components), social media success, and online news exposure, controlling for party size

	Overall Facebook Success	Facebook's Talking about This Scale	Facebook's Likes Added to Page during the Campaign	Facebook Likes (Daily Average)	Online News Exposure
Financial investment in digital media - controlling for party size. (zero-order correlation)	.652* (.752**)	.659* (.730**)	.700* (.796**)	.355 (.505)	.525 (.278)
Number of digital media staff members - controlling for party size. (zero-order correlation)	.488 (.515*)	.397 (.455)	.581* (.529*)	.258 (.291)	.398 (.492)
Digital media's campaign length - controlling for party size. (zero-order correlation)	.060 (.057)	.061 (.004)	.169 (.231)	-.113 (-.082)	.062 (-.164)

*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$, *N=23*

One reason to treat these findings with a bit of caution is that the authors decided to focus on parties and leaders who had a realistic chance of passing the two-percent threshold and getting into the Knesset. This decision makes theoretical sense because the authors do not believe that an investment in Facebook will save a party with little initial support. As argued, the assumption is that investment in social media allows parties and leaders to attract *potential* voters. There are certainly unpopular parties that did invest in social media and never made it into the Knesset. This reality is important to keep in mind, especially for those who might exaggerate the potential of social media to compensate for other, more inherent problems facing political parties and leaders.

Nevertheless, this assumption may be more problematic in some types of elections than others. In the US, for example, the primary system provides opportunities for completely unknown candidates to become popular. In this context, the use of social media may prove critical in generating some initial excitement about a candidate. It would be indeed worthwhile to look at *all* candidates and parties running in different types of elections. One would also assume that social media are more effective in some countries than in others. If so, future studies should examine similar research questions in other countries and other political systems. In addition, it would be interesting to review the topic over time; in different election campaigns in the same country, it will allow us to get a better understanding of the impact over time.

Another limitation has to do with the relatively small number of cases used in the study. The authors measured 14 parties and 9 candidates that had a realistic chance to get elected, constituting a small data set. Since the study deals with the whole range of Israeli political parties, and the findings indicate substantial correlations between the variables, the findings and conclusion are meaningful notwithstanding the small number of cases tested.

Despite these caveats, the findings do tell us that being active in the digital arena has become a significant element in achieving ballot box success.

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KEY TERMS AND DEFINITIONS

Engagement on Social Media: A salient indicator of social media's success is the ability to promote audiences' emotional involvement in its messages. Audience engagement can be measured using various methods, including the number of "Likes" and "Shares" a post receives and the "talking about this" scale.

"Facebook Elections": This term refers to the notion that contemporary elections are won through successful Facebook campaigns due to the rise of social networks as the key campaigning arena.

Investment in Digital Media: Political actors invest resources to promote their messages through digital media based on their appreciation of its role in today's reality. The factors that can help us better understand such investments include the amount of money, the digital campaign's duration, and the number of people working on it.

Political Deliberation: The process of thoughtfully weighing options, usually prior to political decision-making. Deliberation emphasizes the use of logic and reason as opposed to power struggles via the active involvement of citizens in the political process.

Political Success in Election Campaigns: Political success is measured by the election outcomes. In parliamentary elections, political success is measured in the number of seats a party receives.

The Equalization-Normalization Debate in Social Media: A debate regarding the ability of social networks to promote equality between incumbents and challengers, due to the ease with which social media campaigns are launched in comparison to the mainstream media campaigns. Equalization refers to social media's ability to promote equal standing whereas normalization refers to maintenance of the former inequality.

The Israeli Political System: Israel has a multi-party proportionate representation system, which has always led to the formation of coalition governments. The Israeli Parliament ("the Knesset") has 120 seats, and the citizens in Israel vote for their preferred party.

ENDNOTES

1 The Israeli parliament.

2 The term "engagement" in social media refers to all activity on a party or a candidate's page (as shown in the number of "Likes", the Facebook "Talking about this" scale, etc.). The level of online engagement reflects political success on social media.

3 In the 1996, 1999, and 2001 election campaigns, the electoral system was changed to a "direct election of the Prime Minister" system. Citizens were given two ballots and were asked to vote for a particular candidate for Prime Minister and a political party for the Knesset. In the 2003 elections, Israel returned to the original system with some changes, but some believe this further accelerated the more personalized type of voting.

4 The candidates examined in the study are: Netanyahu, Lapid, Yachimovich, Bennett, Yishi, Liberman, Galon, Livni, and Mofaz. The parties are: HaLikud, Yesh Atid, Haavoda (Labor), Habait Hayehudi, Shas, Meretz, HaTnua, Kadima, Am Shalem, Kalkala, Ale Yarok, Otzma LeIsrael, DaAm, and Eretz Hadasha. Only four parties that were elected for the Knesset in the 2013 elections were not examined in the study. All of them represent sectorial groups in the Israeli society, and do not turn to the average, Hebrew-speaking Israeli for his vote. Three of the parties are Arab political parties that together have 11 of the 120 seats in the 19th Knesset, and their campaigns (both in the traditional and digital media) are in Arabic. The fourth is Yahadut Hatora (with seven seats in the 19th Knesset)—an Ultra-Orthodox party that does not campaign online (or in the mainstream traditional media), since it turns to Ultra-Orthodox voters that do not tend to use digital media for religious reasons.

5 Interviews were conducted with campaign staff members of 12 of the 14 parties, and all candidates studied. For most parties, at least two interviews (one of which was with the campaign manager or digital campaign manager) were conducted.

6 Unlike many other countries, Twitter is not popular in Israel: only 150,000 Israelis have Twitter accounts (Goldenberg, 2013).

7 Not all Facebook pages of candidates and parties were available for analysis at the same time. Some Facebook pages were mined starting from December 5, 2012, and others from December 24, 2012 due to data availability. The Facebook measurements are based on the daily average of activity.

8 The number of likes can be reduced if users "unlike" a page.

9 Although our hypotheses do not deal with online news coverage, nor whether such coverage is positive, the correlation can help us better understand the influence of digital investment on the parties and candidates overall level of publicity.

10 An examination of the correlations between each component of the investment in digital media by itself and digital media success is presented in Table 5.

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Chapter 63
Leveraging the Design and Development of Multimedia Presentations for Learners

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ABSTRACT

The chapter addresses how multimedia presentations can be designed effectively for learners. Based on the literature, it defines the related terms and discusses the role of human factors during the design and development process of multimedia. Then, it discusses strategies, such as providing learner control and using visual cueing, to design effective multimedia presentations. In addition, various technologies in creating multimedia-based instruction are described. Finally, the chapter discusses evaluation frameworks, as well as the implications for integrating multimedia into educational practices.

INTRODUCTION

We know the old saying that "A picture is worth a thousand words". And many times we assume that learning from the combination of words and pictures should be better than learning from words alone. That may be the major reason that we have illustrations in the printed textbooks, we have a job aid with static screenshots and text labels to show you how to install a piece of software, or we have a narrated video to get you started for a brand new laptop with a new operating system. Sometimes however, as a teacher, an instructional designer or a developer, you may rely solely on your experience and intuition

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to design and develop a multimedia presentation without evidence-based guidance. Your target audience may still find the instruction difficult to understand even with the combination of words and pictures. In this chapter, we will define multimedia related concepts and discuss human factors and strategies for effective multimedia design and development in the hope of inspiring both research and practice. To guide educational practices, we will also identify technologies for multimedia design and development, provide evaluation frameworks for effective multimedia products, and discuss implications for integrating multimedia into practices.

Defining Multimedia Presentations as Levers for Learning

In computer-based learning environments such as online learning systems, intelligent tutoring systems, or virtual worlds, information may be presented to learners in a variety of forms, such as on-screen texts, music, narrations, illustrations, diagrams, animations, and videos. The combination of all or some of these media is considered as multimedia. Mayer (2005a) adopted a presentation mode view to define multimedia—"presenting material in verbal and pictorial form" (p. 2). From this broad perspective, multimedia are not limited to computer-based environments. Texts and visualizations in printing format can also be considered as media. Also, a learner is learning from multimedia if the printed texts and visualizations are presented with other technology-based media (e.g., computer-based animations and narrations). As technology advances, multiple forms of information presented on mobile devices may also be categorized as multimedia. For instance, by tapping on the screen of your mobile phone, you learn about how to conduct a knee surgery from the application *Virtual Knee Surgery* that includes audios, visuals and on-screen texts (see: http://www.edheads.org/activities/knee). This type of mobile learning is also in the form of multimedia. In sum, the term *multimedia* in this chapter refers to multiple forms of information presented on a wide range of platforms and these platforms are mostly technology-based.

Multimedia learning, particularly in research, is to describe learning in multimedia environments. It occurs when a learner constructs mental representations via multimedia in his/her working memory by integrating his/her prior knowledge and stores these representations in his/her long-term memory. The rationale for using multimedia presentations to foster learning is that presenting information in multiple formats is aligned with our humans' cognitive architecture (Mayer, 2005b).

Based on our current understanding of human's cognitive architecture, we process incoming information via two channels, one channel dealing with verbal information and the other channel dealing with visual information (Baddeley, 1986; Mayer, 2005b; Paivio, 1986). These two channels do not necessarily process information separately. Information processed in one channel can be converted to the other channel for further processing. For example, when the word "dog" is presented to a learner textually, an individual may process the information via his/her verbal channel. However, he/she can also mentally form a visualization of a dog, therefore converting verbal information to visual information and allowing the visual channel to process. It is also possible that a learner may mentally construct textual descriptions when he/she views an animation that shows the blood flow in the human cardiovascular system. Due to the limited capacity of our working memory (Miller, 1956), each channel can only process a limited amount of information. A learner may experience cognitive overload if too much information is squeezed into one channel at the initial processing stage. For instance, when both animations and on-screen texts are used to explain human cardiovascular system, all of these visual instructional messages may be initially processed through a learner's verbal channel, and his/her limited processing capacity may become a bottle neck for information processing, thus preventing him/her from understanding the

incoming instructional messages. However, if animations are visually presented with narrated audio of the instructional explanations, a learner can initially receive and process information via both channels and his/her understanding may be fostered. Therefore, externally presenting instructional messages through multimedia is aligned with our humans' internal cognitive architecture, and multimedia presentations optimize the information processing in our verbal and visual channels.

Exploring Human Factors for Strategic Multimedia Design and Development

Based on decades of studies on the effectiveness of multimedia in education and training, researchers find that there is a diversity of animated visualizations (Ploetzner & Lowe, 2012), which may contribute to the diversity of the efficacy of multimedia (e.g., Mayer, Hegarty, Mayer, & Campbell, 2005; see Höffler & Leutner, 2007; Tversky, Morrison, & Betrancourt, 2002). Hegarty (2004) pointed out that research should investigate "what conditions must be in place for dynamic visualizations to be effective in learning" (p. 344). To inspire research and guide educational practices, it is important to discuss the human factors during the process of designing and developing multimedia presentations.

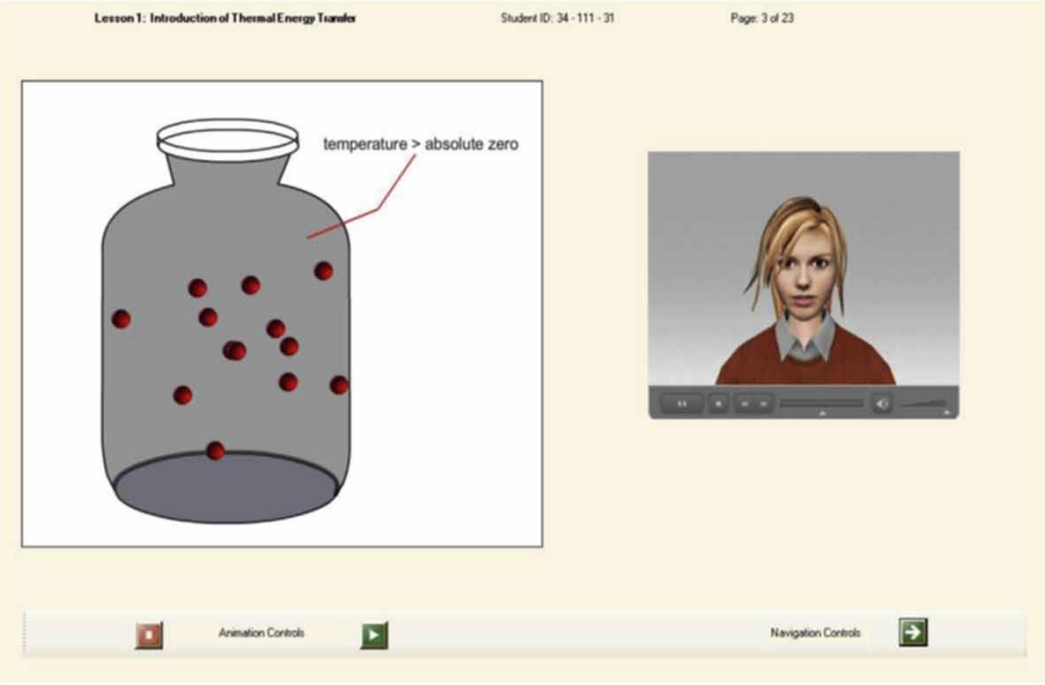
Learners' prior knowledge is one of the human factors that researchers and practitioners should consider. For example, a primary school child cannot understand a derivative function no matter whether the instruction is multimedia-based or not, because he/she has not even learned algebra. Research in the past decades has supported the claim that the instructional design that enhances novice learners' learning may not be helpful for expert learners, and vice versa (c.f., *expertise reversal effect*, Kalyuga, Ayres, Chandler, & Sweller, 2003; Kalyuga, Rikers, & Paas, 2012). For instance, two recent experiments demonstrated that when learners were instructed to learn soccer play, novice learners benefited more from static and low-speed presentations, whereas expert learners benefited more from animated and high-speed presentations (Khacharem, Zoudji, Spanjers, & Kalyuga, 2014). As learners' existing knowledge plays an important role moderating the effect of instruction, instructional designers should have some knowledge about their target audience's prior knowledge before designing and developing their products. This process is usually referred to as learner analysis in the systematic instructional design process (Dick, Carey, & Carey, 2005). Researchers and practitioners can also focus on designing and developing learning systems that provide adaptive instruction to individual learners (Kalyuga, 2007), as there is evidence showing adaptive computer-based tutoring can produce large learning gains (Sabo, Atkinson, Barrus, Joseph, & Perez, 2013).

Learner motivation is another factor that plays an important role in multimedia-based learning and instruction. Cognitive processes such as selecting information, organizing information in meaningful structures and integrating information with one's prior knowledge, are all influenced by motivation. A highly motivated learner may be willing to spend a considerable amount of time and effort making sense of the presented instructional material, which may lead to enhanced learning and performance. However, a learner lacking motivation may choose to quit learning. The challenge for educational researchers and practitioners is how to motivate learners in multimedia presentations. Traditionally, instructional designers present a problem, ask a question, or present a scenario at the beginning of the instruction to stimulate learners. When this type of motivation techniques is applied to learning in multimedia environments, there is empirical evidence showing that they may be effective. For example, some researchers presented learners with a series of predicting questions and instructed them to predict the function of a mechanical system. They found that this technique enhanced learners' understanding of the mechanical system no matter whether they viewed static or animated visualizations of the system (Hegarty, Kriz,

& Cate, 2003). On the other hand, technology per se has a great potential to motivate students in multimedia environments. Multimedia can be used to provide abstract outlines for learners before detailed instruction is delivered, which is served as the function of an advance organizer. Willerman and Mac Harg (1991) utilized a concept map as an advance organizer in an 8th grade science classroom and they found that the students performed better in a science test than their peers who did not use the concept map. Vogel-Walcutt, Guidice, Fiorella, and Nicholson (2013) used video games as advance organizers before a computer-based training that taught learners to complete a military's call for fire task. They found that learner who played the video games showed more interest in learning. In addition to pre-instruction motivators, other technology supported techniques have showed promises. Embedding an animated pedagogical agent in a multimedia presentation is one method that researchers have investigated in the 21st century. An animated pedagogical agent is "a lifelike character that provides instructional information through verbal and nonverbal forms of communication" (Lin, Atkinson, Christopherson, Joseph, & Harrison, 2013, pp.239, see Figure 1 for an example). When the multimedia environment incorporates an agent, learners may consider interacting with the computer as a social event and are motivated to interact with the computer to learn (Atkinson, Mayer & Merrill, 2005). In summary, learner motivation plays an important role in the effectiveness of multimedia presentations, and there are multiple ways to motivate learners in multimedia learning.

It is of note that there are other human factors, such as learners' affect state, metacognition, and self-regulation, which teachers, instructional designers and developers should bear in mind during the design and development process. We recommend conducting a learner analysis (and other related analyses such

Figure 1. A screen shot of a multimedia environment embedded with an animated agent (Lin, Atkinson, Christopherson, Joseph, & Harrison, 2013)



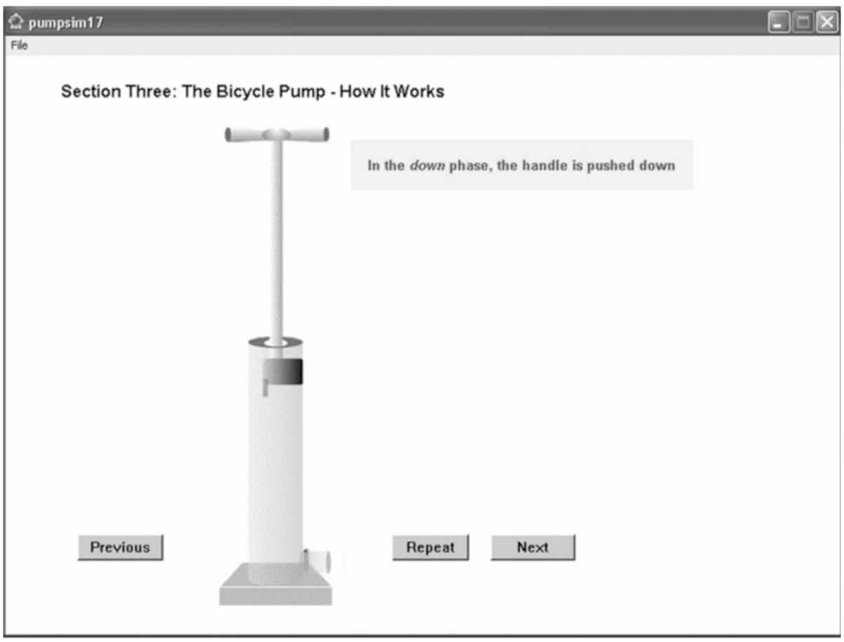
as needs assessment) at the beginning of a systematic instructional design process so that a clear picture of the target audience can be obtained.

Understanding Strategies for Creating Multimedia Presentations

Based on well-designed scientific studies, researchers have proposed a series of evidence-based principles to guide both research and practice in multimedia presentations (Mayer, 2005c). These principles provide a solid foundation for teachers, instructional designers and developers to understand the strategies for creating multimedia presentations.

Providing learner control is the first strategy we would discuss for creating multimedia. Based on the empirical evidence, Clark and Mayer (2011) summarized it as the *Learner Control Principle*. According to Betrancourt (2005), learner control is to let learners control the pace and/or the direction of a multimedia presentation. This is critical to learning when dynamic visualizations, such as animations and videos, are used to deliver instruction in the learning environments. Due to the transitory nature of an animation, a learner may not fully understand the information contained in the animation when the presentation of the animated information has already finished. Granted with the control (e.g., a playback button or a pause button), a learner can go back to receive the instruction by viewing the animation once again. And he/she can view the animation for the third or even fourth time, if he/she feels that there is a need to do so. The results of some research studies have provided empirical evidence to support this design strategy (Evans, & Gibbons, 2007; Hasler, Kersten, & Sweller, 2007; Mayer, & Chandler, 2001; Mayer, Dow, & Mayer, 2003; Moreno, & Valdez, 2005; Schwan, & Riempp, 2004; Wouters, Tabbers, & Paas, 2007). For instance, Evans and Gibbons (2007) found that using an interactive diagram, in which a learner can control the presentation of texts and segments of animations (see Figure 2), facilitated

Figure 2. A screen shot of the interactive version of the learning environment (Evans, & Gibbons, 2007)



undergraduate students' deep learning about the mechanism of a bicycle pump. In their case, learners could click the Repeat button to play the segment of animation again, click the Previous button to study the previous segment and the Next button to study the next segment. However, learner control may not be as critical in static visuals as in dynamic visuals, since static visuals are not transient in nature. The study conducted by Boucheix and Schneider (2009) provides some evidence that integrating a series of static graphics without learner control enhanced students' understanding of a mechanical system.

Visual cueing (or "signaling") is another strategy to create effective multimedia presentations for instruction and training. It is a technique to add non-content signaling devices to the learning environments to direct learners' attention to the important information. It is not difficult to imagine a situation that so many elements, such as on-screen texts, narrations, animations, control buttons, navigation links and other elements, are presented to learners in a multimedia environment that learners' attention may be directed to perceptually salient information that may be irrelevant to learning. As a result, instructional designers and developers need to direct learners' attention by utilizing visual cues. Lin and Atkinson (2011) used arrow cueing to point to the important information presented in the animation that showed concepts and processes of rock cycle (see Figure 3), and they found cueing fostered efficiently learning. Nelson, Kim, Foshee and Slack (2014) found that learners experienced lower mental demands in a virtual world, in which sheep objects were cued with symbols (see Figure 4). The current literature shows other empirical evidence to support the use of visual cues as a strategy for creating an effective multimedia presentation (e.g., Lin, Atkinson, Savenye, & Nelson, 2014; see de Koning, Tabbers, Rikers,

Figure 3. A screen shot of the learning environment that shows visually cued animations (Lin, & Atkinson, 2011)

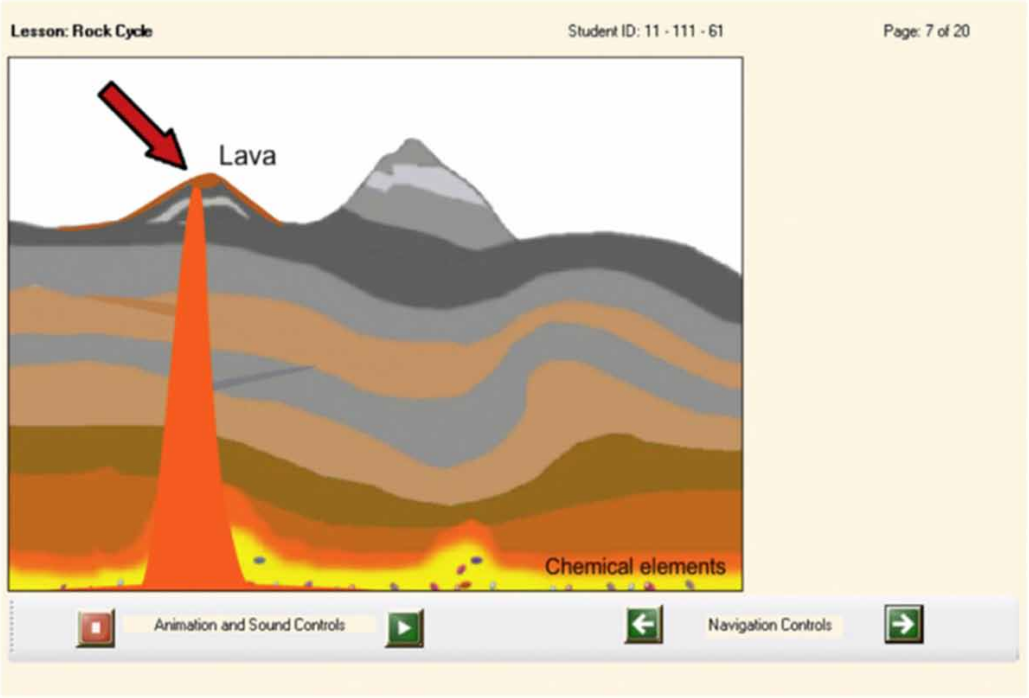
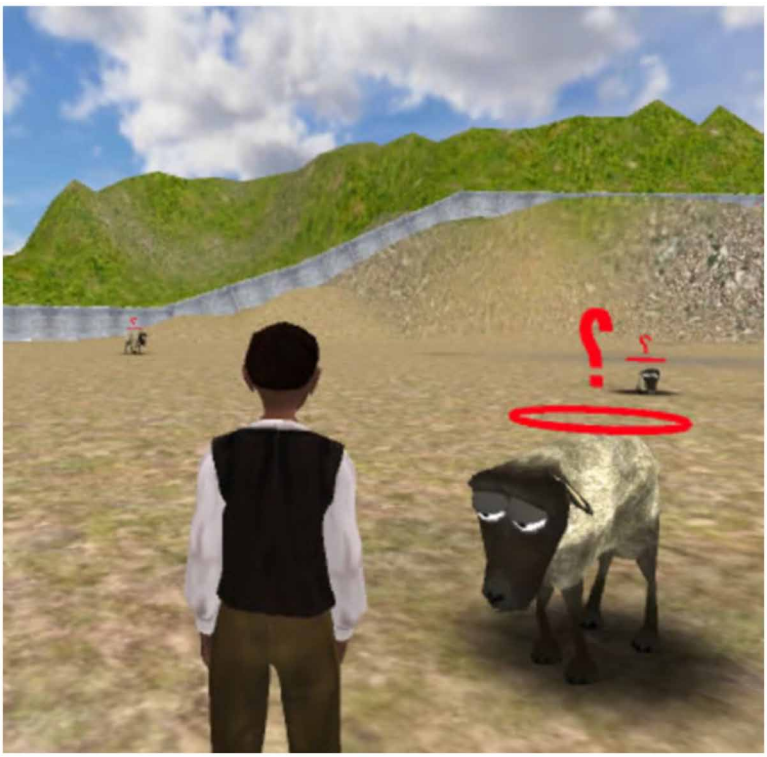


Figure 4. A screen shot of the virtual world environment that shows a player is interacting with a visually cued sheep (Nelson, Kim, Foshee, & Slack, 2013)



& Paas, 2009 for a review). The learning principle based on it is referred to as the Signaling Principle (Mayer & Moreno, 2003).

We have described two prominent strategies—providing learner control and visual cueing—for creating effective multimedia presentations. These two strategies are unique for multimedia, but there are other strategies that are worth mentioning. For example, when designing and developing multimedia, visualizations should be arranged in close proximity to the corresponding texts to enhance the limited attention; graphics accompanied with audio narrations are better than graphics with on-screen texts to optimize learners' information processing in their cognitive system; animations are better to be presented in segments to overcome the transitory nature of animations. These strategies are all based on evidence-based learning principles in the multimedia learning literature (Mayer, 2005c).

Identifying Technologies for Creating Multimedia Presentations

When creating multimedia presentations, we should always keep the aforementioned strategies, providing learner control and utilizing visual cues, in mind and identify appropriate technologies for project development. Media types used in multimedia presentations may include text, images, animations, audio and video; therefore, one may select a variety of hardware and software for the multimedia production. What technologies do we need to consider when creating multimedia presentations? How do we identify appropriate technologies for such presentations?

First, let us look at the technologies available for creating multimedia presentations. Technology advances rapidly. It is much easier to develop a multimedia presentation today than before because many computers come with a built-in microphone and camera, and many multimedia applications are user-friendly at low cost or even free of charge. Hence, it is not difficult to develop a multimedia presentation. However, producing a sophisticated multimedia presentation of high quality may still require money and time that many people cannot afford.

In general, when producing a multimedia presentation, one should use a powerful computer with appropriate hardware and software. Examples of the hardware include, but are not limited to, video cameras, digital cameras, microphones, scanners, storage devices (CDs, DVDs, or/and external hard drives), ports (firewire or/and USB), and monitors. Examples of the software include, but are not limited to, *PowerPoint, Keynote, Prezi, Metta, Mediator, Adobe Captivate, Articulate Presenter, and Camtasia*. For more information concerning multimedia presentation technologies, one may simply conduct an Internet search using keywords, such as, multimedia tools or applications, etc.

How do we identify out of those available technologies the appropriate ones for the multimedia presentation we want to create? One factor to consider is the purpose of the presentation. A presentation with a commercial purpose is expected to be very different from a presentation for education. A sophisticated and highly professional commercial multimedia presentation may help to sell the product. Such a level of sophistication is not required to facilitate student learning in educational multimedia presentations; those presentations may be deemed successful as long as they support student learning.

A learning goal is a key factor to consider when identifying technologies for creating multimedia presentations. If the goal of a multimedia presentation is to teach students specific concepts, one may consider using *Metta* that allows instructor to include YouTube videos, pictures, voice recordings, and content from Pinterest, and then to insert a quiz during or at the end of the presentation. Should the purpose of a multimedia presentation be to help learners develop a presentation and to deliver it in front of an audience, one may consider the use of presentation software (e.g., PowerPoint and Keynote), since they are commonly used and widely available.

Another factor for consideration when identifying technologies for creating multimedia presentations is budget. As we mentioned earlier, it is no longer difficult to create multimedia presentations due to the technology advancement and decreasing cost of hardware and software. However, some technologies are still costly, especially the ones for commercial multimedia presentations. Therefore, one should check how much money has been earmarked for the multimedia production before one starts the project. Otherwise, one might run out of money before the project is complete.

The other factor for consideration is the target audience, e.g., culture, age, and gender. Although this factor might not be strictly related to identifying technologies for creating such presentations, it plays a critical role in developing the presentations. For instance, a multimedia presentation for a young learner may involve considerable amount of animations that might not be appropriate in a presentation for adults. For audiences with certain specific backgrounds and cultures, a developer needs to carefully decide the use of colors. A color may mean something positive to one group of people but symbolize the opposite to another. For example, the color of "yellow" symbolizes "Mourning" to Egyptians while means "royalty" to Chinese.

In summary, nowadays everyone should be able to create a multimedia presentation. Factors for consideration when identifying technologies for creating multimedia presentations include, but are not limited to, purpose, goal, and budget. The target audience is also an important factor to consider when developing a multimedia project.

Evaluating the Effectiveness of Multimedia Presentations

Formative evaluation and summative evaluation are two types of evaluation that are commonly used in instructional design and other educational and training practices. Formative evaluation is conducted when the design and development activities are still ongoing. The data collected for this type of evaluation can be quite informal: small-scale interviews with the target audience, interviews with the internal experts, and very small-scale quantitative surveys, etc. It is very useful to improve the ongoing project, as designers and developers can modify their work with relatively low cost of time, money and other resources. It can effectively avoid a project's changes or growth that cannot be controlled as the project progresses ("project creeps"). Summative evaluation is conducted to assess the final project and is usually conducted externally. The data collected for this type of evaluation could be focus group interviews, expert ratings, large-scale attitudinal surveys, and learning outcomes, etc. The results of this type of evaluation are to judge the actual value of the final product—whether it is good or bad. A systematic design and development process for an effective multimedia product definitely needs both formative and summative evaluation. For instance, we, as a team of instructional designers and developers, need to create a multimedia program to teach high school students about thermodynamics for a science course. We have followed the systematic design process: (a) We know that the target students have some knowledge about thermodynamics and they are easily bored in class (learner analysis). We also know that the school would like to have some changes in traditional teaching methods (need analysis). (b) We have formulated a series of instructional goals and objectives according to the standards and consultation with teachers. We have determined the contents and instructional sequence, as well as the interface of the multimedia program. At this stage, a formative evaluation could be conducted by consulting with teachers and interviewing with students to determine (a) whether the contents and instructional sequence are appropriate, (b) whether teachers and students like the program interface. Based on the results of this round of formative evaluation, we modify the content and the program interface if necessary, and then hand the product to the technology staff to let them work on the development. When the developers have a prototype ready, we can run another formative evaluation internally (alpha testing) to test the prototype and provide feedback to the developers. Then, the developers modify the program and we, along with some teachers, run another formative evaluation (beta testing). At the final stage, we submit the multimedia product to the school leaders and teachers and, with their approval, implement the product in class. Based on the collected data from the schools leaders and teachers (interview records, quantitative ratings, etc.), class observations, and students' attitude and learning outcomes, all concerned parties can make a judgment (summative evaluation) about the effectiveness of this multimedia program

Another well-known evaluation model is the Kirkpatrick's four-level model (Kirkpatrick, 1994; Kirkpatrick, & Kirkpatrick, 2006). This model has been so widely used to evaluate training programs in academia and industry that we believe it is still applicable to assess the effectiveness of multimedia presentations. The four levels are *Reaction*, *Learning*, *Behavior*, and *Results* and they are listed in order. The first level *Reaction* is to evaluate attitude: how learners perceive about the program—whether they like it or not, whether they feel boring or interesting, satisfied or dissatisfied, competent or incompetent, etc. The second level *Learning* is to evaluate learners' knowledge: how the learners perform on a post-training test (it could be a self-designed test, a standard test or both). The third level *Behavior* is to evaluate the effectiveness of a program on the behavioral level: whether learners have changed their behaviors, how learners apply their knowledge, etc. The fourth and the final level *Results* is to evaluate the effectiveness of a program on an institutional level or on a community level: how the company's

sales have changed, how many prospective employees have applied for positions in the company, how many additional students have enrolled, etc. It is often very difficult and costly to conduct the evaluation activities on the third and fourth level, no matter whether it is in the academia or industry. But educational professionals could utilize the Kirkpatrick model to evaluate the effectiveness of multimedia presentations. Using the multimedia program to teach high school students about thermodynamics as an example, Table 1 presents the data sources that we believe could be collected to evaluate the effectiveness of the multimedia program using the Kirkpatrick model.

Implications for Integrating Multimedia Presentations as Best Practice

This section will address: 1) ways of constructing effective learning environments for students' success, 2) pedagogical functionalities of multimedia presentations that can positively impact the successful implementation of technology integration practices, and 3) possible barriers to integrating multimedia presentations.

Multimedia presentations, as a delivery medium in teaching, require pedagogically equipped facilitators who create effective environments for successful learning. Research reports that multimedia presentations impact students' learning in specific contexts where research-based and goal-oriented learning environments promote learning. The prominent learning environment reported was a constructivist-based learning environment using multimedia (Neo & Neo, 2009). It can be seen that students experienced high levels of motivation and self-esteem when doing the multimedia project. More importantly, it enhanced their confidence levels in the newly acquired skills because they realized that they can use the same skills in future undertakings. A technology-enhanced constructivist learning environment, as suggested by Jonassen (1994, 1999), can be successful in allowing students to engage in meaningful, relevant problem-solving activities, experience active learning, and be more engaged in their learning processes. Another environment that is worth mentioning for is an authentic learning environment (Herrington, Reeves, Oliver, & Woo, 2004). In this environment, students showed increased understanding of the topic and were able to see the relevance of the project to real-life situations. The third environment is a multimedia-assisted, project-based learning environment (Moursund, 1999). This method promotes a learner-centered constructivist model, and helps students develop the pre-service teachers' knowledge and self-efficacy in (a) technology, (b) subject matter, and (c) teaching (Seo, Templeton, & Pellegrino, 2008).

Additionally, we need to pay attention to pedagogical functionalities of multimedia presentations that address many of the contemporary issues in education, such as self-directed learning and evidence-

Table 1. Use the Kirkpatrick model to evaluate a multimedia program that delivers instruction about thermodynamics to high school students

Kirkpatrick Model	Data Sources
Reaction	Students' satisfaction, perceived confidence and competence, etc.
Learning	Students' scores on an in-class quiz, midterm exam, etc.
Behavior	Observations of applying knowledge in daily life, etc.
Results	Increased enrollment of the course, etc.

based (data-driven) teaching. A growing body of theoretical and empirical literature supports the view that, when students' perceptions of control in the learning situation increases, so does their motivation to learn (Alderman, 1990; Ames, 1990; Deci & Ryan, 1991). Researchers recently reported a relatively strong relationship between multimedia technologies and self-directed learning (Kim, 2012). Therefore, we can see that learner controlled, multimedia-rich learning environments foster self-directed learning by enabling learners to have control over the pace of their own learning and by being empowered to take charge of their learning trajectories. In terms of data-driven teaching, the assessments in multimedia presentation tools offer more access to instant data than ever before for teachers (Gonzalez-Sanchez, Chavez-Echeagaray, Gibson, & Atkinson, 2013). Multimedia presentation tools strengthen the capacity to access data to improve developmentally appropriate decision-making in instruction, which leads to adaptive learning and personalized learning opportunities.

Although multimedia presentations hold many promises in education, it is important to be aware of some possible barriers to their successful integration and utilization. Steelman (2005) identified technical difficulties with software, hardware, and networks, and teachers lacking uniformed tools, as main hindrances. Time restraints, insufficient teacher training, and tedious administrative requirements, such as keeping up with permission slips, were other difficulties cited. In the course of developing their multimedia projects, the students encountered software glitches and computer malfunctions that led to a great deal of frustration for them. These problems also caused more anxiety when there was no prompt technical support. In addition, it was challenging for the instructor to address the needs of all students because they had different interests and varying degrees of computer skills. Further, teachers need to be able to customize instruction in such a way as to fit the target students' knowledge levels and learning goals. It is critical to understand both the promises and barriers in implementing multimedia presentations as well as making the connection with pedagogy, technology, and content.

CONCLUSION

In this chapter, we have defined the concepts of multimedia and multimedia learning based on the literature. Several factors, such as prior knowledge and motivation, were identified and discussed in the contexts of designing and developing multimedia-based instruction. In discussing these factors, we argued for better understanding of the cognitive mechanisms that contribute to the efficacy of multimedia presentations in helping learners learn. Further, reviewing related research evidence led to identification of effective strategies for creating multimedia that supports learning and instruction. Based on that, we provided principles to guide instructional design and development practices. Finally, we identified and described several technology-based tools and applications that could be used for creating multimedia, along with the frameworks for evaluating multimedia and implications for integrating multimedia into practice.

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KEY TERMS AND DEFINITIONS

Animated Pedagogical Agent: A lifelike character that is incorporated into a multimedia environment to provide verbal and nonverbal forms of communication.

Expertise Reversal Effect: Instructional design that enhances novice learners' learning may not be helpful for expert learners, and vice versa.

Formative Evaluation: Evaluation conducted when instructional design and development are still ongoing.

Learner Control: Let learners control the pace and/or the direction of the instruction.

Multimedia: Presenting verbal and pictorial materials through multiple media.

Multimedia Learning: Learners construct mental representations in multimedia environment in which verbal and pictorial instructional materials are presented.

Summative Evaluation: Evaluation conducted to assess the success of a final project or program when it is completed.

Visual Cueing: A technique to add non-content signaling devices to learning environments to direct learners' attention to the important information.

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Chapter 64
Digital Humour, Gag Laws, and the Liberal Security State

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ABSTRACT

This chapter presents a case study of Facu Diaz, a Spanish satirist whose on-line ridicule of the Spanish government created a political furor that brought him before the courts. The chapter engages the problem of the criminalization of political dissent by liberal states in the digital age. The case highlights how digital media is now being used to create content for satire, as well as to replicate and infiltrate more traditional political and media forums, changing many traditional forms of political practice. The case [points to some of the central problems inherent in liberalism which may give reason to curb the enthusiasm of those who think that new digital media creates fresh opportunities for augmenting the 'public sphere'. It is argued that liberalism as a political theory and ethos, tends to be blind to non-traditional political expressions like satire and other artistic work. In addition, the expansion of security laws in many countries suggests, liberalism's ostensible commitment to freedom needs to be reframed by recalling its historical preoccupation with security.

INTRODUCTION

On 29th October 2014, Facu Diaz a 23 year-old Catalonian comedian broadcast a three-minute satire called 'The Popular Party is Dissolved' on the Spanish 'Tuerka' television news program. It was then uploaded onto the internet. The comedy routine generated significant national and international controversy and provoked a swift legal reaction in Spain. The Spanish group *Dignity and Justice*, claiming to represent victims of terrorism, an organization closely associated with absolutist and extreme members of the ruling Popular Party, initiated criminal proceeding claiming Diaz had contravened Spain's anti-terrorist legislation by 'glorifying terrorism'.

Diaz was not alone. Other activists like the Spanish rapper 'Cesar Strawberry' was one of many arrested in mid-2016 in a police operation against those using digital media and specifically Facebook and Twitter, who it was alleged committed the crime of glorifying terrorism. Police claimed the singer used

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digital media to praise 'the Anti-Fascist Resistance Group left (Gapo) and the Basque separatist group ETA. Guillermo Zapata (Madrid City Councilor) and member of a grassroots political movement (Ahora Madrid) faced similar charges for tweeting comments which police alleged 'discredited and 'humiliated victims of terrorism. Alfonso Lazaro de la Fuente and Raul Garcia Perez two puppeteers from the theatre group 'Puppets From Below' (Títeres Desde Abajo) were arrested and charged with the same offence in 2016 for allegedly making comments supportive of ETA.

It is often said the genius of good comedy depends on the timing. In cases like Facu Diaz and his co-accused, timing was everything.

While Diaz's primary object of critique was the ruling Popular Party Spanish government, which led him to raise the sensitive issue of political corruption, Diaz also used new media to pushed a number of historically sensitive buttons. Diaz used the digital media to produce and broadcast a powerful remix satire targeting the powerful while at the same time reminding Spaniards of their recent experience of financial crisis and the longer history of terrorism as he drew an analogy between the Basque separatist group ETA (*Euskadi Ta Askatasuna*)[1] and the ruling Popular Party.

The bid to call Diaz to account provides an example of a more general attempt to criminalize political dissent, and in this case those using new forms of media to engage in political debate. It is argued that there should no surprise when an ostensibly liberal democratic polity move to criminalize dissent. The chapter situates art, and in particular satire at the centre of politics, arguing that such practices work to broaden the public sphere and secure liberal principles like the right to free speech. This case study also demonstrates how digital media is being used to create and communicate satirical political humour in ways that are integrating that technology into participatory political practice. It is a popular form of political communication which spreads easily on-line in the context where the technology and interest to do so is now at the fingertips of many citizens.

By the time Diaz aired his satire in 2014, the Spanish government, along with many other governments had increased their regulation of political activity and dissent. Such moves to criminalize dissent involving those who engaged in on-line political activity poses questions about democracy and the socio-ethical base of the contemporary political order. It also raises questions about the extent to which digital media can be employed for the purpose of extending participation in democratic practices. It also raises questions about the ways new media can itself be used by the state to monitor and regulate that participation.

It is now generally acknowledged that many jurisdictions have seen significant increases in criminalization of political activities. This includes the creation of new laws and the reform of old legislation treating certain behavior as criminal. As studies show, we have seen a punitive turn and increases in criminalization on the part of governments of all political orientation Ashworth 2009, Lacey 2012, Zedner 2009, Garland 2001). Legislatively this involves declaring more activity illegal by increasing the number of criminal laws or by mandating longer prison sentences. In the courts it evident when judges issue harsher sentences and a higher likelihood of prison sentences, increased emphasis on the rights of victims and a corresponding reduction in regard for the rights of defendants and reduced use of parole. On the streets it is evident in the ways increased police powers enable the use of stop and search practiced. It can also mean that governments and police increasingly rely on preventive justice measures like the use of anti-social behaviour orders, control orders or dispersal orders (Ashworth and Zedner 2014).

While most liberal states have a long history of criminalizing political dissent, this disposition seems to have intensified after the terrorist attacks in New York and Washington on 11 September 2001. For Aoude it marks a time when we began living with 'a permanent fear of terrorism' as governments introduced measures privileging security at the expense of civil liberties ostensibly designed to protect

their citizenry (Aoude 2002). As Hogg observes, academics and lawyers alike became deeply concerned about the fate of the rule of law and liberal democratic institutions in the 'war on terror' (Hoggs 2007 p.84). And as Hocking pointed out the evolution of counter-terrorist law and policy since 2001 in western democratic states allowed 'for the pre-emptive control of political conflict and dissent, which may or may not protect individual citizens but which certainly protects the state itself' (2003 p.371).

This is the backdrop for the increased criminalization of political protest and public assembly. In advanced democracies like Canada we saw the management of protestor managed courtesy of search, seizure and detention powers. In 2010 eg., a 10,000 strong police contingent corralled protestors involved in the the anti-G20 'March for Justice Toronto' into confined spaces where they were contained for many hours (Salter 2011:211-238). Many many governments have also extended their already far reaching electronic surveillance to monitor all citizens on the assumption we are all potential offenders. Many states also use such electronic surveillance to pre-empt and monitor activists who have increasingly come to rely on digital media to communicate, mobilize and organize action. All this occurred alongside moves to expand, to retain and analyze mega-data without the conventional regulation implicit in judicial warrants. This is taking place in democracies like Australia, UK and USA, France and in autocracies like China, Iran and Russia. In Spain Facu Diaz, was charged with violating the 'glorification of terrorism laws' because he drew analogies between corrupt government politicians and well-known Basque terrorists and then used digital media to disperse his message and engage in further public debate (Berrerda 2015).

The fact this was done by autocratic regimes may not be so surprising, but the criminalization of dissent has become normalized in liberal democracies that their claim to be different from authoritarian totalitarian states because they protect and promote civil liberties (eg freedom of speech, freedom of association association, and civil disobedience) may be more of surprising to those who take liberalism at face value. As Brabazon asks 'Why would these states … not welcome social movements and dissent … as a natural part of the rich fabric of citizen participation in decision-making?' (Brabazon 2006 p.3).

In this chapter I consider the ideal standard or normative basis of the political conceived within the modern neoliberal security state with its overvaluation of order and consensus, and revisit arguments that dissent is a vital aspect of any vibrant democratic polity. It is an analysis also of how this takes place in a context marked by increasing use of digital media for the purpose of political communication. I begin with an outline of the comedy skit itself.

CASE STUDY: FACU DIAZ'S SATIRE AND DIGITAL MEDIA

The sketch which lasts three minutes began with Díaz sitting at a desk, pretending to be a spokesperson-news reader with his face covered by the iconic black balaclava worn by the Basque separatists. On the wall behind him were logos made to look like those of the ruling conservative Christian 'Popular Party' (PP). In front of Diaz was a photo of Francisco Granados, former Minister of the Presidency, Justice and Home Affairs in Spain's governing Popular Party government. In October 2014 Granados was sentenced to prison for high-level corruption. It was a high profile scandal that revealed how syndicates of political elites had been receiving lucrative kickbacks of 2-3% on government contracts worth 250 million Euros.

Diaz also portrayed himself as a spokesperson for 'People's Party' and began reading a statement ostensibly issued by the ruling 'Popular Party', but did so in a style that mimicked ETA's distinctive way of issuing political demands. The statement referred to widespread political corruption which he declared left the 'People's Party' on the brink of collapse and disbandment. While pretending to be a

spokesperson for the 'Peoples party' Diaz asked for a 'ceasefire from far left-wing political group', a reference to the new and increasingly popular leftist party 'Podemos' ('We Can') (Global Voices 2015). Diaz used digitally re-mixed announcements to create the content of his satire, calling for the 'Popular Party corrupt prisoners' to be relocated closer to places '…where 'the food is good', a barbed reference to ETA's earlier demands that their imprisoned members be repatriated to their Basque homeland.

Diaz then switched genres performing a mock interview with himself, asking (himself) what he would do in the future as a comedian if the 'Popular Party' collapsed under the weight of the series of corruption scandals. He answered he would lose a rich source of inspiration for his satirical work. He continued the jibing, announcing that several members of 'Popular Party' will be integrated back into political life through the new right wing Christian 'Popular Party', a breakaway party 'VOX' ('Voice') and the anti-separatist UPyD ('Union Progress Y Democracia').

Diaz's satirical humour went viral online within hours. Political jokes it seemed provided carnivalesque relief that worked to subvert, and open opportunities for critique. The prevalence of new communication technology meant such critiques could be instantly replicated and sent rapidly through vast social and political networks with ease.

Diaz's satire distributed primarily through digital media served as a lightning rod for Spanish popular anger and indignation directed at the politically corrupt and a government seemingly more concerned about the health of major banks and the well-being of financiers than ordinary citizens. It was a situation made more difficult to bear in a context where so many people were suffering as a result of harsh austerity measures which the government claimed were necessary in order to make savings and to demonstrate the state's fiscal responsibility to international creditors.

It is perhaps unsurprising that when Diaz drew analogies between the ruling government and the Basque National Liberation Movement he would receive the responses he did. Besides provoking the ire of the president of the high court specializing in terrorism, the true spokesman for 'People's Party', Javier Berreda accused Diaz of ridiculing victims of 'ETA terrorism' arguing: 'We cannot support those who make mockery of the victims of terror' (Berreda 2015). Diaz responded on-line, explaining that his satire was not directed at victims of ETA, but at the 'People's Party'. He invited people to view the video on-line, where he said they will see no such reference and argued that those who were representing his satire as an attack on victims of ETA were disingenuous and opportunistic because such claims were making political capital out of the satire, while also diverting attention away from the legitimate criticisms he was making, (eg, their corruption) (Diaz 2014).

Diaz found himself summonsed to appear before the Spanish High Court on charges of 'glorifying terrorism' where he was required to answer for his 'mocking tone', offences that carried the prospect of imprisonment for 2 years. At that point Diaz relied on digital media to spread his suspicion that the legal challenge was really motivated by conservative interests concern about the growing popularity of the progressive politician with whom he was affiliated - Palbo Iglesia (founder of Spain's new left 'Podemos' political party). The Podemos political party became an increasingly popular opposition party born out of the anti-austerity *Movimiento 15-M* and the *Indignados* protests against inequality and corruption (Global Voices 2015). They were Spanish expressions of a global youth movement that came into being in the wake of the international economic crisis of 2008. It was a social movement reliant on new media to communicate information and mobilize action which developed out of concern, primarily by young people, about their future, high unemployment, and cuts to the public sector.

Ironically Diaz's trial took place (9 January 2015) two days after the shooting of workers in the French satirical newspaper Charlie Hebdo (7 January 2015) and as millions of people mobilised on-line

and in the streets across Europe in support of freedom of the speech. Even more paradoxically at the same time the Spanish government took a public stand in support of freedom speech, voicing support for the French satirical magazine Charlie Hebdo. Spain's Prime Minister Mariano Rajoy declared that 'They will not be able to destroy the most sacred that we human beings have, that is, our rights and our freedoms' (Rajoy 2015).

Adding to the irony, the official statements declaring support for free speech came soon before the government's introduction of its own new 'Citizens Security Law, "Gag Law," (1 July 2015) said to represent the biggest threat to democratic rights since the Franco era. Reportedly a majority of Spaniards (82%) opposed the law. The incongruity was not lost on Diaz and his supporters who used digital media to make more political capital by making jokes about that contradiction.

In the lead up to Diaz's court appearance millions of people entered the fray, rallying on-line and in the streets supporting Diaz, using his encounter with the legal fraternity as a platform for further protest about political corruption and clamp downs on freedom of speech (see Facu Diaz of #YoconFacu - 'I'm with you Facu'). Prominent politicians like Spain's Secretary General Pablo Iglesia, leader alternative party 'Podemos' ('We can') defended the satirists on twitter. Meanwhile demands that Diaz apologize to victims of ETA and be punished continued.

Diaz appeared in the 'National Court' on 15 January 2015. Magistrate Javier Gomez Bermudez closed the case declaring Diaz had not contravened the law, and that his satire was not humiliating for victims of terrorism: 'Like it or not, it [the satire] does not discredit or humiliate the victims' (Bermudez cited Europa press, Nacional 2015). While that decision saved Diaz from further prosecution it is a reminder of how any modern state is rarely a fully coherent or integrated entity and usually consists of groups with quite different interests and competing views that are resolved always in political struggle. In this case groups of intellectuals and artists critical of state repression of free speech were joined by judicial groups like the 'Judges for Democracy' (http://www.juecesdemocracia.es/), and by journalists who initiated legal action in the European Court of human rights (December 2015) in a bid to force the Spanish government to repeal its new 'security law'.

Context

To appreciate the responses to Diaz's political comedy it's helpful to recall the recent history of Spain. Spain had been making a major transition from a brutal and authoritarian dictatorship under General Franco that lasted for nearly forty years into a constitutional democracy. The process began in November 1975 on the death of Franco. Franco made King Juan Carlos I, his successor and the king, led Spain into a democratic order in 1978 when Spain adopted a democratic constitution. The constitution had a major impact on Spain's institutional and legal framework. Equally the details of this transition are still being worked through with respect to the rights of citizens, which amongst other things, were seriously compromised by the struggle with Basque separatists and by the adoption of 'Austerity' policies in Spain after 2009. Added to this is the increased media literacy of entire populations and its integration into everyday democratic practices.

The claim by Diaz that the Spanish government behaved like terrorists in adopting Austerity measures hit a large, and particularly raw nerve. The 'Basque conflict', also known as the Spain–ETA conflict, or what some describe as 'Basque terrorism' refers to a long history of political and armed conflict between Spain and the Basque National Liberation Front (ETA). In 1959 ETA launched a campaign for

autonomy first against the Franco dictatorship which they continued with the constitutional government that assumed office in 1976.

The fact that debate is still active about what to call the struggle with Basque separatists is a reminder that the power to define reality and alternatives is the ultimate power: in most cases as Bourdieu observed we can safely assume that power normally resides with the state (2014). The Basque National Liberation Front (ETA) has been proscribed as a terrorist organisation by Spanish, French, British and American governments. However as one writer argued the Basque political conflict is based on a legitimate claim by Basques for sovereignty in a Spanish state which denied them the right to decide their own status something that was grounded in a legal framework inherited from the Franco dictatorship (Blasquez 2011). In 1978 autonomy was restored to the Basques who achieved a significant degree of self-government based on the *Statute of Autonomy* which ensured Basques had their own police corps and manage their own public finances. The Basque Autonomous Community was led by the Basque nationalist Christian Democratic party since its reinstatement in the early 1980s until 2009 when the Socialist Party of the Basque Country gained office in the Basque autonomous region of northern Spain.

If the Basque conflict highlights deep fissures in modern Spain over national identity, the financial crisis and recession of 2008 exacerbated that inherent rift while digital media helped place inequality and justice on the political agenda. The issue of large-scale and high-level political corruption was a similarly sensitive topic for Spanish citizens still reeling from the hardship most suffered courtesy of the 2008 Global Financial Crisis, an economic catastrophe many saw as the direct result of official corruption, and the criminality and excessive risk taking on the part of many business elites. Adding insult to injury were decisions taken by treasury to use tax-payers money to 'bail out' the banks and others responsible for creating the financial crash. It was hardship was made worse by the government's decision to implement 'austerity policies'.

The 2008 recession had a devastating effect on workers and their families and on welfare beneficiaries especially in southern Europe. Many governments implemented a range of monetary, fiscal and other policies ostensibly to mitigate damage to credit markets and to restore economic growth and market activity. This involved large-scale nationalisation of banks as well as fiscal stimulus packages including increased government spending and tax cuts tax cuts,. To fund these projects money was borrowed from capital markets. The European Union also provided a 200 billion euro strategy for its member states to meet the immediate crisis. Once the immediate crisis seemed to be under control another crisis emerged.

Towards the end of 2009 the European Central Bank and the IMF backed by the German and French governments discovered another problem or sovereign debt default. It became apparent that some governments like Spain, Greece, Italy, Portugal and Ireland could not to repay or refinance the debts they incurred in their bids to mitigate the damage caused by the 2008 crisis (Weber and Schmitz 2011). To reduce the risk of those governments defaulting on their loans, (Germany, the European Central Bank and the IMF) offered them more credit so they could repay their earlier loans - but with new strings attached. The loan offers were now conditional on governments who were at risk of defaulting agreeing to implement 'austerity' policies. The 'austerity' measures were harsh and aimed at reducing public debt, involving tax increases, job and wage cuts in the public sector effecting education, health and welfare expenditure. Moreover, they were justified in terms of 'adjustments' 'needed' to stabilize the economy and demonstrate the states capacity to be 'fiscally responsible'. This meant amongst other things that many government employees lost their jobs, or took salary cuts, it meant increased costs of basic amenities (like electricity), cuts to welfare, education, health services and public sector generally. Not surprisingly, many people were not happy. Apart from the context that Diaz drew on to make his satire

so pointful, the Diaz case raises questions about the salience and the effectiveness of digital media for political communication, the state of democratic politics and indeed how we think about the political.

One starting point is Habermas' influential contribution to discussions about deliberative democracy and the possibilities for reviving the 'public sphere' (1989).

Participation, Democracy and the Internet

Habermas described the 'public sphere' as that space constituted by citizens freely engaging in critical and rational deliberation about public issues (1984, 1987). Subsequently he added his 'communicative action' model (1989). It was an account of discursively grounded communication theory built on Kant's principle of universalisability, which argued that for a decision to be valid we need to ensure that everyone affected by it can accept the consequences of their observance. According to his 'ideal speech situation', valid norms of action are only legitimate if they can be justified in such a moral-practical discourse. In this way Habermas outlines the claim that those affected by a decision ought to participate in processes that led to the decision. In short, those with an interest in the decision at which this process arrives ought reasonably to prefer that decision to any alternative (1996). Writers have subsequently elaborated Habermas' work (eg Dryzek 1990, Olson 2006).

The affinities between Habermas's conception of the 'public sphere' (1989) and the idea that the internet provides a digital platform for a new public sphere has been a significant focal point for theorists and researchers for several decades. For many of these commentators a good case exists for revising traditional accounts of politics and the public sphere given the ways in which digital technology is now being used to engage more people politically and to open-up new deliberative spaces.

They point to new forms of political action enabled by the digital media such as hacker 'clubs', movements like 'Anonymous' and 'Lulz sec' and electronically sponsored Distributed Denial of Service (actions, the later of which that facilitate the digital co-ordination of large numbers of protesters to disable websites) (Bessant 2016, pp.921-937). Popular protests and large-scale political mobilisation of people using digital media in Egypt and comparable developments in Tunisia, Yemen and Libya, the 'Occupy movement' across many Westerns countries, plus student action against fee increases in many countries highlight how digital medium was central to the distribution of ideas and to recruitment and organization of people for different kinds of political action (Bessant 2014).

Dahlgren is an important post-Habermasian interested in the democratic potential of digital space, while distancing himself from Habermas's account of a single public sphere and the idealization of deliberative practice on which it relies. Dahlgren does not accept Habermas' insistence that deliberation should only ever be directed towards consensus, pointing to instances where democracy has been promoted by political conflict and antagonism – something that is ever-present in relations between various political interests (2009:156). Dahlgren's point is that citizens are more than rational beings and democracy can be augmented by means other than rational deliberation (Dahlgren 2009: 147–162, 2000: 335–340.). 'Non-rational' human qualities including moral emotions like righteous anger, disillusionment, or disgust, and responses like laughter and hilarity evoked by humour or satire play a critical role in the public sphere. These expressive responses play a role in political life as much as more conventionally understood forms of political action like rational deliberation. As many writers have noted contemporary digital media provides the affordances which enhance the production and distribution of opinion including genres like user-generated satire in what now constitutes multiple public spheres.

Given that normatively more participation on relatively equitable grounds is good, digital media provides a technical means for enlarging participation in will formation. In this way digital media *can* provide a technical resource for enhancing equity by opening multiple spaces and by helping to secure political cultures where values like equity, fairness, openness and a pluralism may be realized (Dahlgren 2009).

Unlike Habermas who is skeptical of the Internet's capacity to enhance deliberative practice, Dahlgren maintains that digital technology moves us beyond narrow definitions of the 'public sphere' by connecting us to 'civic cultures in subtle, unintended and surprising ways' (2009:48).

Dahlgren unlike Habermas does not rely on an untenable account of the political and the liberal polity by insisting on consensus and by blanking out of dissent from the picture which in Habermas's case is done prescriptively. For Habermas a functioning public sphere can be identified by the way it encourages a flow of ideas and exchange of information that produce consensus and political will, which then becomes political action by means of various political actors. It assumes that liberal democratic polities welcome and promote democratic dissent as part of that process.

Yet as I now explain, there is no reason however to suppose this is the case.

TWO PROBLEMS WITH LIBERALISM

Liberalism has always had major difficulties accommodating dissent. This is so for two different but connected reasons identified by a body of distinguished critics of contemporary liberal politics.

1. Consensus Rationality

As Unger argues, the liberal tradition assembled over many centuries by the likes of writers such as Locke, Kant, Bentham, Mill, Berlin and Rawls, privileges a rationalist, universalist and individualist conception of human being and society (1977). Liberalism that assumes that rational consensus is possible, that it can eliminate conflict, that it is preferable to dissent and protest, and that electoral politics is the essential institutional device for a democratic polity.

Many unspoken assumptions about what constitutes 'the political' operate in the liberal tradition. One is that for an action to be political, motivation needs to be expressed in political language, that is it has to be rationally articulated and expressed through legitimate institutional means. This focus on rationality highlights the ways disciplines like political science legitimate activity as being 'political' by relying on the idea that 'rationality' relies on conventional forms of strategic political action (Akram 2014 p.382).

Added to this is political theory that is also interested in what counts as political. It's a tradition that articulates conventional rules of engagement, values and consensus over dissensus and privileges *rational* deliberation. For Habermas all communicative action is oriented towards 'understandings' or agreements (1984 1996). Such understandings rely on mutual comprehension (i.e. people using the same words with the same meanings so they can reach shared or mutual comprehension) which extends to consensus about truth and what is good (Habermas 1984 p.42).This rational communication considered necessary for democracy involves identifying the rules or norms underpinning rational discourse or ideal speech (eg listening to each other, taking turns, relative equity between participants etc). Habermas' claim that a 'public sphere' connects rational deliberation to the democratic political process is fine in theory, but how does that happen? What does this mean in practice he doesn't say (1989).

The ostensibly defining features of liberalism, like its privileging of rationality and consensus, have helped erode a normative conception of the political as an inherently 'agonistic' enterprise (e.g. Mouffe 2005a and b, Unger 2014). Some contemporary theorists refer to a crisis of of 'the political' and of liberal democracy (Furedi 2005, Mouffe 2005 a-b). For Mouffe, too many proponents of liberalism are 'blind to ... the political in its dimension of conflict-decision' and cannot perceive the value of opposition in political life (2005:3).

Mouffe's point is made clearer when she distinguishes between antagonism and agonism. Antagonism is a 'we–they' relationship where 'they' are 'enemies' and do not share common ground. Agonism refers to a 'we' relationship in which conflicting parties declare commitments to shared ethical–political principles (e.g. liberal democracy). While agonists acknowledge there may be no immediate, or even long-term solution to their differences, they nonetheless recognize the legitimacy of their opponents' disagreement and resistance and its value for democratic processes.

The preference for consensus over conflict and the 'blindness' to the value of opposition encourages a taming of disagreement and dissent. It is a trend exacerbated from the early 1980s with the rise of a neo-liberal political imaginary that supports the 'economization' and 'technicization' of politics which characterize conflict as a source of economic inefficiency or political dysfunction (Buchanan and Tullock 1962). All this narrows and depletes the public sphere.

2. Security, Order and Prerogative

The second closely related problem inherent in liberalism is that rather than valuing freedom, liberalism exhibits a preoccupation with maintaining order and security. As Neocleous argued, this privileging of order and security over freedom is deeply embedded in the history of liberalism (2000, 2003).

As Neocleous argues, these are bad days for liberty because any 'claim to liberty in the contemporary world is offset by the counter-demand for security (2007: 131). As he says the claim that in seeking security, 'states need to constantly limit the liberties of citizens, and that the democratic society is one which has always aimed to strike the right 'balance' between liberty and security' (2007:132).

Although there is considerable detailed political and philosophical explanation to be engaged in, and more than is possible here, Neocleous' argument is that if we search for a solid liberal belief in freedom over security we will not find it. Indeed if we go back to the origins of liberalism to Locke's account of civil society we see the latent preoccupation with order and security.

Neocleous' reading of Locke is clear (2007: 134-7). Locke's political thought appears to revolve around the power of the people to enter into a contract with each other to form government in which again they place political supremacy in the legislature. Here is the liberal founding myth: the legislature is supreme because it assures the rule of law, protects life, liberty and property, and prevents any exercise of arbitrary power.

Yet Locke says there must also be scope for discretion, because the public good - the protection of life, liberty and property - may sometimes require immediate and decisive action to preserve the good order of the state.

Locke concedes that 'the good of the Society requires, that several things should be left to the discretion of him, that has the Executive Power'. Events may occur where 'strict and rigid observation of the laws may do harm'. Law-making is often too slow, too cumbersome and cannot deal with 'accidents and necessities' that may concern the public. The power to act in these circumstances is what Locke understands by prerogative power:

This Power to act according to discretion, for the public good, without the prescription of the law, and sometimes even against it, is that which is called Prerogative.

According to Locke it is through prerogative that the people permit their Rulers to act 'of their own free choice', not only where there is no clear legal position ('where the Law was silent'), but sometimes where they might feel the law insufficient or unimportant ('against the direct letter of the Law').

Prerogative therefore grants to the sovereign discretionary powers not bound by law and which might even be used against the law. This is 'an Arbitrary Power', Locke comments - in parenthesis, as though it were a minor point which might be passed over and which allows him to ignore the fact that arbitrary power is precisely the kind of power his constitution was designed to prevent. Prerogative, then, grants rulers powers which are legally indeterminate at best. At worst, prerogative serves to place rulers beyond law. The only requirement is that prerogative be exercised in the interests of the 'public good'. ' *Salus Populi Suprema Lex* [the safety of the people is the supreme law] is certainly so just and fundamental a Rule that he who sincerely follows it, cannot dangerously err'. In other words, prerogative 'is, and always will be just' so long as it is exercised in the interest of the people (Locke, 1988, 373-375, 377, 405). Determining what is in the interest of the people is of course the state will alone determine.

In short this is why liberal states so freely declare 'states of exception' (Agamben 2007) as they breach constitutive principles of liberalism, such as the rule of law and rights to freedom of speech and assembly in pursuit of order and 'security'.

DISCUSSION AND CONCLUSION

The implication of this argument for this chapter is that we cannot assume as many have, that a natural or elective affinity exists between dissent of the kind evident in on-line satire and a liberal polity. This affinity cannot be assumed simply because we now have new kinds of open access or peer-to-peer technologies. Any affinity between dissent and a liberal polity has to be argued for repeatedly by people who are prepared to engage in political dissent and to defend this practice.

Inherent in liberalism is a tendency towards security and order as much as there is an interest in freedom. When push comes to shove however if its power is threatened, the state has at its disposal that prerogative to deny liberties like freedom of speech and to squash any dissent deemed to threaten the state. In this way what we are seeing now in places like Spain and many other liberal democracies is the exercise of that prerogative and a playing out of the preference for security over freedom.

This chapter adumbrates the point made by Appiah that laughter and ridicule can make moral revolutions happen and bring about political change (2010:3-17). The case of Diaz demonstrates how in the context of economic crises, digital media offers the means to create content for satirical humour and to communicate it so it filters through vast networks in ways that ridicule and provoke political debate.

According to traditional liberal theory, activities like satire do not fit the category of rationality because it relies on emotion, is playful and not oriented towards consensus. The modern liberal constitutional state privileges an overly narrow conception of politics-as-consensus and defines its remit as needing to work in accordance with that.

As such satire, particularly if it is on-line does not fit the traditional Habermasian liberal category of deliberative practice said to be an essential feature of a public sphere. Indeed for writers like Griffith, frivolity is problematic because it is open-ended and resistant to closure or consensus (1994). Yet while

on-line satire and the digital debates that accompany it may not fit these accounts of 'rational' action or 'the political', it does none-the-less augment participation and offers a powerful and influential political critique. It is also a direct form of communication that typically comes from 'below'. As Kiley and Shuttleworth observe, satire's literary manner blends critique with humour, and wit for the purpose of 'improving' social conditions (1971).

While the influence of humour and ridicule in politics has been acknowledged in political science (Holbert 2013:305-323, Baym and Jones 2012), it has received minimal acknowledgment by conventional political science.

Brian Barry (2001) is a modern philosopher who made the case for a right to ridicule, a case grounded in his conception of justice. It is a case worth rehearsing. He argues that there should be only one status of citizen (no estates or castes), so that everybody enjoys the same legal and political rights (Barry 2001:7). Barry is interested in deriving principles of justice that allow persons with highly divergent interests, attitudes and conceptions of the good to live together amicably- because everyone will recognize that whatever disputes do arise they will be adjudicated according to principles that all can appreciate as fair.

By privileging rationality and consensus traditional liberal theory omits the idea of politics as 'agonistic'. In this way proponents of liberalism are 'blind to politics' that comes in the form of conflict-decision', and cannot perceive the constitutive role of opposition in social life (Mouffe 2005a p.3). I pointed to the ways liberalism relies on an excessively rationalist individualist conception of human being and society, and assumes rational consensus is possible, that it can eliminate conflict, that consent is preferable to dissent, and that electoral politics is the essential institutional device for a democratic polity.

Finally user-generated satire like Diaz's comedy has flourished with the advent digital media, as users make their own content and broadcast them globally. As Dias da Silva and Luís Garcia argue, this has come to play a significant role in politics (2011: 89-114). Millions of remixes and mash-ups in the form of spoof and satire now circulate courtesy of the web. This has 'knock on' effects in mainstream media in ways that see satire break out of sharing sites and smaller networks and enter into mainstream media and political forums in ways that shape 'public opinion', contemporary politics and that reveal how digital media has become integrated into participatory democracy.

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ENDNOTE

[1] In 2011 ETA declared a permanent ceasefire.

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Chapter 65
The Irrevocable Alteration of Communication:
A Glimpse Into the Societal Impact of Digital Media

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ABSTRACT

In our digital society, the ability to communicate has irrevocably changed. The purpose of this chapter is to provide a glimpse into the impact of digital media on society, specifically digital communication. This glimpse is framed in terms of four characteristics of digital communication: product/ion, semiotic, public, and transitory. Issues are examined that relate to the democratization and monopolization of communication, who has access, the persistent Spiral of Silence, privacy, cyber bullying, identity theft, the ethereal being captured, as well as education and new literacies. Methodological gaps are noted in the research corpus and suggestions are proposed regarding the need for timeliness, support for a comprehensive span of research paradigms, and representation of a full range of populations. Finally, implications and recommendations are explored for civic engagement, commerce, education, and policy.

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INTRODUCTION

Communication is core to human existence. Throughout time and civilizations, humans consistently created varied forms of communication. Ancient civilizations created cave drawings, petroglyphs, pictograms, cuneiform, hieroglyphs, and alphabets. More recently, civilizations created newspapers, magazines, telephones, and radio. The ability to share ideas, emotions, desires, and plans, to mention a few reasons we communicate, is the essence of the human experience. The purpose of this chapter is to discuss the societal impact of digital media on communication. We view society, digital media, and communication as dynamic entities that are inextricably intertwined and continually impact one another. Therefore, we examine both the impact of society and digital media on communication as well as the impact of digital communication on society. To manage this broad and varied topic our discussion is framed in terms of four characteristics of digital communication: product/ion, semiotic, public, and transitory (Baker, 2001). We define and illuminate each characteristic by exploring research related to exemplars. Issues emerge regarding the democratization and monopolization of communication, access to digital communication, persistent Spiral of Silence, online ethics and safety, ethereal captured while privacy is compromised, and education. Methodological gaps are evident in the extant research corpus. Implications are discussed and recommendations are made for local and global civic engagement, commerce, education and policy. We acknowledge that other frameworks, constructs, and exemplars can be used to understand digital communication. Our goal is not to provide a comprehensive or conclusive discussion of digital communication but to provide fodder for grappling with this timely and emerging topic.

IMPACT OF DIGITAL MEDIA ON COMMUNICATION

Production Nature of Digital Communication

Production is defined as "the process of making something" while product is defined as "something that is the result of a process" ("Production", n.d., para. 1; "Product", n.d., para. 1). By definition, written communication culminates as a product. Up through the first millennium mankind created varied written products including pictographs, hieroglyphs, letters, and scrolls. In 1999, the Biography channel broadcasted a countdown of the most influential people of the second millennium. This countdown included such notables as Newton, Darwin, and Einstein. Among these notables, they concluded the most influential person of the second millennium was Gutenberg. Arguably, one reason Gutenberg was given this distinction is that the printing press made it easier to transform communication into products that, in turn, could be widely disseminated. Communication has always been shaped by the technology at hand (Hartman, Morsink, & Zheng, 2010; Leu, 2006; Leu & Kinzer, 2000). With the advent of digital media, it is argued that we are witnessing a comparably significant, and likely more significant, even unprecedented development in the history of communication (D. Hartman, personal communication, August 17, 2012).

In her analysis of the ontology of literacy, Baker (2010a, 2013b) argued that the ability to transform communication into products is significant because products can travel through time and space. Written communication can defy the laws of physics. Authors and readers can become time travelers who explore historical times and geographical locations that are beyond their physical limitations. Because Socrates' words were written down we can read his thoughts--even though we live in a different time and place.

The product/ion nature of written communication allows authors and audiences to travel through time and space. In our digital era, this travel is not only instantaneous but also global. Each day 182.9 billion emails are sent (Radicati, 2013), 55 million Facebook statuses are updated (Facebook Statistics, 2014), and 1,400 hours of YouTube video are uploaded (You Tube, n.d., para. 3). The instantiation of communication as products defies physical limitations to time and space by affording global dissemination within seconds. The mitigation of production means that anyone with a digital device and Internet access can produce a message that is instantly available worldwide. Publishers are no longer the gatekeepers of producing and disseminating written communication. The proliferation of blogs, FaceBook, Twitter, citizen journalism, self-publishing, and eBooks exemplifies the product/ion nature of digital communication.

- **Blogs:** Blogs, "originally a space for narrating personal life stories" (Harrison, 2014, p. 337) are often used to create traffic for business endeavors, incite political action, and teach audience members interested in affinity content (e.g., parenting and cooking). For example, blogs written by ordinary people whose purpose is to share private information among an affinity group, such as individuals struggling with infertility, now "play an important role in public and political negotiations of fertility issues" (Harrison, 2014, p. 338). Drawing a similar comparison to blogging and foreign policy, Hestres (2008) asserted, "blogs have evolved into more than alternative media outlets: they have become vehicles for online organizing and activism for ordinary individuals who care about foreign policy and are willing to take action to influence it" (p. 1). Endorsed with sponsored advertising, bloggers have the opportunity to communicate with a polished and professional appearance. In 2014, one blog platform, WordPress, boasted 75.5 million blogs that had 409 million views and 60.5 million posts each month (Digital Marketing Ramblings, 2014b). Blogs, produced with the specific intent to inform, educate, and persuade audience members across the globe, are a tool accessible to any unskilled person. What was once a casual conversation between like-minded individuals, or a nicely designed tri-fold brochure for local distribution, has become an opportunity to influence the masses by creating a polished blog that is official in appearance.
- **Facebook and Twitter:** Beyond blogs, platforms such as Facebook (launched in 2004) and Twitter (launched in 2006), contribute to the unskilled person's ability to produce professional-grade communication. In a 2013 survey of 1,802 Internet users, Duggan and Brenner (2013) found 16% used Twitter while, ranking the highest, 67% used Facebook. The ability to produce written communication on these platforms, at face value, might not seem to yield global impact. Originally designed to connect users with families and friends, the possible applications of these platforms has evolved to include audience solicitation and audience retention methods which provide publishers, skilled and unskilled alike, with a forum to sell ideas, products, and entire belief systems to a global audience. The statistics indicate that the public is taking advantage of available platforms to publish their ideas.
- **Self-Publishing and eBooks:** In 2000, Mace (2010) deemed eBooks as "failed" for the following reasons: not enough eBooks, cost, cumbersome hardware, nascent digital periodicals, and poor marketing. Mace noted that "at least six eBook reader devices [were] on the market or in preparation" (para. 2) with estimates of seven million devices to be sold in 2011, by 2015 over 10 percent of the publishing market will be eBooks, and by 2030 over 90 percent will be eBooks. The increase in eBook production provides greater variety and choice for consumers and illuminates challenges for self-publishers. Aside from the few that skyrocketed to fame, the majority of self-publishers engage in time-consuming activities to build a fan base and create awareness of their offering in

a market ripe with choices. Social media endeavors and exclusive content offerings are two of the ploys that authors use. One such author, Rachel Abbott, reported spending 12 hours a day just to build her profile (Carolan & Evain, 2013). Self-publishers are not discouraged by these statistics. It seems the allure of production is more compelling than roadblocks to monetary gain. Baverstock and Steinitz (2013) found that self-publishers have two fundamental motives: desire for control and pure love of writing.

Semiotic Nature of Digital Communication

Since the advent of the alphabet, written communication has been predominantly verbocentric (Reinking, 1998). That is to say, written communication has historically been dominated by the use of words. While printed newspapers, magazines, and books include non-verbocentric information such as illustrations, photographs, and charts, written communication has been overwhelmingly dependent on words. With the advent of digital media, written communication is increasingly semiotic. Semiotics is the study of sign systems (Peirce, 1991). The alphabet is merely one of a myriad of sign systems we use daily. For example, we communicate with body language. A smile, smirk, cold stare, and frown communicate volumes. We communicate with paintings, sculpture, and music. Baker (2001) noted that digital communication increasingly mimics face-to-face communication by allowing authors to compose multimedia products. The popularity of incorporating audio, photos, and video in digital communications demonstrates the semiotic nature of digital communication.

- **Popularity of Audio, Photo, and Video:** Podcasts, Pinterest, and YouTube are less verbocentric than print media because they allow authors to capture auditory and visual communication. Podcasts are an example of audio-based digital communication. Podcasts are defined as, "a program (as of music or talk) made available in digital format for automatic download over the Internet" ("Podcast," n.d., para. 1). The term podcast was coined by technology writer, Ben Hammersly, who made an off-hand comment about names for online radio (Sterne, Morris, Baker, & Freire, 2008). Podcasts were first made popular by the introduction of the iPod. Free software such as Audacity, launched in 2002, made the production of professional-grade audio ubiquitous (Sterne, Morris, Baker, & Freire, 2008).

In 2010, the top three podcasts were categorized as general, music, and technology; education came in 8th and news 14th (Olmstead, Mitchell, & Rosentstiel, 2011). In 2004, Duke University provided Apple iPods to all incoming freshmen so they could download podcasts with schedule information as well as lectures (Flanagan & Calandra, 2005). From 2009 to 2010 Olmstead, Mitchell, and Rosenstiel (2011) noted a 28% growth in podcast production; nonetheless only 45% of Americans knew what a podcast was. In 2014, Wolf found that podcasts were on the rise and posits this is due to "continued smartphone growth, better podcast apps and the explosion in great content, [as well as] dedicated podcast fans" (para. 1). The product/ion and semiotic nature of digital communication are unmistakable; digital communication that emulates a full range of *semiotic* sign systems appears to increase as technology enables both authors and audience to *produce*, disseminate and access digital semiotic communication.

Pinterest is an example of photo-based digital communication. Pinterest is a social network where photos are "pinned" to a virtual board. These pins are linked to websites of origin. Authors share pins and re-pin photos on other authors' boards. The basic function is to allow users to collect, organize, and

share pins (Han et al., 2014). The pins are organized on the boards by tastes and interests. Pinterest was launched in 2010 and by 2014 had 70 million users who had created more than 750 million boards with over 30 billion individual pins (Digital Marketing Rambling Statistics, 2014a; See also Smith, 2014a). In addition, 54 million new pins are added each day (Bercovici, 2014). To emphasize the popularity of photo-based digital communication, it has been said, "Facebook is selling the past and Twitter the present, Pinterest is offering the future" (Bercovici, 2014, para. 9). Users access Pinterest with computers as well as mobile devices with 52% using smartphones as the primary device to pin photos (Smith, 2014b). Each board, each pin, is a photo that is posted to communicate ideas, thoughts, and possibilities. These statistics are staggering and underscore the semiotic nature of digital communication.

YouTube is an example of video-based digital communication. YouTube, since its inception in 2005, has transformed daily life into a global production, capitalizing on the semiotic nature of communication. Anyone with a digital camera, a smart-device, or a computer, can become authors of video-based communication. Prior to YouTube, there were other online video websites that did not succeed. Shareyourworld.com, launched in 1997, was one of the first video-sharing websites. Then came Singfish in 2000, which was acquired by Thompson Multimedia. Blinkx, founded in 2004, offered a video search engine. These forums did not flourish, but the power of video-based digital communication did. In 2005, Google Video as well as Yahoo! Video began as video search engines that allowed people to search the web for videos (Soukup, 2014). Meanwhile, in 2005 Chad Hurley, Steve Chen, and Jawed Karim founded YouTube as a way to post and share video. Google bought YouTube in 2006 with expectations that the website would grow (Strangelove, 2010). YouTube was transformed from a repository of videos to "becoming a force that is investing in content creation" (YouTube & News, 2012).

By 2010, 150 million videos were posted to YouTube each week (Strangelove, 2010). In 2011, YouTube was viewed for the one-trillionth time. By 2014, YouTube had one billion users who uploaded 100 hours of video per minute, posted 150 million videos per week, and watched six billion hours each month (Smith, 2014c). According to Purcell (2013), 72% of adult Internet users have watched a video on a video-sharing site like YouTube, 56% have watched videos online, and 36% have downloaded video files to a phone or computer so they can watch at a later time. Four features are credited for the success of YouTube: video recommendations, email links that enable video sharing, comments, and an embedded video player (Gannes, 2006). It also offers social networking features (Soukup, 2014). Given its magnitude, Strangelove stated that YouTube showcases the lives of people around the world, from videos providing intimate details of indiscretion, to American presidential primaries, to soldiers documenting their lives and killings in Iraq (Strangelove, 2010). These statistics indicate that what was once the purveyance of face-to-face communication has migrated to digital communication.

Vine is an example of the semiotic nature of digital communication that, similar to YouTube, embraces video. Vine is designed for smartphone users and allows them to create six-second videos and then embed these videos in text messages, Facebook, and Twitter (M. Miller, 2013). Vine launched in 2012. In 2013, Twitter bought Vine, which quickly attained 40 million users (Fiegerman, 2013). By late 2014 over one billion Vine loops were played each day (Crook, 2014).

- **Ubiquity of Capturing the Ethereal:** An important aspect of the semiotic nature of digital communication is the ubiquity of capturing the ethereal. Ethereal refers to, "lacking material substance" ("Ethereal," n.d., para. 2). With the ability to record audio, photo, and video with Internet-connected mobile devices the ethereal is readily captured and shared, worldwide. Before the ubiquity of such digital devices, conversations, actions, and settings were fleeting—they lacked substance, they

were ethereal. Now, surveillance videos assist with crime detection (e.g., Boston Marathon bombing), street witnesses capture police brutality (e.g., Arab Spring), and on a lighter note, cat owners capture the antics of their pets.

In 2012, Google developed Google Glass; a pair of glasses intended to provide seamless online access. Users see an Internet screen in the upper right side of one lens. Among other things, they can capture covert videos and photos and instantly share them online. Honan (2013) conducted an informal study of Glass by wearing them throughout most of 2013. He wore them to identify their usefulness—but instead found consistent derision and increased animosity by those around him. He became known as the "Glasshole." Even his wife was willing to let him video record the birth of their child with a traditional video camera—but not with Glass. While there are reports that Google Glass is being abandoned, wearable technology is in its infancy and will likely become less obvious and a social norm. As it does, the capturing and sharing of the ethereal will become increasingly normal.

British surveillance cameras demonstrate the pervasive ability to capture the ethereal. Schlosberg and Ozer (2007) described Britain's response to the bombing of London in the 1990s by the Irish Republican Army. By 1994, 79 British cities installed surveillance cameras for their central districts. By 1998, up to 75% of Britain's crime prevention budget was spent on cameras. The result was that by 2004, Britain installed over four million surveillance cameras in approximately 500 British towns. By 2006, the average person in London was captured on video 300 times per day.

Google Glass and the British video surveillance system are two examples of how the ethereal is readily captured and shared. Consider the sheer number of audio, photo, and video postings made to social networks. Users post conversations, actions, and settings that were formerly ethereal. The ethereal has become a product—and these products are readily distributed.

Public Nature of Digital Communication

Public is defined as "exposed to general view" ("Public," n.d., para. 2). There is a plethora of digital communication that is public. Consider web sites, blogs, and social networks. These digital communications, pending privacy settings, are public. Anyone with Internet access can view these digital forms of communication. Ten billion "ALS ice bucket challenge" views on Facebook alone during the summer of 2014 (Smith, 2014d) is evidence of the speed at which digital communication is crafted, distributed, and received, internationally. Due to the breadth of this topic, in this section we focus on a particular phenomenon related to the Public nature of digital communication: collective intelligence. Wooley, Chabris, Pentland, Hashmi, and Malone (2010) contended that just as individuals have intelligence, so do groups. The Center for Collective Intelligence at MIT examines how people and computers can work together "more intelligently than any person, group, or computer has ever done before" (2014, para. 2). While collective intelligence is as old as society and exhibited by most forms of life (Malone & Bernstein, in press), due to the public nature of digital communication, we are on the precipice of something previously unattainable. We can formulate collaborative communities that span the globe to generate intelligence that previously lacked coordination and the power generated through think-tank contributions on a global scale (Weiss, 2005). Some examples include Wikipedia, Arab Spring, Kickstarter, online product reviews, HapMap, Uber, World of Warcraft, and Coursera. These examples represent the following types of collective intelligence: knowledge, political action, funding, commerce, medicine, crowdsourcing, entertainment, and education. A closer examination of citizen journalism, Massive Mul-

tiplayer Online Games (MMOGs), Massive Open Online Classes (MOOCs), and Arab Spring reveals the public nature of digital communication.

- **Citizen Journalism:** Glaser (2006) described citizen journalism as,

People without professional journalism training [using] the tools of modern technology and the global distribution of the Internet to create, augment or fact-check media on their own or in collaboration with others.… The average citizen can now make news and distribute it globally, an act that was once the province of established journalists and media companies…. One of the main concepts behind citizen journalism is that mainstream media reporters and producers are not the exclusive center of knowledge on a subject — the audience knows more collectively than the reporter alone. (Para. 1, 2, 3)

Citizen journalism has become a modern vehicle for communication of events, both in the realm of serious news writing as well as entertainment. Howe (2008) stated that in order to keep costs and profits in balance, news reporting is outsourced to "a large, undefined group of people via an open call, generally over the Internet" (p. 47). Several platforms support the organized dissemination of news via citizen journalists. Huffington Post and BuzzFeed are among the most popular with BuzzFeed staffing 170 writers, including reputable award-winning writers. Mitchell (2014) reported that in 2012 there was a 6.4% decline in newspaper jobs while in 2014 there were more than 5,000 full-time professional jobs for online journalists at approximately 500 digital news outlets.

Photojournalism by citizens is also on the rise. According to Pew Research Center's Journalism Project Staff (2012), during the week following the 2011 tsunami in Japan, videos of the disaster, mostly recorded by eyewitnesses, were watched more than 96 million times. Another example of citizen journalism is evident in the dissemination of photographs by American soldiers, wherein soldiers capture their daily activities and observations, and share them with the world via email and other platforms (Sontag, 2004).

- **MMOGs:** Massively Multiplayer Online Games (MMOGs) are an example of collective intelligence. MMOGs "are highly graphical two-or three-D video games played online, allowing individuals, through their self-created digital characters or 'avatars,' to interact not only with the gaming software (the designed environment of the game and the computer-controlled characters within it) but with *other players*' avatars as well" (Steinkuehler, 2007, p. 298). MMOGs are an example of collective intelligence because players around the world are able to perform acts of "intelligence" that are qualitatively different and enhanced over what they would accomplish as individuals. Users form teams or organizations that cooperate together in order to win virtual battles or accomplish virtual tasks. Typically, team members are familiar with each other only in these online environments. Online voice communication and a shared online interface allows users to play concurrently. Users are able to interact and work in real time to organize activities in the games (Ruiz, 2013).

According to Wiess (2006), this mode of sharing is increasingly growing and affecting the mindset of the present and future generations. Collective intelligence for these generations has become the norm. Flew and Humphreys (2005) argued that "interactivity" in the online game environment and the continual dialogue between consumers and game designers, who are active in videogames as groups or associations, frequently collaborate to accomplish their goals (see also Lévy & Bononno, 1998). Jenkins (2006) suggested, "collective intelligence can be seen as an alternative source of media power" (para. 6). Because

of their collective intelligence, the participatory cultures that emerge between media companies, game producers, and users show a central change in the nature of media production and consumption. Gosney (2005) examined Alternate Reality Gaming and described it as an "across-media game that deliberately blurs the line between the in-game and out-of-game experiences" (p. 2). Actions occur outside the game reality and extend into players' lives. This genre of gaming requires an exceptional level of collaboration and collective intelligence to solve mysteries posed within the game.

Banks (2003), a cultural theorist and online community developer, studied the influence of online fan communities in the invention of Trainz (a series of 3D train simulator computer games). He claimed that its commercial success was primarily due to "the formation and growth of an active and vibrant online fan community that would both actively promote the product and create content extensions and additions to the game software" (p. 11). The fans' collective intelligence enabled improvement and promotion of the game.

- **Massive Open Online Classes (MOOCs):** Massive Open Online Courses (MOOCs) are an example of collective expertise. MOOCs have open registration, publicly shared curriculum, open-ended outcomes, and are commonly free (McAuley, Stewart, Siemens, & Cormier, 2010). MOOCs incorporate social networking, available online resources, and are assisted by leading experts in the field of study. More importantly, MOOCs engage students according to their personal learning goals, background knowledge and skills, and mutual interests. The collective knowledge created by participants generates a whole that is greater than the sum of its parts. "It is, in many ways, a microcosm of a nation" (McAuley, Stewart, Siemens, & Cormier, 2010, p. 54). MOOCs work best when people bond on the basis of their lives, interests, and understandings of their worlds. MOOCs create a collaborative and interactive experience for those who would otherwise not have the opportunity to get an elite education.

Coursera is a MOOC identified as a "social entrepreneurship company that partners with many top universities across the globe to offer free courses online for anyone to take" (Audsley, Fernando, Maxson, Robinson & Varney, 2013, p. 137). Its purpose is to educate millions of people around the world by offering courses on numerous topics from privileged universities such as Stanford, Princeton, the University of Michigan, and the University of Pennsylvania. Professors have the ability to teach 30,000 or more students at once due to an instructional platform reinforced by vigorous computing power and complex infrastructure (Audsley et al., 2013). Anyone in the world with Internet access has the capability to obtain a self-paced education. Coursera purposely encourages digital communication between students. For example, students work together through discussion boards and virtual study rooms. Al Filreis, professor at the University of Pennsylvania, is fascinated by the ways in which the students interact on the discussion boards. "Coursera is building a system like Yelp that will let these students value each other's comments; the most valued and respected will rise to the top" (Henn, 2012). Filreis noted that within just one Coursera class, he is able to teach more students than he ever has throughout his career (Borup, West, & Graham, 2012). MOOCs focus on collective intelligence over individual intelligence, participation over publishing, breadth of expertise over concentrated expertise, and collaboration over individual authorship (Stewart, 2013).

- **Arab Spring:** The Arab Spring is another example of collective intelligence. It represented a new kind of revolution; a "Revolution 2.0" as Ghonim (2012) called it. The ability to orchestrate efforts

reverberated throughout the world. Conventional forms of civil disobedience were transformed by the capabilities of digital communication. Howard and colleagues (2011) suggested that social media is commonly used for political conversations. The demographic group in the Arab Spring was "young, urban, relatively well-educated individuals, and many of whom were women" (p. 2). Social networks were used to coordinate efforts and recruit participants. In a Facebook-based survey, Salem and Mourtada (2011) found that nine out of ten Egyptians and Tunisians reported that they used social networks to heighten awareness and arrange protests. During the Arab Spring, the use of social media doubled (Huang, 2011). Although the Arab Spring occurred for many reasons, collective intelligence is recognized as pivotal in efforts to advocate for democratic revolution (Rheingold, 2007).

In addition, news media contributed to the collective by forming an almost symbiotic relationship with people reporting from the front lines. This relationship allowed participants to effectively raise awareness of the more violent actions of the ruling governments against their citizens. This awareness reached international news sources that promoted their cause with unprecedented velocity. This type of dissemination informed citizens throughout the world and facilitated the organization of protests. Before and throughout the revolutions, these people worked on social media to put pressure on their governments. Governments also recognized the power of opposition movements armed with social media. Tunisia officials tried to block social media sites and arrested people who used social media to spread negative news about the government (Howard et al., 2011). While these efforts stalled and disrupted digital communication, the collective was tech-savvy and gained assistance from hackers and skilled computer programmers who were able to close online government services and offer protesters alternatives to censored access. Information that had been localized was instantly made public. Aided by the power of collective intelligence, young Arab people overcame what was thought to be insurmountable barriers and made their plight known. Government forces were unable to stop the movement. Internet controls were transcended by the ingenuity of the collective. A local issue became a worldwide concern through digital communication of text, image, and video.

Transitory Nature of Digital Communication

Baker (2001) argued that digital sources and compositions are in continual flux; they are transitory. Transitory is defined as "tending to pass away: not persistent" ("Transitory," n.d., para. 1). In the morning, you might read an article in the digital version of USA Today®—then when you share it with someone the same afternoon it may be updated; it may no longer be the same article. The same is true of postings made to social media, YouTube, eBooks, retail sites, and the list continues. Digital media is readily revisable making it perpetually transitory. Karlsson (2012) referred to digital communication as liquid, dynamic, and fluid. Others referred to the ephemeral nature of digital communication (Metz, 2013). Analyses of wikis, Snapchat, online news, and video production demonstrate the transitory nature of digital communication.

- **Wikis:** Wikis are an example of the transitory nature of digital communication because users can update them—at any moment. Unlike print media, that is stable, wikis are transitory. WikiWikiWeb, created in 1995 by Ward Cunningham, is credited with being the first wiki ("WikiWikiWeb," n.d.). "The term 'wiki' comes from the Hawaiian word "wee kee wee kee" which means, "fast" (Shu &

Yu-Hao, 2011). As the Hawaiian name implies, wikis are quickly and easily modified; they are transitory. Wikis allow multiple people to make changes instantaneously.

Wikipedia, established in 2001, is the most widely used wiki (Rand, 2010). According to Rand, the English version of Wikipedia receives 8,291,487 views per hour, which equals nearly 200 million views per day—in English alone. Any registered user can revise Wikipedia (Rand, 2010). Due to the openness of revisions, Wikipedia maintains administrative oversight of these revisions. At the time of this writing, Wikipedia had active editors in 285 languages that contributed to 31,000,000 articles ("Wikipedia: About," n.d.). "Every day, hundreds of thousands of visitors from around the world collectively make tens of thousands of edits and create thousands of new articles to augment the knowledge held by the Wikipedia encyclopedia" ("Wikipedia: About," n.d., para. 4). The English edition is the largest with 4,641,658 articles ("Wikipedia: About," n.d.). "Wikipedia is among the most prolific collaborative authoring projects ever sustained in an online environment" (Bryant, Forte, & Bruckman, 2005, p. 1).

Wikipedia's accessibility (Bryant, Forte, & Bruckman, 2005) makes it easy for the 23,051,284 registered users of the English version ("Wikipedia: About", n.d.) to edit and contribute new information. Unlike printed encyclopedias, authors do not have to worry about size constraints (Rand, 2010). Rainie and Tancer (2007) contended that Americans' reliance on search engines and the prevalence of Wikipedia sources on those search engines, have contributed to the growth and popularity of Wikipedia. Google's algorithm is interested in the number of links a site has. The vast number of links within Wikipedia, which also links readers to other Wikipedia articles, is a contributing factor for its popularity in search engines (Rainie & Tancer, 2007).

- **Snapchat:** App users have become interested in a type of social media that claims to erase their digital communication within a timeframe they specify. What was available a few seconds ago (10 seconds is the maximum amount of time that Snapchat postings can be viewed) has now vanished ("Support," n.d.). Snapchat has 100 million monthly active users who send over 700 million Snaps and view over 1 billion Stories per day (Wong, 2014). These numbers have doubled since the third quarter of 2013 when 350 million Snaps were sent (Duggan, 2013). MacMillan (2013) reported that rival apps are available in China and Japan. There is fascination with digital communication that disappears as soon as it is viewed. Users appear to value the transitory nature of digital communication.
- **Online News:** Online news has entered the transitory arena, although it did not begin this way. Originally, it was much like print news with the exception that it was online (Karlsson, 2012). Online and offline news were comparably static. In his examination of online media, Karlsson found that this is no longer true of all online news sources. He stated, "Online news has the ability to rework or delete incorrect stories or facts swiftly and without notice" (Karlsson, 2012, p. 390). Karlsson studied four different Swedish news sites. He monitored 15 stories on these sites for a period of three months. He manually captured what the sites published every 10 minutes. He continued to watch a story until that it had not been updated for three hours. He then revisited the story three more times over the next 24 hours to see if any additional changes had occurred. While Karlsson's work focused on Swedish news sites, which are subsidized and therefore may have the resources to revise more frequently than others, this work demonstrates the transitory nature of digital news. He found that not only were the online articles changing via internal updates but also external updates. Three of the four sites encouraged citizen journalism by asking viewers to send in pictures,

videos, and other information. He found news reports were updated between three to nine times with stories commonly updated eight times.

- **Video Production:** If we purchase a DVD, we know that the movie we purchased will be the same each time we play it. However, digital video files can be manipulated quite easily. In his book *Rewire,* Zuckerman (2013) gave the example of the film *Desert Warrior* created by Sam Bacile in the summer of 2011. The script was poorly written and ridiculed by the actors. When the trailer was published on YouTube in 2012, the actors' lines had been overdubbed and the title had been changed to *The Innocence of Muslims*. At this point, it became clear why the filmmaker was indifferent to the quality of the script. He had a different agenda. "The actors now delivered lines about the Prophet Muhammad, portraying the Prophet as a sex-obsessed, violent pedophile" (Zuckerman, 2013, p. 31). According to one of the actors, Tim Dax, those who were hired for their roles thought they were starring in a film about ancient warriors. Dax thought he was hired to play the role of the Biblical character, Samson (Gould, 2012). Unbeknownst to the actors, the director re-created the film for his own purposes. The transitory nature of digital video surprised the actors but fulfilled the purposes of the filmmaker.

Summary

In this section, we explored digital communication in terms of the following characteristics: product/ion-oriented, semiotic, public, and transitory. We highlighted exemplars for each characteristic (see Table 1). We want to point out that these exemplars, while used to illustrate specific characteristics, in reality exemplify multiple characteristics. For example, while Facebook mitigates challenges to production it is simultaneously semiotic, public, and transitory. While Wikipedia mitigates challenges to revising encyclopedia entries (transitory) it is simultaneously product/ion-oriented, semiotic, and a perfect example of collective intelligence (public). In a sense, the fact that these exemplars can be used to illustrate multiple characteristics reiterates our point: digital communication is product/ion-oriented, semiotic, public, and transitory.

Table 1. Exemplars used to illustrate characteristics of digital communication

Production Exemplars	• Blogs • Facebook • Twitter • eBooks
Semiotic Exemplars	• Podcasts • Pinterest • YouTube • Vine • Surveillance cameras • Google Glass
Public Exemplars	• Citizen journalism • MMOGs • MOOCs • Arab Spring
Transitory Exemplars	• Wikipedia • Snapchat • Online news • Video production

CURRENT ISSUES

A range of issues emerges in a world with blogs, eBooks, podcasts, Pinterest, YouTube, Vine, Google Glass, surveillance cameras, collective intelligence, wikis, Snapchat, and ubiquitous video production. It is argued that digital communication, while being democratized is simultaneously being monopolized. In addition, there are issues related to access, the persistence of the Spiral of Silence, ethical violations and safety, the ethereal being captured while privacy is compromised, and the preparedness of education.

Democratization and Monopolization of Communication

It has been argued that digital media fosters the democratization of communication (Boler, 2010; Howard & Hussain, 2011). The ability to capture the ethereal, record previously fleeting moments of conversations and actions, and produce a message that no longer requires gatekeeper approval for dissemination, is lauded as providing voice to the masses. The aforementioned discussions of citizen journalism, self-publishing, YouTube, FaceBook, Twitter, Google Glass, MMOGs, MMOCs, Arab Spring, and Wikipedia all lend themselves to the democratization of communication. The bottleneck, formerly held by gatekeepers who maintained access to audience, has been opened. Anyone with an Internet-ready digital device can *produce* a *semiotic* message and make it available to the *public*.

There are, however, indications that the democratization of communication is in peril. There is concern that the masses rely too heavily on a few providers (Greenwald, 2014). Currently, Facebook with 1.2 billion active users, Twitter with 300 million active users (comparable to the U.S. population), Google with 3.5 billion searches each day, and YouTube with over 4.2 billion video streams each day (YouTube Statistics), outpace their rivals. Given limited conduits for digital communication raises serious issues. While the popular providers of digital communication will come and go, concern for the monopolization of communication remains anytime few providers control access to digital communication. "We are nearing the point where an idea banished by Twitter, Facebook, and Google all but vanishes from public discourse entirely" (Greenwald, 2014). McChesney (2013) argued that capitalism is turning the Internet against democracy and noted, "that what is emerging veers toward a classic definition of fascism: the state and large corporations working hand in hand to promote corporate interests, and a state preoccupied with militarism, secrecy, propaganda, and surveillance" (p. 171).

Access to Digital Communication

The monopolization of communication raises issues of access. For some, access is a matter of availability. For others it is an issue of government control. In terms of availability, Wang (2013) found that more people own cell phones than have access to functioning toilets. Specifically, nearly 6 billion of the estimated 7 billion people in the world have access to mobile phones while only 4.5 billion have access to properly functioning toilets. In 2014, Mobithinking reported that there were 6.9 billion mobile cellular subscriptions with broadband subscriptions expected to reach 2.3 billion in 2014 (Sanou, 2014). This data indicated that the Internet, on average, appeared to be accessible. However, government control remains a concern.

Because organizers used social media to plan the 2009 Ürümqi riots in China, the government shut down access to Facebook (Kirkland, 2014). With pressure from international businesses, in 2013, the Chinese government reopened access—but only within 17 miles of Shanghai. Since the 2009 shut down,

the Chinese government has taken an active role in monitoring online communication. The Chinese government deletes posts and blocks access to websites (Kirkland, 2014). Bradsher and Mozur (2014) pointed out that Chinese Internet censorship causes economic problems for companies that export out of China. In 2014, Google decided to encrypt users' searches. The Chinese government responded by blocking access to Google (Bradsher & Mozur, 2014). The Google blockade made it difficult for businesses to place ads and collaborate via Google Drive.

In addition to China's efforts to censor and deny access to digital communication, there are other dictatorial governments that actively monitor Internet communication, censor digital communication, shut down access to primary providers (e.g., Twitter, Facebook, and Google), and shut down Internet access (see Table 2). Nonetheless, citizens in these countries find ways to get around bans via proxy servers, virtual private networks (VPNs), and anonymous browsers (Bennett, 2014). Digital communication is so vital that citizens around the world strive to gain access.

Persistent Spiral of Silence

The Spiral of Silence (Noelle-Neumann 1974, 1993) is the phenomenon in which people do not talk about topics that are not popular or will not be well received. "A major insight into human behavior from pre-Internet era studies of communication is the tendency of people not to speak up about policy issues in public... when they believe their own point of view is not widely shared" (Hampton et al., 2014, para. 1). Hampton and colleagues wondered if Facebook and Twitter had changed the culture of talk and empowered people to speak despite the Spiral of Silence. In a survey of 1,801 adults, they found that the pre-Internet Spiral of Silence phenomenon persists in the Internet era. They asked participants if they would be willing to discuss the Snowden issue (an American computer professional who leaked classified information from the National Security Agency). Eighty-six percent of respondents said that they would discuss it in person, while only 42% said they would share information on the issue via Facebook or Twitter. The survey results indicate that one's audience, similar to the pre-digital era, influence self-censorship. According to Hampton and colleagues, "In both personal settings and online settings, people were more willing to share their views if they thought their audience agreed with them" (para. 7). For the vast majority of authors, a like-minded audience remains key to choosing whether to produce and disseminate digital communication.

In an era in which digital communication is readily available to the masses, the Spiral of Silence raises concern regarding the voices being heard. There is an issue regarding the variety of information being communicated through digital media. It also follows that, if there is not an audience for a particular viewpoint, then it may not get communicated, despite the digital tools at our disposal. Wikipedia may be an example. The English version offers more than double the selection of the next largest edition, Swedish (Wikipedia, 2014). This creates an imbalance of power, or at the very least, presence, in this digital space.

Ethics and Safety

- **Privacy Settings:** Based on the growth trajectory of social media, it appears that such services will persist into the foreseen future and remain a conduit of digital communication for millions of people. The popularity of these services raises issues of ethics and safety. Wasike (2013) explained that when information is public, there are limited guarantees of privacy. Even if the information

*Table 2. Countries that have limited access to social media**

Country	Facebook	Twitter	YouTube
Bangladesh	Government monitors for inappropriate posts. In 2010, it was shut down for an entire week.		
China	Banned except for a 17 square mile zone of Shanghai	Banned	Banned
Cuba	Internet is difficult and costly to access with slow download speeds. The only place that the Internet can be accessed is in Internet cafes.	Internet is difficult and costly to access with slow download speeds. The only place that the Internet can be accessed is in Internet cafes.	Internet is difficult and costly to access with slow download speeds. The only place that the Internet can be accessed is in Internet cafes.
Egypt	For several days in 2011, several social media sites were blocked due to the fact that people were trying to overthrow the regime of President Hosni Mubarak.	For several days in 2011, several social media sites were blocked due to the fact that people were trying to overthrow the regime of President Hosni Mubarak.	For several days in 2011, several social media sites were blocked due to the fact that people were trying to overthrow the regime of President Hosni Mubarak.
Iran	Banned except for government officials.	Banned except for government officials.	Banned
Mauritius	Blocked for a day in 2007 due to someone making a fake account pretending to be the current prime minister.		
North Korea	Banned Foreign visitors can access the Internet via a new 3G network.	Banned Foreign visitors can access the Internet via a new 3G network.	Banned Foreign visitors can access the Internet via a new 3G network.
Pakistan	Blocked for two weeks in 2010 due to blasphemous content about the prophet Muhammad. Continues to be monitored for such actions.	Allowed	In discussion with Google about the possibility of allowing it.
Syria	Blocked from 2007 to 2011 as the government feared Israeli infiltration.		
Turkey	Allowed	Allowed However, it was blocked for two weeks in March 2014 ahead of the government elections.	Banned since March 2014
Vietnam	Although, it is not banned, many people who live there state difficulty being able to get on. In 2009, it is reported that for a week no one could access the social media site. What can be said on the social media sites is limited by Decree 72, which was put into place September 2013. Prohibits news being shared on social media sites.	Allowed What can be said on the social media sites is limited by Decree 72, which was put into place September 2013. Prohibits news being shared on social media sites.	Allowed What can be said on the social media sites is limited by Decree 72, which was put into place September 2013. Prohibits news being shared on social media sites.

*Data from Bennett (2014) and Kirkland (2014)

is deleted from the author's account, the information may have been copied and shared. Thus, the information persists. Vander Veer (2008) found that 25% of social media consumers cannot locate the security settings offered by social media services and are therefore left to the mercy of default settings. Flatow (2008) found that control of privacy has limited benefits to the users by noting that too many options confuse the users who then make poor choices. For example, he describes

how consumers use their self-designated "friends" to guarantee privacy, and this can make users' information more accessible than if they are presented with fewer, but easier-to-understand options. Lenhart and Madden (2007) found that only 66% of teenagers use the privacy settings to reduce access to their profiles. Regardless of an increasing awareness of the importance of their "digital footprint," tracking personal information left behind by social media communication, only 3% of social media users check their online presence regularly (Madden, Fox, Smith, & Vitak, 2007). Acquisti and Gross (2005) found that many users have misconceptions about the privacy of their communications.

- **Cyber Bullying:** The two-edged nature of digital communication, balancing between opportunities and risks, reveals an emerging societal issue recognized as cyber bullying (Walrave & Heirman, 2011). Electronic bullying, online bullying, and cyber bullying are new means of bullying. These types of bullying are defined as harassment using technology such as social websites, email, chat rooms, mobile phone texting and cameras, picture messages, IM (instant messages), and/or blogs (Miller & Hufstedler, 2009; Beale & Hall, 2007). Studies confirmed that cyber bullying is a widespread and a serious problem. Mishna, Khoury-Kassabri, Gadalla, and Daciuk (2012) found that over 30% of students had personally experienced cyber bullying, either as victims or offenders; within a three month period, one in four (25.7%) stated that they were involved in cyber bullying as both a bully and a victim. Adams (2010) found that around 20% of students said they had been cyber bullied. Meanwhile, in a survey of 62 adolescents, Wong-Lo and Bullock (2011) found that 90% of the participants had experienced cyber bullying either as victims or as bystanders. The outcomes of cyber bullying can be serious. Brown, Jackson, and Cassidy (2006) reported indications that victims struggle with suicide, eating disorders, and in extreme cases homicide. Victims of cyber bullying can show "consequences ranging from low self-esteem, anxiety, anger, depression, school absenteeism, poor grades, an increased tendency to violate against others, to youth suicide" (p. 16). Cyber bullying "can contribute independently to psychological distress" (Mitchell, Finkelhor, Wolak, Ybarra & Turner, 2010, p. 132).
- **Identity Theft:** Reznik (2012) described two types of identity theft. The more common type happens when a perpetrator builds a fabricated profile of the victim and then uses that identity for online communications. The second type happens when the perpetrator steals a victim's password or gets access to a victim's social media account and subsequently impersonates the victim by using that account. Rainie and colleagues (2013) found that 55% of Internet users ages 18-29 have experienced at least one of these types of identity theft problems, compared with 42% of those ages 30-49, 30% of those ages 50-64 and 24% of those ages 65 and older.

Ethereal Captured While Privacy Compromised

In the not too distant past, people told strangers only basic information about themselves. But, nowadays, revealing names and place of birth as well as other information like the names of favorite books, movies, first pets, etc. is a common practice. People share this information without much concern. On social media, people share not only basic information but also narrate their lives through photos, videos and comments. This information has become fodder for such companies as Google, Microsoft, and Facebook. They use this information to create user profiles, which in turn allows them to provide personalized advertisements. Microsoft, for example, identified women with risk of postpartum depression through

mining online conversations, and Facebook studied how parents and kids interact (Jayson, 2014). What was once private has become public. What was once ethereal has been captured and distributed worldwide.

In a world where we capture and document what was once ethereal, privacy issues are not just limited to social media; video surveillance raises issues. Kelly (2013) explained that facial recognition software…

… Identifies objects by shape, size and color. It can read license plates and recognize cars. When it comes to people, it can detect their gender, approximate age, mood and other demographic information. Using multiple cameras, it can track their patterns and some behaviors. It automatically zooms in on any person's face and identifies them based on things like the distance between their eyes or the shape of their nose. (Para. 15)

When cameras with facial recognition software are linked to the same database, it becomes possible to track people. It becomes possible to single out a person who has attended multiple political protests at different places (Kelly, 2013). The ability to capture what was formerly ethereal raises issues of privacy.

Given that the ethereal can be captured and made public, the European Union has actively sought and formulated regulations known as the "Right to be Forgotten." The concept is that people have the right to control their online identities. Instead of misleading, erroneous, and negative information being replicated and persistently available online, individuals should have the right to erase such information. The primary strategy for this erasure is to eliminate information from Google searches. In other words, regulations require Google to censor its search results. It is argued that international laws of censorship sets precedent for additional forms of online censorship thus stepping over "a first amendment red line" (Scheer, 2014, para. 1). To facilitate the Right to be Forgotten, others call for the breakup of Google (Shapiro & Meyer, 2014).

Education, New Literacies, and Digital Communication

The ability to proficiently communicate with digital media is an active research agenda among the literacy research community. Leu and colleagues investigated the literacy skills required to skillfully find, synthesize, and report findings from Internet-based queries (e.g., Leu et al., in press; Leu et al., 2011). Gee and colleagues examined the literacy skills involved in gaming (e.g., Gee, 2007; 2010). Others examined the literacy skills required to proficiently communicate with various digital formats such as fan fiction (Black, 2008; Chandler-Olcott & Mahar, 2003; Thomas, 2007), multimedia (Mayer, 2008; Stein, 2008; Wyatt-Smith & Elkins, 2008), synchronous chats (Baker, Vogler & Schallert, 2014), voice recognition (Baker, 2012, 2013c, 2014), and zines (Guzzetti, 2010). There is research that examined the blurred lines between digital authors and digital audience (Baker, Rozendal, & Whitenack, 2000), ways to support comprehension of digital texts (Proctor, Dalton, Grisham, 2007), embodied literacies (Fleckenstein, 2003; Leander & Boldt, 2013; M. Miller, 2013), as well as theoretical groundwork of reading and writing with technology (Baker, 2010b; Leu & Kinzer, 2003). These and others contended that the ability to communicate with digital media requires literacies that previously did not exist. These literacies are known as New Literacies (Baker, 2010b; Coiro, Knobel, Lankshear, & Leu, 2008).

Despite significant investment in technology, schools struggle to incorporate these digital and informational literacy skills into the curriculum (Leu et al., 2013). In 2011, Hutchison and Reinking conducted a national survey of U.S. teachers to examine their perceptions of how well they support students' development of new literacies and digital communication. They found that the research being

done has had relatively little infiltration into classrooms. In an analysis of elementary classroom web sites, Baker (2007a, 2007b) found woefully lackluster opportunities for students to learn and use either traditional or new literacies and therefore proposed strategies for making a match between technologies and classrooms (Baker, 2003). Some teachers do not know how to use technology tools. Some mistake the transfer of curriculum from print to pixel as inherently equivalent (Hartman, Morsink, & Zheng, 2010). Others feel constrained by high-stakes tests that focus on traditional instead of new literacies (Hobbs, 2010). Legislation that was intended to "leave no child behind" has had the opposite effect. Those struggling to pass the high-stakes tests are required to practice for the test and therefore do not have time to learn new literacies (which are not on the test) (Baker & Dooley, 2010; Baker, Schmidt, & Whitmore, 2011; Leu, 2006).

Some may argue that students do not need to be taught how to effectively communicate with digital devices. After all, they are digital natives (Prensky, 2001) who have spent their entire lives communicating digitally. They have extensive out of school experiences with video, social networking, gaming, and texting (Alvermann, Hutchins & DeBlasio, 2012; Zickuhr, 2010). Surprisingly, research indicates that even digital natives know relatively little about digital communication (Bennet, Maton, & Kervin, 2008; Leu, 2006). Rather, K-16 students tend to be proficient communicators with the few platforms they use with their peers. This leaves them woefully unprepared for the digital communication required in the workplace (Mikulecky, 2010). Students struggle to find, critically evaluate, and read online information (Forzani & Burlingame, 2012; Graham & Metaxas, 2003; Kuiper & Volman, 2008). "Rather than seeing the web as a neutral source of 'information,' students need to be asking questions about the sources of that information, the interests of its producers and how it represents the world" (Buckingham, 2007, p. 113).

As part of the standards movement, the United States has moved from No Child Left Behind (2002) legislation to the Common Core State Standards (CCSS) which specify learning goals for the end of each K-12 grade. Several of these goals support the use of new literacies in the classroom. For example, Writing Anchor Standard 6 states, "Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others" (CCSS, 2012, p. 43). Writing Anchor Standard 8 states, "Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism" (p. 44). These CCSS require students to develop the ability to participate in complex digital communication tasks that involve multiple steps and skills that emulate the real world. These standards expect teachers to think in new ways about how to evaluate and teach students to proficiently communicate digitally (Drew, 2013; Leu et al., 2013). While these standards draw some attention to new literacies they lack specificity. It is uncertain how educational policies, curricula, and pedagogy will make the necessary shifts to prepare children to be proficient digital communicators.

METHODOLOGICAL GAPS AND FUTURE RESEARCH

Given the transitory nature of digital communication, there is a wide range of topics emerging for which relatively little is known. Instead of discussing these topical gaps, that quickly emerge and fade, in this section we focus on something more fundamental: we focus on methodological gaps. As we explored research regarding the societal impact of digital media on communication, we noted that the research methods themselves had the following gaps: timeliness, paradigm, and population.

Timeliness Gaps

Traditionally, it takes three to five years for research to be conceived, conducted, and reported in peer-reviewed journals. The impact of digital media on communication outpaces conventional research cycles. By the time research is published it may provide insights into bygone digital communications. The current process of scholarship fails to keep pace with a world in which 100 hours of video was uploaded to YouTube in the last 60 seconds (YouTube, n.d.). Each of these videos provided semiotic illuminations that impact who we are, what we favor, and how we choose to communicate in and about our world. The information we receive from research studies can be stymied by being out of date before they are published. We refer to this phenomenon as a timeliness gap.

News reporters provide up-to-date information about digital communication. Many news outlets have sections dedicated to technology. Other news outlets specialize solely in the societal impact of technology (e.g., CNET, Wired). There are daily reports of the impact of online bullying, government censorship, the use of Twitter, Facebook, YouTube, and such to influence politics and instigate revolution. While trusted news reporters research their stories, their research methods do not meet the robust criteria required by scientific research. Thus, while trusted news outlets provide timely information, they lack systematic and scientific research methods.

Paradigm Gaps

Kuhn (1970) argued that the history of science is a history of scientific paradigms that coalesce around concepts of ontology, epistemology, and methodology (Hatch, 2002). Different paradigms have "fundamentally different beliefs systems concerning how the world is ordered" (Hatch, 2002, p. 11). In this sense, Hatch described five research paradigms: positivist, postpositivist, constructivist, critical/feminist, and poststructuralist. Each paradigm defines reality differently and therefore enacts research differently. Positivists define reality in objective terms and therefore collect and analyze objective statistical data. Such data can be quickly generated and analyzed by software. Internet sites such as Pew Research, Expanded Ramblings, and KISSmetrics provide information about who, what, and how many people use various forms of digital communication. Herein, positivistic studies are poised to address the aforementioned timeliness gap. While valuable, positivistic research only one of many paradigms.

Postpositivists are described as those who view reality as complex and "due to limitations of human inquiry… [view reality as] approximated but never fully apprehended" (Hatch, 2002, p. 14). Research therefore can merely provide approximations of reality. Constructivists define reality in terms of the users. Research therefore involves labor-intensive examination of individual cognition and is commonly situated within social norms. Critical/feminists define reality in terms of power structures and focus on who is being empowered and disempowered. Such research also requires labor-intensive analysis of social norms. Finally, poststructuralists say there is no inherent reality. While positivistic and non-positivistic paradigms derive insights from both quantitative and qualitative data it is common for non-positivistic paradigms to employ qualitative research methods that require prolonged, in-situ data collection and analyses that are inordinately labor-intensive such as those used to grounded theory, conduct ethnography, case study, phenomenology, and naturalistic inquiry. Herein lies a conundrum: On one hand, research that seeks to understand the societal impact of digital media on communication is threatened by lack of timeliness; on the other hand, there is a need for the research corpus to represent a full range

of paradigmatic insights. Positivistic insights can be timely—but represent only one of many views of reality. Non-positivistic research can reveal a range of valued insights—but commonly require extensive labor-intensive work with findings that emerge over time.

Population Gaps

Another noteworthy methodological gap is *who* is represented in the research corpus. We contend that digital communication permeates digital cultures and therefore impacts users from birth to death. However, the majority of studies we found were skewed toward 18-45 year olds. While there were studies that focused on preschool and elementary children as well as adults over 45, the vast majority focused on the 18-45 year old population. A population gap creates a skewed understanding of digital communication. For example, the research corpus about MMOGs focuses on adolescent gamers and therefore creates a misconception that gamers are a youth subculture. An entire volume of the *Journal of Adolescence, Vol. 21*(1), was dedicated to the damaging effects of video games on adolescent gamers. Yee (2006) pointed out that research reiterates the stereotype that gamers are both adolescent and that gaming has damaging effects. Griffiths, Davies and Chappell (2003) noted, "the image of a typical gamer is seen as socially negative and remains firmly within a youth subculture" (p. 81). Population gaps leave us relatively uninformed of digital communication among large pools of the population.

Future Directions for Research Methodologies

Given insights into research gaps, we offer suggestions for future research. Our suggestions are limited by our own research methods. Specifically, we sought to glean research that revealed understanding of the product/ion, semiotic, public, and transitory nature of digital communication. So, while we posit that research gaps in timeliness, paradigm, and population appear to be significant, we base this on our review of research as it pertained to our framework. We recommend that both meta-analyses and metasyntheses (S. Miller, 2013; Sandelowski & Barroso, 2007) of research that investigates digital communication be conducted to dis/confirm the following recommendations we make for future directions of research methodologies.

Timeliness is currently addressed by statistical reports and trusted news outlets. As stated, statistical reports ignore insights offered by multiple paradigms and news reports lack scientific rigor. We advocate for continued statistical reports as well as concerted efforts to support non-positivistic research. Federal and foundation funding for grounded theory, ethnographies, case studies, phenomenologies, naturalistic inquiry, and other non-positivistic work is necessary if we are to ascertain an informed understanding of digital communication. Given the plethora of news reports, one such effort could be an on-going systematic content analysis of these reports that focuses on social interactions and the nature of digital cultures as well as varied non-positivistic constructs. Open access and online journals may mitigate challenges to timeliness by decreasing the time it takes to disseminate research. Population gaps need to be addressed by all research paradigms. We recommend statistical as well as qualitative analysis of all age groups. While our work indicated a population gap as it relates to age we recommend a systematic analysis of whether a range of populations related to gender, race, class, sexuality and disability, are included in the research corpus.

IMPLICATIONS AND RECOMMENDATIONS

The title of this chapter is, *The Irrevocable Alteration of Communication: A Glimpse into the Societal Impact of Digital Media.* Some may argue that digital media has had little impact on the alteration of communication. After all, communication has always had a production component (e.g., cave drawings, cuneiform, alphabets), included semiotic sign systems (e.g., body language, illustrations, photos), for an audience/the public, and been edited and revised (transitory). What is irrevocably altered? Isn't digital communication simply non-digital communication—just in digital form? At the beginning of this chapter, we stated that communication is fundamental to human existence. Linguists argue that humans communicate to satisfy physical, emotional and social needs as well as to learn about one's milieu, be creative, and convey facts (Halliday, 1977). Our exploration of the nature of digital communication reveals that the *reasons* humans communicate remain unaltered, while the *ability* to communicate appears to have been profoundly altered. A brief discussion of implications and recommendations for local and global civic engagement, commerce, education, and policy brings to light a sample of alterations in our ability to communicate.

Civic Engagement

Civic engagement is dependent on communication. To be civically engaged, local and global citizens must ascertain issues relevant to the public. Citizens engage in face-to-face conversations with their friends and neighbors, read local newspapers, and attend local city council meetings. In the past, geographic restrictions limited citizens' abilities to have these conversations with those across the state, country, and globe. In our digital world, what was once limited to local civic engagement can be instantaneously distributed and accessed regardless of geographic location. Whether by real-time interactive video feeds (e.g., Skype) or by following hashtags, digital communication mitigates challenges to geographic limitations. Hackers and skilled programmers were civically engaged in the Arab Spring regardless of their geographic location. Their participation subverted government attempts to shut down communication and facilitated open access for local protestors to organize and communicate with one another as well as with the world. The ability to *produce* a *semiotic* message that can be made *public* and instantaneously distributed worldwide has irrevocably changed how citizens engage in local and global civic action. The digital *collective* appears to be qualitatively different from previous forms of civic engagement. It will be interesting to see how the nature of digital communications continues to impact the civic engagement of citizens and in turn impact our societies.

Commerce

The *public* nature of digital communication appears to have an irrevocable impact on commerce. Consumers share evaluations of products and services. Before purchasing a toy, book, or car, consumers read previous consumers' ratings and decide whether to buy the product and from whom to make the purchase. Using smartphones, consumers scan bar codes to attain price comparisons. Is the baby food in your cart offered elsewhere at a better price? You no longer have to drive around town to find out. Just check prices from multiple merchants on your smart phone. It remains to be seen if this collective intelligence favors monopolies that can sell at cheaper prices. Some may be concerned that Amazon and Alibaba are too big. The purpose of this chapter is not to parse economic philosophies. However,

we would be remiss if we did not highlight the significant impact that digital communication is having on commerce.

In 1999, DiNucci popularized the term, Web 2.0. He argued that a paradigm shift had occurred on the Internet. Early web sites were dispensary. Users could explore retail shops and local grocery store web sites to see what was on sale. In the late 1990s this changed. Web sites became interactive. Users could respond to web sites. They could post comments. They could join social networks. In the case of wikis, they could become co-authors. In 2006, Markoff argued that the Web morphed again. Specifically, in Web 1.0 and Web 2.0 iterations, the user reads the web. In Web 3.0 iterations, the web reads the user. Cookies, algorithms, and artificial intelligence are used to personalize what users receive as they explore the Internet. Web 3.0 has implications for many areas of our lives, but we highlight it here for the implications it has for commerce. Information on the Internet is immense. Users want to find what they are looking for. Web 3.0 attempts to understand users and sift through the myriad of information online to provide them with what they seek. This includes giving users advertisements that pertain to their interests. Users are more likely to pay attention to ads that feature goods and services they want. On the other hand, Web 3.0 has implications for who is empowered to discern search results: the Web or the users? Similar to shifts in civic engagement, it will be interesting to see where commerce goes in an increasingly interconnected, digitally communicative world.

Education

Digital communication requires heightened awareness of new communication skills, demands an understanding of new pedagogies, and provides new opportunities for learners. Studies indicate that the ability to read offline has no correlation to the ability to read online (see Current Issues: Education, new literacies, and digital communication). In this chapter we discussed a range of technologies (e.g., blogs, Twitter, Facebook, YouTube). Each technology requires specialized communication skills. Each technology has specialized affordances. For example, for a parent to communicate with a child to determine if he is ready to be picked up from soccer requires an understanding of the affordances of text messaging versus email, social media, and the like. Baker (2013a) proposed that these affordances can be readily integrated into classrooms as new genres. Every teacher teaches genre (e.g., Baker & Monte-Sano, 2012; Baker & Shanahan, 2012). Every teacher can teach new genres. There are new communication skills required to proficiently read digital texts as well as compose digital texts. Too often, it is assumed that digital natives will pick up on these skills. Yet, we do not make this assumption regarding print natives. Why would we make this assumption about digital literacies? Policymakers, principals, parents, teachers, and the public need to be made aware of the need to teach K-16 students how to effectively communicate in our digital world. We recommend a heightened awareness of this need. Otherwise, we are in danger of preparing our children for the 1950s instead of the 2050s (Baker, Pearson, Rozendal, 2010).

Similarly, there are new pedagogies. There is a need to recognize that classrooms that integrate technology as well as online education are not merely digitized versions of traditional classrooms. There is a need to recognize the existence and harness the affordances of new pedagogies. We recommend extensive support for teachers. In his seminal sociological study of teachers, Lortie (1975) found that teachers teach the way they were taught. In other words, pedagogy is a social practice. Teachers emulate those who taught them. Herein lies the dilemma: the pedagogies of yesteryear are insufficient for today. Concerted efforts must be made to heighten awareness as well as support teachers as they prepare children to be active citizens who can effectively compete in a global, digital market. We recommend

that professional development, advanced degrees, pedagogical coaching, any and every innovative and effective support be given to teachers as they face this exciting and challenging time. High stakes tests appear to exacerbate this effort by threatening teachers who neglect to teach to the test (Baker & Dooley, 2010; Baker & Pacheco, 2011; Baker, Schmidt, & Whitmore, 2011). We recommend professional support as teachers surmount and master these cultural shifts.

Meanwhile, digital communication is opening doors previously unavailable educational opportunities. MOOCs, online universities and university courses, as well as online K-12 schools and K-12 courses are increasingly available. Students are no longer limited by their inabilities to travel to schools, pay for schools, or find time for schools. Education is available to those with Internet access, MOOCs and a myriad of educational information are available for free (e.g., Khan Academy), and many are asynchronous which allows students to participate at times that fit their family and work schedules. Critics warn that MOOCs simply disseminate information, which should not be confused with an education and are driven by profit not pedagogy (Mazoue, 2013; Rees, 2013). It remains to be seen whether MOOCs and other online K-12 courses are forces for democratization or economic exploitation.

Policy

We advocate for policies that support digital communication. This includes continued efforts to protect users from online exploitation. Identity theft, privacy, and cyber bullying are just a few examples of the need for policies that keep online users safe. In addition, we advocate for access. At the time of this writing, net neutrality and corresponding policies are being debated. While these policies are politicized, we advocate for policies that protect access. Digital communication is central to civic engagement, commerce, education, entertainment and more. Policies should support efforts to communicate. Finally, policies need to support research. Funding for multiple paradigms that investigate digital communication among a broad spectrum of the population in a timely fashion is needed.

FINAL THOUGHTS

This chapter provided a glimpse into the impact of digital media on society, specifically digital communication. We framed this glimpse in terms of four characteristics of digital communication: product/ion, semiotic, public, and transitory. To explicate the nature of digital communication we highlighted a few exemplars of each characteristic. These exemplars included blogs, Facebook, Twitter, eBooks, podcasts, Pinterest, YouTube, Vine, surveillance cameras, Google Glass, citizen journalism, MMOGs, MOOCs, Arab Spring, wikis, Snapchat, online news, and video production. We discussed issues related to the democratization and monopolization of communication, who has access, the persistent Spiral of Silence, privacy, cyber bullying, identity theft, the ethereal being captured, as well as education and new literacies. We explored methodological gaps in the research corpus and made recommendations regarding the need for timeliness, support for a comprehensive span of research paradigms, and representation of a full range of populations. Finally, we discussed implications and recommendations for civic engagement, commerce, education, and policy.

Our attempt to understand the nature of digital communication was ambitious. This chapter is characterized as a mere glimpse. Given the breakneck pace by which varied instantiations of communication

technologies rise and fall, this glimpse will quickly become an historical record--a snapshot in time. The impact of digital communication on society is evolutionary. It is our hope that this chapter, in concert with this volume, contributes to the national and international dialog that seeks to understand the impact of digital media on society.

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KEY TERMS AND DEFINITIONS

Collective Intelligence: Collective intelligence is the phenomenon that emerges when large pools of individuals share, collaborate, and compete thus formulating intelligence that was unattainable by individuals. Examples include collective political action, collective funding, collective medicine, and collective reviews.

Ethereal Captured: Ethereal captured is the phenomenon whereby conversations, actions, and settings that lack substance are electronically captured. When the ethereal is captured, what lacked substance (e.g. conversations, actions, settings) is instantiated and becomes available for replay and dissemination.

New Genres: New genres refer to categories of digital communication that provide unique affordances. Examples include text messages, email, and social networks. Text messages have communication affordances dissimilar to email or social networks.

New Literacies: New literacies refer to the abilities needed to communicate with digital media in ways that were non-existent in a pre-digital era. Examples include the abilities to find online information, use hyperlinks, and compose multimedia texts.

New Pedagogies: New pedagogies refer to the abilities needed to teach with digital media in ways that were impractical or non-existent in a pre-digital era. Focus is placed on the affordances of technology to support learning that were impractical or non-existent in pre-digital era. Examples include using social media to foster the development of a community of learners, asynchronous conversations with a worldwide group of learners and experts to forge collective intelligence, and situating learners in authentic settings via virtual reality.

Spiral of Silence: Spiral of Silence is the phenomenon in which people do not talk about topics that are perceived as unpopular or anticipated to be ill received.

Transitory: Transitory is the characteristic of being fleeting, temporary; something that lasts a short time.

Verbocentric: Verbocentric refers to phenomena that are dominated by words. Examples include oral language and alphabetic print media.

Web 3.0: Term coined in 2006 by John Markoff of the *New York Times* to characterize a paradigm shift in the evolution of the Web from dispensary (Web 1.0) to interactive (Web 2.0) to reciprocal (Web 3.0) whereby instead of users reading the Web, as done with Web 1.0 and 2.0, the Web also reads the users. Examples include cookies, algorithms, and artificial intelligence that personalizes what users receive as they explore the Internet.

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Chapter 66
Media Literacy Organizations

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ABSTRACT

Media Literacy is reckoned as an integral part of learning innovations in modern day technology enabled learning domains. In order to facilitate the information handling and interaction procedures, essence of media literacy cannot be underestimated. Many Organizations and institutions in different setups play a significant role in inculcating media literacy among the citizens of a nation. These organizations are carrying out initiatives for facilitating critical thinking, awareness about different media setups to different stakeholders in both real and virtual environments. They provide user-friendly tools for facilitating educators, researchers, policy makers, young media makers, and students to find the information they are looking for in a timely and organized manner. This chapter attempts to explore, identify and analyze various such organizations that facilitate media literacy in different settings.

INTRODUCTION

Media education is a quest for meaning. Much of the value of a quest lies in the search itself as well as in the achievement of the goal. — Chris Worsnop

The current digital age witnesses a paradigm shift in information and communication technology (ICT) giving rise to an innovative practice of literacy termed as computer literacy or web literacy (Livingstone, 2004). According to Kellner and Share (as cited in Gainer, 2010), most of the information is obtained from highly fashioned audio visuals and media layouts. People today usually prefer to retrieve electronic

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information over the traditional print sources. Keeping the shift in mind, it is just inadequate to educate students to read and write only with letters and numbers. Students and citizens need to be well aware about the growing technologies and media so that they can effectively access, scrutinize, evaluate and create media messages of all kinds. It has also become equally important for an individual to possess the necessary skills to handle different types of media available (Media Literacy Project, 2014). Media literacy as a discipline includes the critical thinking skills and offers a variety of methods and styles for the efficient scrutiny of media messages enclosed in any media presentation. It is defined by Dutch Culture Council (2005) as "the whole of knowledge, skills and attitudes that allow citizens to deal with a complex, changing and mediatised world in a conscious and critical manner. It is the ability to use media in an active and creative manner, aimed at social participation". Media literacy enables students to develop a critical understanding of the nature of mass media, the tools used by them, and the impact of these tools. More specifically, it is education helps students to know how the media work, how they can produce meaning to the media and how they can organize and construct. Media literacy also aims to provide students with the skills to create new media products.

The prime objective of media literacy is to address the indiscriminate use of the media. In order to become media literate, users ought to take responsibility to know the programming they use. It does not only involve practical skills, but it also involves media awareness from practice, insights in the mechanisms of commercial communication and the media industry, critical information and strategic skills, and sensible and safe use of media. At present, utmost information is received through the complex combination of text, pictures, and sounds. Media literate individuals are better able to comprehend the complex messages from the digital media. Many educators are of the view that media literacy is an operative and engaging way to apply critical thinking skills to an inclusive range of concerns. To strengthen the public interest to improve socio-political conditions, people need to be media literates. Media literacy empowers people to participate actively in open discussions and deliberations to affect change, and to fulfil their rights and obligations (Martinsson, 2009). It brings the world into the classroom, giving proximity and applicability to traditional subjects such as History, Politics, Health, Psychology and the Creative Arts, making it as a perfect bond for subject amalgamation and interdisciplinary studies. It also embodies and furthers current pedagogies, which stresses student-centered learning, the acknowledgement of multiple intelligences, and the investigation and management – rather than just the simple storage – of information. Media create a mutual environment and hence acts as catalysts for smooth learning. The literacy further boosts users to use multimedia tools innovatively, a strategy that contributes to "understanding by doing" and prepares them for a workforce that progressively demands the use of stylish forms of communication (Valerie, 2014). The concept of Media literacy is widening and becoming more complex as new media are being developed. This means that media literacy is not mere easy task to master the skills and become literate all at once, but it is a part of lifelong learning. Hence, media literacy is of primary significance for all age categories, although it is certainly true that "learn young, learn fair" applies as always. Media literacy as stated by Thoman (1995) comprises of three stages. First stage is the stage of becoming conscious of how much media individuals are learning on daily basis. In the second stage, unique skills required for critical viewing, analysing and questioning what is in media are identified. And in the last stage an individual becomes aware about who produces media, their purpose and media advantages and disadvantages.

BACKGROUND

Literacy is usually referred to as an ability to read and write and just like that media literacy refers to the capability of an individual to access, scrutinize, evaluate and create media messages of all kinds. Today, most of the information needed is retrieved through interlaced system of media technologies. Traditional media is rapidly transmuting into Digital media and is accessible to most of the modern learners. This change is extraordinarily broad and so is its impact. The impact of this change is very extensive, but for now focus is on the learner's response to the media they use. It has become important for an individual in 21st century to possess the necessary skills to read many types of media available [Media Literacy Project, 2014; United Nations Alliance of Civilizations (UNAOC), 2014]. Media literacy is having an intense influence on the behavior of a user, the way in which he passes his time, process information, and ponders about world. Surely, interactive technology adds to the excellence to the standard of users' lives (meanwhile, on the other hand, privacy and computer interruption have emerged as severe apprehensions). Undeniably, the Media literacy is redefining almost every sphere of professional development of user's life (Fixmer, 1999).

Information literacy, the concept originally conceptualized in 1970s (Bundy, 2004), nowadays is frequently used to define the proficiency of an individual to communicate and interact efficiently in the digital environment. Lot of discussions and debates have taken place as to know whether the term is appropriate enough to describe the skills required by the citizen of the information society. It is however evident that assorted literacies are required in order to use the web based technologies, communication media and traditional sources of information. Predominantly information literacy can be used to define the skills and proficiency required by an individual to use information and communication technologies effectively and efficiently (Wallis, 2005). Ability of an individual to access, comprehend and generate communication in assorted contexts is termed as media literacy. The term being in use for at least a quarter of a century is still in a state of muddle and disagreement about its appropriate explanation. The similarity between the concept of print literacy and media literacy raises number of questions about the learning and interpreting media and so on (Buckingham et al., 2005). Earlier literacy actually just means to be able to read and write with the aid of the media form of the day, whatever that would be. Consuming and constructing words through just reading and writing was taken to be sufficient for the centuries. But now this tech-society has numerous new, easy to use and inexpensive tools and technologies and an individual needs to be familiar with novel forms of media as well as texts counting sound, graphics and moving images. All this changed the nature of literacy as well, as now expression has made a swing from sternly individual to social, kinds of communication. Traditional articles remain indispensably significant, but they now co-exist with innovative media within the framework of a "social web," regularly referred to as Web 2.0, which permits collaborative narrative construction and publication through blogs and services like Myspace, Google Docs, and YouTube (Ohler, 2009). The outlook of the society about mass media began to take a new shape from the earlier set definition of media and entertainment as "the culture of reforming and remodeling human personality along the lines enacted by technological domination" (Aronowitz and Giroux, 1991) and thus needed to be loathed, dreaded, and banned. With the passage of time educators began to feel that we should come over the prejudice thinking that print is the only actual medium to what we should stick to. The whole new generation of educators came up with the fact that television and multimedia should be recognized as a novel form of expression, communication and education but also explored practical ways to promote serious inquiry and analysis—in higher education. Educators in many fields of study are eager to find pedagogical tools that help their

students engage in conversations about media, popular culture, and digital communication technology as a means to guide their learning. Gathering of members of media literacy education community in the year 2009 at Detroit, Michigan came up with a clear picture of progress in building the communication, creativeness, cooperation and critical intellectual skills of children, youth and adults in relationship to mass media and emerging technologies (Hobbs & Jensen, 2009). In this age, everybody needs to be media literate to some extent. If not full-fledged, then at least an individual should be aware of the basic skills. Depending on the purpose and usage of media by an individual, he/she needs to develop the skills and become media literate. Media literacy is not just intellectual thing and rational matter: it involves emotive reaction, amusement and ethnic gratitude. It is far more than merely a matter of learning to safeguard oneself from things that are seen as being in some way immoral or destructive. Upcoming research needs to embrace an extensive, non-reductionist attitude to study media literacy in practice (Buckingham et al., 2005). Media literacy is not just a single concept of literacy. It is indeed amalgamation of various form of literacy, which are information literacy, visual literacy, documentary literacy, innovative media literacies, and mass media literacy. The idea of media literacy is growing its importance day by day and among others UNESCO and the European Commission have systematized research and called upon national government to include media literacy in their policies. Pretty good number of European governments have already acted on this, variety of projects are approved within the field, but there is still lot more to do. Authors and experts are of the view that it is the job of the library personnel to improve the media proficiencies and skills of school children, adults and other citizens. This a tough challenge for libraries in an age where patrons are switching from the library and encyclopedia to web resources (Nijboer, Hammelburg, 2010). Users prefer to use web sources of information over the traditional ones because of its fast and easy accessibility whereas the reliability of the information seems to be of less concern. The searchers are not usually aware of many breaches in their media literacy aptitudes. Many a time's students do not have any idea how to evaluate the retrieved documents and select the relevant ones for the assignments (Dirkx et al., 2006). Educators needs to be competent enough to make use of media as a whole and for that libraries need to take a position by actively seeking cooperation with educational field and with media producers.

MEDIA LITERACY ORGANIZATONS

Massive amount of literature has been published highlighting the significance of Media Literacy in the current digital information driven age. It is divulged from the available literature that a number of organizations and institutions have come up with Media Literacy as a part of their academic curricula and have furnished interactive platforms including a plethora of Digital Literacy resources on the web to enhance the media literacy among its users. Some of the organizations that cover the same domain has been discussed are as:

1. **Media Education Foundation (**http://www.mediaed.org/**):** The Media Education Foundation (MEF) is a non-profit organization which produces various educational resources (documentary films, transcripts, study guides, links, articles which frame the comprehensive issues of media education) and distributes the same in order to stimulate the critical thinking about social, cultural and political impact of American mass media. MEF designs its discussion guides to assist teachers and students in various issues raised in their videos and these guides mostly provide free

access to various sections like video section summaries, discussion questions, key pints, writing and research exercises, various additional resources and internet links. It has a large collection of its own films having full record in terms of transcripts which provide an easy and rapid access to text of MEF films so that those films while referencing could be properly cited. Besides, these transcripts increase the comprehensiveness of each film to its users. In Handouts & Articles section MEF provides both short handouts and in depth details of classroom use and various issues related to media education. MEF e-newsletter, a free monthly e-newsletter which includes news articles; information about special offers, new video releases, and various upcoming events; updates about media education and media reforms along with action alerts is send to the registered users of MEF. Furthermore, users can have access to the archives of past e-newsletters as well. MEF bookstore provides the collection of books authored by those scholars who have been featured in MEF videos and these books can be purchased by interested users through an online independent seller of used and new books namely Powell's Books. Since MEF is a non-profit organization, a part of this purchase gives a financial support to the foundation.

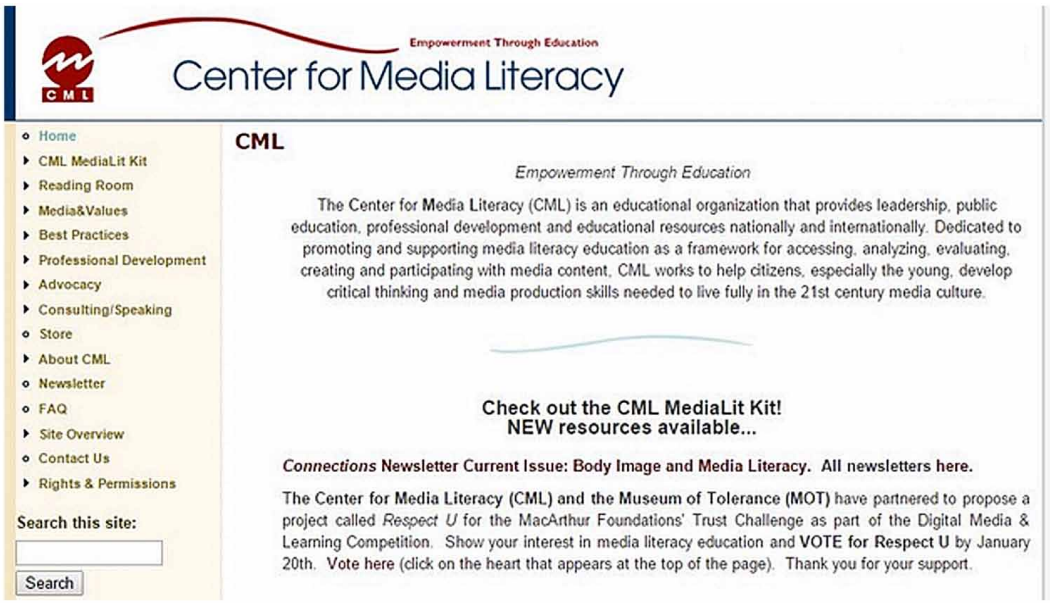
2. **Center for Media Literacy** (http://www.medialit.org/)**:** The Center for Media Literacy (CML) has been the pioneer in its field over the years. It is an educational organization providing leadership, professional development, public education and educational resources both at national and international level. CML completely dedicates its support to promote media literacy education. With this aim, it helps citizens, especially young enthusiastic people to develop critical thinking and various skills related to media culture. CML devotes itself to a vision of literacy for 21st century with a motto to help populace in this global media culture by translating research and theory of media literacy into training, practical information and educational tools. Besides, CML promotes an educational philosophy of "Empowerment through Education" which incorporates three concepts. Firstly, in present global media world, media literacy is education for life. It is the responsibility of today's families, schools and all community institutions to prepare youth for their living and learning in this global culture that is connected through multi-media. Secondly, the central point of media literacy lies within an informed inquiry which encourages and helps young and energetic people to attain an empowering set of navigational skills which includes the ability to access information, analyze and explore how messages are created, evaluate these messages, express or create one's own messages using various media tools, and take part in a global media culture. Finally, Media literacy is antonymous to political points of view and does not endorse such partisan agenda. Its power lies

Figure 1. (Source: http://www.mediaed.org/)

in its ability to encourage independent thinking and cultivate critical analysis. As long as CML propagates this educational philosophy, it is totally devoted and dedicated to media education as a very crucial and empowering life-skill for the 21st century. CML provides various consultation and training programs which include guidance, motivation and information about media literacy field, pedagogy about basics of media literacy, and specific execution of change management strategies and programs. Since its inception, CML has organized and successfully conducted more than two dozen model workshops. These workshops are meant to introduce teachers to media literacy education which encompasses its theory/pedagogy, classroom practices, various topic areas like violence in media etc. It provides an educational resource called as CML MediaLit Kit, originally formed in 2002 and updated regularly since then. The Kit provides an elementary framework for media literacy, besides having a collection of foundational resources like handouts, posters etc. that can be used in classrooms, training programs, community education etc. CML, along with the help of authors, producers or developers, originates new resource materials to meet the evolving needs of teachers and leaders in schools, community and religious agencies, etc.,. Besides, CML's work has its roots in *Media & Values* magazine which is evolved during 70's to 90's, has documented various important issues still relevant at present and now has developed to a publication with extensive editorial crafting as an educational resource. It reflects the early days of media literacy, besides providing a foundation for national movement in United States. Reading room, an important facility provided by the foundation, is an online reference center which provides access to core research works, background articles, and reports along with historical archive which documents media literacy development in United States. Monthly newsletter is issued by the Consortium of Media Literacy offering research highlights, teaching tips, current events and MediaLit.

3. **Media Literacy Project** (http://medialiteracyproject.org/)**:** The foundation for this nationally recognized project, Media Literacy Project (MLP), was laid in 1993 by Deirdre Downs. Since then, the

Figure 2. (Source: http://www.medialit.org/)



project has been housed by Albuquerque Academy. MLP is known to deliver a number of robust multimedia presentations at various workshops, conferences, symposiums, and classrooms all over the country. The project is working on the mission to transform society into critical media users, inform media policy, as well as create such media which reveal their lived experiences through various education programs and campaigns. MLP delivers media literacy training programs to their users across the New Mexico and the U.S. and these programs are customized according to the needs of users and include up-to-date and related media examples like music video clips, commercials, TV shows, photographs, movie, audio etc. It may include any area of media literacy from a single presentation on minimum 45-minutes to multi-day literacy trainings. MLP which is a non-profit body advances media education and advocacy for media justice. It manages its own pressroom where latest news regarding the recent advances in media literacy are updated at regular intervals. Besides, it keeps a track of local and national press coverage of their work and maintains its own blog as well.Youth for Media Justice (Y4MJ) is a new program that has been recently launched by MLP considering the interest of young people in Albuquerque under age group of 15 to 21 who are willing to work on media justice and media policy issues.

4. **MEDIA SMARTS (**http://mediasmarts.ca/**):** MediaSmarts, formerly recognized as Media Awareness Network, is a Canadian non-profit charitable organization showing award-winning performance from over 15 years for producing digital and media literacy resources and programs. The organization was the result of a TV violence initiative launched in early 1990s by Canadian Radio-Television and Telecommunication Commission (CRTC). It then began its journey in 1994 under the auspices of the National Film Board of Canada and then in 1996, it became an autonomous body. It works with the vision that the youth develop critical thinking skills to get involved with media as informed and dynamic digital citizens. In order to achieve this goal, they have developed a high quality of digital and media literacy resources, besides inculcating leadership in developing digital and media literacy in Canadian homes, schools and communities since 1996. The work of MediaSmarts falls into following three main areas; Education, Public Awareness, and Research and Policy. MediaSmarts has a collection of K-12 resources covering a comprehensive range of traditional media issues and

Figure 3. (Source: http://medialiteracyproject.org/)

addressing various unique issues arising for digital media as well. Most of the educational resources are freely available on the website of MediaSmarts which include classroom lesson plans, along with work sheets, tip sheets and essays multimedia games and quizzes, etc. Other than the free resources, MediaSmarts also license professional development workshops for teachers and librarians along with interactive modules for students. MediaSmarts makes it possible to increase awareness about the importance of media literacy among youth and children. In order to achieve this goal, they have developed extensive awareness campaigns and online resources for parents and people who work with these children and youth. 'Media Literacy Week' is one of the main awareness event that is being held annually by MediaSmarts in collaboration with the Canadian Teachers' Federation so that Canadian people can be more involved in media literacy activities all over the country. Above and beyond, there are various research and policy programs run by MediaSmarts. Young Canadians in a Wired World (YCWW) is an ongoing research program initiated in 2000. YCWW is Canada's largest and most comprehensive study about the internet use among young generation. Besides this program, MediaSmarts produce discussion papers both independently and in collaboration with other institutions as well. These discussion papers include a wide range of media issues comprising of digital literacy, privacy education, food marketing, internet governance, and online civic engagement.

5. **PROJECT LOOK SHARP (**http://www.projectlooksharp.org/**):** Project Look Sharp is a curriculum-driven media literacy initiative managed by the School of Humanities and Sciences at Ithaca College, working in collaboration with local school districts, New York State BOCES, the National Association of Media Literacy Education (NAMLE) and other national media literacy organizations. Like other organizations, this project is also designed with a view to encourage and support the integration of media literacy and critical thinking among the youth at all grade levels, as well as to evaluate the efficiency of media literacy education in schools. The project works directly with teachers and supports the staff so that they can reach students, besides helping to foster a spirit of collaboration among the educators using media literacy. It offers curriculum materials, besides advice and strategies for media literacy instruction. It acts as a link between educators and the media literacy field as well. Besides all these features, the project provides a number of profes-

Figure 4. (Source: http://mediasmarts.ca/)

sional development services for teachers, students, faculty and other professionals working with K-12 organizations. One such service is Media Literacy Summer Institute which is conducted by Project Look Sharp every year for all the educators, faculty, support staff and other professionals dealing with the students in an educational setup. It provides training in both theory and practice of media literacy, and help participants learn various applications of digital technology that can be useful in media literacy education. Another such professional development service includes Workshops and Speakers. Various large and small scale workshops and presentations are conducted on a variety of topics related to media literacy ranging from general introduction about the use of media literacy in classrooms to specific workshops having some specific themes pertinent to media literacy. Moreover, there are a number of goals and objectives for which Project Look Sharp is working ranging from promoting and supporting media literacy education at community, state and national level; providing trainings to teachers and mentoring them in media education; evaluating the effectiveness of media literacy as pedagogical approach to education; and developing a model which can be included in school curriculum at all grade levels.

CONCLUSION AND SUGGESTIONS

Media Literacy enables users to browse, access, evaluate and involve in intellectual thinking about a plethora of information they locate, retrieve and disseminate so as to make wise decisions related to the problems that they face usually regarding their information needs, health, personal, politics, religious etc. It allows persons to partake actively in open discussions and debates to affect transformation and to accomplish their rights and responsibilities. Moreover, it ensures users to achieve outlook on the

Figure 5. (Source: http://www.projectlooksharp.org/)

impact of communicating media (mainly on the Internet and digital resources) on users and culture and furnishes a platform to decipher the complex content into an easy comprehensible form. It also brings the world into a single interface thereby providing collocation and applicability to outmoded subjects such as History, Politics, Education, Health, Psychology and Creative Arts, making it as a flawless bond for subject unification and interdisciplinary studies.

Literature divulges that Media literate users attain skills to make use of digital media in an efficient way. It calls for the inclusion of media literacy skills in the academic institutions, organizations and educational standards of every country and in almost every subject. Media literacy comprises of a number of interdisciplinary knowledge beached in work in Economics, Sociology, Mass media, Communications, Biotechnology, and Information technology. Furthermore, various national and international organizations, agencies, government institutions and various centers are working in the field. Although, a number of organization are playing a pivotal role in furnishing resourceful platforms and programs for inculcating Media literacy skills among its users globally as discussed above in the chapter but there is still a long way to encompass cent percent literacy among all the individuals worldwide.

FUTURE RESEARCH DIRECTIONS

Media Literacy has led to the re-construction of meaning of literacy from traditional to new literacy thereby changing the role of media in a society. The advent of media technology calls for understanding new media and promoting the importance media literacy among researchers, educators, and policy makers. Media literacy educators must have a better understanding of the past, to understand what changes we have in present and what can be in future. It becomes necessary for educators to assist students to become best writers of media news, using variety of digital media and technological tools for self-expression, research, and education. Media literacy will surely help in addressing the issues that are central to the growing up in a world full of mass media as well as digital media. It will further enable an individual to learn how to analyze news and advertising, examining the social functions of digital tools, introduction of media tools in classes, means of entertainment and application of information media in other domains of life. With the advancement of digital media, a plethora of new media literacy skills have been witnessed and it is the need of the hour that educators should take foremost steps to inculcate these skills among the novice users so that they can use the nascent media tools in more efficient and can deepen students' reasoning, critical thinking, and communication skills. Though the concept of Media literacy is still in the budding stage but its scope has highly widened and needs to be given application in each and every sphere of life.

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KEY TERMS AND DEFINITIONS

Digital Media: Media that are encoded in a machine-readable format and can be created, viewed, distributed, modified and preserved on computers.

Information Literacy: The ability to know when there is a need for information, to be able to identify, locate, evaluate, and effectively use that information for the issue or problem at hand.

Multimedia: Content that uses a blend of diverse content forms contrasting with media that use only basic computer displays. It includes a combination of text, audio, still images, animation, video, or interactivity content forms.

Pedagogical Tools: Tools relating to teaching and education.

Social Web: Set of social relations that link people through the World Wide Web. The Social web incorporates how websites and software are designed and developed in order to support and foster social interaction.

Socio-Technical: The interaction between society's complex infrastructures and human behaviour.

Visual Literacy: The ability to interpret, negotiate, and make meaning from information presented in the form of an image.

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Chapter 67
Digital Leisure or Digital Business?
A Look at Nigerian Women Engagement with the Internet

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ABSTRACT

The fourth world conference on women in Beijing in 1995 was a springboard for women acceptance to explore various media possibilities to enhance their global visibility for societal recognition, address the negative media portrayal of women, and strengthen the gender equality struggles. Their platform for action on women and the media was to strategically increase the participation and access of women to expression and decision-making in and through the media and new technologies of communication. These declarations and strategies were clear indications and a call for creating new avenues for expression and participation for the purpose of empowering women. These plans of action and adoption of new technologies of communication must translate into relevant engagement with these technologies to be able to achieve the set goals. Engaging with technologies for leisure purposes (digital leisure) are likely to be of little significance to serious Internet activities relevant to women empowerment drive (digital business). The purpose for which women engage these new technologies should reflect issues that are in tandem with women empowerment drive. This Chapter examined what area Nigerian women are engaging the Internet. Findings showed that more Nigeria women access the Internet through mobile devices such as smartphones and tablets. Nigerian women engage the Internet for both digital leisure and digital business but they do more leisure-based Internet activities than serious activities that facilitate women empowerment (their Internet activities are more leisure oriented than business oriented) The women Internet empowerment drive can only be realised if Nigerian women up their game in digital business activities on the Internet.

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INTRODUCTION

When women accepted (at the fourth world conference on women in Beijing in 1995) to explore the use of ICTs as one of their options to enhance their global visibility for societal recognition, strategically increase the participation and access of women to expression and decision making, it was a call for serious business of engaging with new technologies for desired global impact. Are Nigerian women using ICTs for leisure or the business of women empowerment? Digital leisure oriented activities such as downloading beauty tips, latest fashion styles, latest movies; teens flirting on social network sites and virtual gaming may seem like typical behaviour in developed countries where these technologies have been appropriated in their everyday life, yet in the context of developing countries, it is seen as unusual and perhaps an anomaly in their new media practice especially when viewed from the perspective of the need to focus on more serious issues that would translate into some form of socio-political and economic advantages (Arora & Rangaswamy, 2013).

Nigerian women participation at various global fora for women attest to the fact they are not isolated from the global trends in respect of women. Nigerian Women visibility at the Beijing Conference in 1995 indicates their acceptance of the positions of the conference its platform for action on women and the media. The growing penetration of ICTs since 1998 and the formulation of Information technology Policy, which although does not reflect gender characteristics, make it necessary to explore how ICT such as the Internet manifest in the lives of women and their quest for empowerment. Wilson and Lawan (2015) notes female undergraduates in Nigeria use the Internet for various purposes but do not make inputs (which is an important activity on the Internet towards empowering others with useful information) on the Internet.

Since several Internet activities take place among Nigeria women, how relevant are these activities to women empowerment drive? Are the activities leisure-based or based on the business of women empowerment?

The Chapter examines whether Nigerian women activities on Internet is for leisure or for women empowerment. The study has the following objectives: to identify ways through which women access the Internet (Internet access platform) and to examine the activities they engage in on the Internet. The study focused on women from various walks of life (Women academicians, women working in private and public sector, self-employed/business women and full time house wives) in two Nigerian cities in North Eastern Nigeria: Yola, Adamawa State and Maiduguri Borno State in 2015. Somolu (2012) sums up the profile of women online in Nigeria, thus, predominantly young: Up to mid-40s, Undergraduate Level Education, Professional / 'White-Collar' Careers. Women professionals form an important part of actualization of the ICTs for empowerment process (a process by which women gain control over resources such as income, knowledge, information technology, skills and training, challenge the ideology of patriarchy and participate in leadership, decision-making process, enhance self-image of women, to become active in the process of change and to develop skills for enhancement (Komar, 2012) These professionals are also vital in policy and contents development as well as mobilization of younger women and housewives to adopt and make maximum use of these technologies to realise their empowerment .

Developments in Information and communication technologies (ICTs) have resulted in human engagement with these technologies for different purposes. Individuals, public and private organization and interest groups globally have embraced technologies as tools for facilitating their global impact. . These show that in modern societies, the ICTs encloses various possibilities by creating new spaces for political expression and participation; increased opportunity for a more active involvement in delibera-

tion processes within a very different interaction framework from the one that is provided by conventional media. ICTs have the potential to improve the social and economic well-being of the poor and ensuring that marginalised groups are not left out in the developments of the global information society (Schultz, 2000; Chadwick, 2006; Esteves, 2007, Gillwald, Milek & Stork, 2010, Wilson, Gapsiso & Usman, 2014). Akinpelu (2008) notes that Information and communication Technology (IT) has been promoted as an important tool in ensuring that marginalized groups, particularly women, are included in the development of the global information society. Jain (2007) notes that in this modern world, ICTs are central for women's empowerment, considering that women have traditionally been excluded from the external information sphere, because of several factors such as lack of freedom of movement or low levels of education. ICT enables women have access to the outside world. Information flows to them without any distortion or censoring. This leads to broadening of perspectives, greater understanding of their current situation and easy avenue for information exchange.

Empowerment of women in the context of knowledge societies requires developing the abilities and skills of women to gain insight into the issues affecting them and their capacity to voice their challenges. It entails developing the capacities of women to overcome social and institutional hurdles and strengthening their participation in the economic and political processes so as to realise an overall improvement in their quality of life (Jain, 2007). The Internet, in particular, has had an immense impact on the development of information society. The ultimate aim of the information society is the empowerment of all its citizens' trough access to and use of knowledge (Goulding & Spacey, 2003). The Internet has delivered useful information, such as market prices for women in small and micro-enterprises, training opportunities for women professionals, health information for women etc. case studies from developing countries such as India China, Philippines reveals that both urban and rural women despite the challenges are successfully using technologies such as the Internet towards their empowerment, marketing their products, banking and networking, expanding their business, discussing issues, finding solutions, to their personal problem and most importantly, educate themselves (Karan & Das, 2005; Nath, 2001).

The Internet has increased information access and sharing globally. Women today do not have to rely on the copy machine and the surface mail to share knowledge. They can have access to feminist library on line through the Internet, check on current developments on a full range of women empowerment issues. They can also through the Internet share messages with other women (Wilson & Gapsiso, 2012; Dillman, 1985).

The Internet enables women to be connected within a country and around the world to share resources, thus creating an environment of togetherness and do not have to depend on the commercial media, which supposedly, limited in terms of information about women projects (Smith, 1983). This shows that the Internet technology is an important tool for women and a very important alternative communication channel providing several opportunities for users. Jagboro (2004) notes that, the Internet is a rich, multilayered, complex, ever-changing textual environment. It is a "live", "dynamic", theoretically borderless with potentially endless space for the production and circulation of information .The Internet, is a mechanism for information dissemination and a medium for collaborative interaction between individuals and their computers without regards for geographic limitation of space (Singh, 2002).

Somolu, (2012) notes that using Internet to Empower women entails: Awareness-Raising; Self-expression; Knowledge-Building, Mobilising groups to transform the world, Documenting work, Sharing information and resources to and from stakeholders; Helping create media coverage for their work; Reaching potential donors; Communicating Online: E-mail; Skype – Internet Research (Search Skills, Alerts) – Internet Business Promotion Strategies: Social Networking Sites; Emailing Lists; Blogs; Websites

Another important aspect of the Internet for women empowerment is in the area of Internet for Advocacy, which involves learning to use technology (social media) to create change in their communities. Exploring the use of technology for advocacy on issues such as Women's Rights, Gender Based Violence, Girls' Education, Health) these activities are made possible through: Communicating a Message Effectively (Writing) – Documenting & Explaining Issues (Blogs) – Capturing an Event (Video, Photos, Text) – Illustrating the Issues (Images) – Coordinating Communities (Social Networking Sites) (Somolu, 2012). One of the most powerful applications of the Internet and other ICTs in the domain of knowledge networking is electronic commerce. Electronic commerce besides the being the business of selling of products and services online, has the advantage of linking producers and traders directly to markets at national, regional and even global levels, allowing them to restructure their economic activities reflect global standard (Jain, 2007) These Internet-based activities contribute to women empowerment business globally and made possible through a nation´s Internet penetration, access and relevant uses status.

The penetration of the Internet technology in Nigeria in the last ten years has placed it as one of the leading nations in Africa in terms of access. Ventures Africa in December, 2014 report, noted that Internet penetration in Africa has been gathering pace over the last half-decade and Nigeria leads the African continent in Internet usage which is driven by inexpensive mobile phone broadband connection. The growth of telecommunication industry has made Internet services cheap and handy to most Nigerians. Telecommunication companies in Nigeria now compete among themselves to provide affordable Internet services alongside other services. This has made it possible for Nigerians to access their Internet via their mobile phones. Studies and reports in recent times have indicated that Internet usage is now driven primarily by mobile phones, (Wilson & Gapsiso, 2009; *Vanguard,* 2010; Aderibigbe, 2014). The Nigerian government recognizes ICTs as tools for empowering women and girls and has put in place policy frameworks to ensure that gender issues move from the side-lines of policy and decision-making and are placed amongst the priorities so that ICTs provide a useful avenue for the inclusion and active participation of women in development.

The possibilities or potentials encapsulated in ICTs surpass the mere access and use but largely dependent on relevant and meaningful utilization of these technologies by interest groups. Mere adoption of Information and communication technologies without a meaningful engagement with these technologies is likely not to achieve the set goals. Engaging with technologies for leisure purposes (digital leisure) are likely not to yield a result that far from the serious business of women empowerment drive (digital business). Jain (2007) notes that access to ICTs is crucial if they are to be a means for women's empowerment. It is important not only to establish physical facilities, such as Internet networks or computers, but also to ensure that these facilities are utilized appropriately.

The success of the Internet for empowerment depends largely on access and most importantly the purpose for which these technologies are used. It is only when women use the Internet appropriately that the set target can be achieved. Wilson and Gapsiso (2012) note that unless women are actively involved in the planning and usage of the new information technologies, there is the risk that ICTs will serve to reinforce rather than overcome gender inequalities. Recognising the importance of women using ICTs many projects are incorporating gender analysis to address women's access, participation and determination of how such technologies are designed and deployed.

There is a serious gender gap in Internet access and usage especially in developing countries ITU report in 2013 has it that 16 percent fewer women than men use Internet in developing countries. There are currently 200 million fewer women online than men and globally, women are coming online later more slowly than men. Out of the world ´s 2.8 billion Internet users in 2013, only 1.3 billion are women

(Thisday, 2014). Somolu (2012) notes that women make up approx. 50% of Nigeria's population, but take up less than 20% of ICT activities. Somolu further notes that technology is an engine of economic development. So economic development is stunted by half of the population left out. Technology is a channel for social development. So learning and networking opportunities lost by low access and poor knowledge of uses of ICTs. There is also gap in terms of the relevance of uses. When users focus on less relevant activities on the Internet, it is considered a gap, and such activities do not usually yield a positive contribution to empowerment issues. Sometimes Internet users spend too much time on the computer chatting and playing games. This constitutes a gap in terms of Internet uses for empowerment. For example spending hours on Internet gaming may be irrelevant to economic empowerment activity of searching for possible market for a product online or looking for donors to fund women activities in some communities ..

An interesting phenomenon in the Internet utilization is digital leisure. Digital leisure entails Photoshopping of newlyweds, downloading the latest movies, music, teens flirting on social network sites and virtual gaming (Arora and Rangaswamy, 2013). The Internet has been a source of leisure before the World Wide Web; recent developments in digital technology have resulted in the unprecedented uptake of digital technology engagement as a leisure-time pursuit across the age span (Grimley, 2012). Lenhart et al, 2008). Many Internet forums have sections devoted to games and, music and funny videos; short cartoons in the form of Flash movies are also popular. Many use the Internet to access and download music, movies and other works for their enjoyment and relaxation. These activities have their positive contributions to human development but they are limited when serious issues of content creation, networking etch for women empowerment. According to Coker (2013) in many organizations, non-work-related web surfing is discouraged. This is not unconnected to its likely minimal relevance to serious issues or business of productivity.

According to Cornner (2012) there are many activities that mere waste of time in organization. Surfing the Internet or website unrelated to work is a major culprit. He noted that many employees spend time surfing non-work related websites everyday, which obviously affects productivity. Goulding and Spacey (2003) note that women spend more time playing games online than men. Men spend more time searching for news, financial information, product or service information, sell and buy stocks and shares and participate in online auction. These activities by men are serious business-related activities that lead to empowerment. For example engagement in online game could be highly time consuming and because it takes full concentration, the player is often socially isolated and completely consumed, with that, important commitments online are neglected. In such a case it is a total waste of time especially as it relates to issues of empowerment (One Cent at a Time, 2015).

As important as contributing materials online could be to Internet users Wilson and Lawan (2015) in a study on Internet access and use by female undergraduates in Nigeria revealed that 74% of the respondents do not post/contribute information/materials on the Internet. Tashiwa (2005) notes that most Internet users in the developing countries are "downloaders" and very few "upload" to the Internets. That in spite the issue of finance posing as a major challenge to Internet access and usage, female students still spend time to use the Internet, mostly for research purpose and they find the women related websites useful but a greater percentage of them do not contribute information or materials on the Internet.

The Empowerment of women as pursued by women organizations worldwide would be highly enhanced if attention is paid on younger women such as female undergraduates who have the educational capability and Internet potentials to effectively pursue the realization of the cause of women in Nigeria

and worldwide by encouraging them to go beyond mere consumption of Internet martials but to also upload useful and meaningful information to the Internet (Wilson & Lawan, 2015).

Digital leisure might be important in the aspect user relaxation but it is unproductive especially when it does not add to empowerment activities. Lavoie and Pychyl (2001) notes that many Internet users spend a reasonable amount of time on the Internet procrastinating; a modern form of cyber slacking in which an individual waste time and company resources by entertaining oneself on the Internet when one should be working on serious empowerment issues (Marron, 2000). Darbi et al (2013) research on the incidence of dysfunctional Internet usage in Ghana, found that more women are likely to use the Internet for personal email and chatting compared to men. Some most common non-productive use of the Internet which constitute some form of unproductive digital leisure activities are personal emails, chatting, game playing, chatting. Social networking leisure activities, video calls, Music Downloads, visiting porn websites, online purchases (Young & Case, 2002; Darbi et al, 2013). What areas are Nigerian women engaging the Internet and its numerous components? Are their engagements for leisure or business?

METHOD

Survey was carried out in Maiduguri Borno State and Yola Adamawa State in North Eastern Nigeria Quantitative data needed for the research was obtained through self-designed questionnaire administered to 500 women who were purposively selected. The Purposive Sampling Technique is selection based relevance of a respondent to a study, which in this case was Nigerian women that are involved in Internet activities or that use the Internet). Furthermore the purposive selection centred on women who are conversant with the Internet and engage with the Internet frequently (daily) more meaningfully (a complex activity like Internet banking, shopping, teaching and learning, uploading information materials, blogging). The study population comprised of Women academicians, women working in private and public sector, self-employed/business women and full time housewives in the two Nigerian cities irrespective of age. The categories of women are in one way or the other involved in one Internet based activity the other. A total 410 questionnaires were retrieved and were found useable. Results were collated and analysed with frequency tables and percentage.

FINDINGS

Internet Access Platform

Respondents were asked to indicate their Internet access platform (ways through which they gain access to the Internet). The result is shown in Table 1.

Table 1. Internet access platform

Platform	Numbers of Responses and Percentage
Personal Computers (Laptop and desk top)	190 (46%)
Mobile Devices (Mobile/Smart phones and Tablets)	360 (88%)

Source: field work 2015

Mobile Devices (Mobile/Smart phones and Tablets) 88% followed by the Personal Computers (Laptop and desk top) 46%. This finding shows that most of the women access the Internet via their mobile devices such as mobile/smart phones and tablets. 360 out of the 410 women use the mobile devices while 190 use personal computers. Among the 190 there are those who use the mobile devices as some respondents ticked both PC and Mobile devices as their access platforms. This finding underscores the unprecedented growth in mobile Internet among Nigerians.

Internet Activities

Using some of Arora and Rangaswamy (2013) Somolu, (2012) classifications of what makes Internet leisure activities and serious business or empowerment activities, two categories (Leisure and Serious business) were drawn with components that make up each category as shown in Table 2.

Respondents were asked to indicate their Internet activities (What activities they engage in on the Internet). The result is shown in Table 2.

Table 2 shows the various Internet activities among by the respondents. The table indicates two categories of activities: the serious business activities and the leisure activities. The table shows that 10% of the respondents use the Internet for serious business of Documenting and explaining women issues (Blogging). 45% carryout Research on the Internet on various issues (search for skills, training.12% engage the Internet for Networking with women groups. 16% of the respondents search for business/ entrepreneurial opportunities and tips. 26% search for women health tips.32% are involved in Online

Table 2. Internet activities

		Number of Responses and Percentage
Digital Business Activities	Documenting and explaining women issues (Blogging)	41 (10%)
	Research (search for skills, training, academic issues)	186 (45%)
	Networking with women groups	48 (12%)
	Searching business/entrepreneurial opportunities and tips	67 (16%)
	Searching women health tips	107 (26%)
	Online Shopping (buying and Selling of products/ services online)	133 (32%)
	Internet banking	80 (20%)
	Women mobilization (connecting with other women on issues that relates to women, Coordinating women communities)	86 (21%)
Digital Leisure Activities	Video calls/Skype	97 (23%)
	Photo shopping fashion styles	82 (20%)
	Downloading movies,	126 (31%)
	Virtual gaming	79 (19%)
	Chatting on social networking platform (Facebook, WhataApp, Blackberry Messages)	266 (65%)
	Sending Personal emails	148 (36%)
	Music Downloads	139 (34%)
	Reading Celebrity news	40 (9%)

Source: Field work, 2015

shopping, which involves activities such as buying and Selling of products/ services online. 20% are involved in Internet banking and 21% so some form of women mobilization (connecting with other women on issues that relates to women, Coordinating women communities).

For the Leisure Internet activities, the table indicates that 23% of the respondents are involved in Video calls/Skype. 20% of the respondents Photoshop fashion styles on the Internet. 31% are involved in downloading movies on the Internet.19% engage the Internet for virtual gaming activities. 65% of the respondents engage the Interne for chatting on social networking platforms such as Facebook, Whata-App and Blackberry Messenger. 36% use the Internet for personal emails. 34% engage the Internet to download music and 9% for reading and catching up on celebrity news.

This table indicates that the highest Internet activity in the two categories is the chatting on social networking platform with 65%.

Table 3 gives an idea of the two categories, which Internet activity thrives more among the respondents.

The table shows 57% of Internet activities is centred on leisure while 43% is serious business activities.

The study further found that these women face challenges such as the high cost of Internet data bundle, which limits their duration of activities on the Internet. Slow Internet service or poor Internet network is another hindrance to Internet activities. The near absence of privacy in Internet activity also hinders the Internet activities of the respondent. Other challenges are the epileptic electricity power supply and the difficulty in retrieving relevant (indigenous) materials on the Internet.

Discussion of Findings

Using the Internet for empowerment requires engaging in activities on the Internet. This study has made an effort to show that women are involved in various activities on the Internet. It is obvious that mobile Internet is continuously gaining grounds among Nigerians. 88% of the respondents access the Internet via mobile devices such as mobile/smart phones as well as tablets. This finding is in line with positions in several reports on mobile Internet in Nigeria for example Ericsson ConsumerLab reports that more than 95% of mobile broadband users in Nigeria access mobile broadband on smartphones. That 82% of mobile phone users are accessing the Internet with their devices on a daily basis (Ojabo, 2015).

Recent statistics by National Communication Commission (Nigeria´s telecommunication regulator) reveals that a number of active Internet subscribers that access the web (Global System for Mobile Communication (GSM) network rose from 63 million in February to over 83 million in February 2014 is a pointer that Nigeria has leapfrogged PC-based Internet access (Ojabo, 2015).

Similarly, Hillsberg, (2014) revealed that more women in The United States of America use smart phones and tablets to access social media. This trend illustrates how women are setting the pace in driving the migration of Internet and especially social media access from desktop to mobile and that 60% of social media time is spent in smartphones and tablet

Table 3. Overall digital business activities and digital leisure activities

Internet Activities	Total Number of Responses
Digital Business Activities	748 (43%)
Digital Leisure Activities	977 (57%)

While access remains a key factor in determining the impact of Internet in any society, Internet use is also a key. This study indicates that there are impressive Internet activities that are both serious business-based and Leisure-based, the highest concentration activity centres on leisure, which is Chatting on social networking platforms (Facebook, WhataApp and Blackberry messaging) with 65%. This finding finds expression in the stance of others in respect of women leisure and business activities on the Internet. For instance Vermeren (2015) notes that women use social media less than men for business purpose, whereas women use social media to share more personal information, revealing more about their personal lives, men in contrast, use social media for serious business activities such as to gather information they need to build influence; perform research, gather relevant contacts and ultimately increase their status. Behind every social media platform stand millions of women and they certainly seem to love their mobile phones on which they spend nothing less than ten minutes social networking through the mobile web or through apps every day. Among the Internet users, a greater percentage of women use Facebook, Tumblr, Pinterest, Snapchat, Instagram and Twitter (Vermeren, 2015).

Similarly Hillsberg (2015) note that several key studies on social media revealed that women dominate this territory. There are more women in top social media platforms and use it more often daily.

There is more of digital leisure activities than the digital business activities as seen in this study. 57% of activities by women is leisure-based. However, that is not to say that there are no serious business activities. The study shows that 43% of Internet activities are serious business activities, which is predominantly Research (search for skills, training, academic issues, women health tips etc). Some of other digital business activities include: Documenting and explaining women issues (Blogging), Networking with women groups, Searching business/entrepreneurial opportunities and tips, Online Shopping (buying and selling of products/ services online), Internet banking and mobilization (connecting with other women on issues that relates to women, coordinating women communities). In line with digital business, Lee (2011) notes that there is an unprecedented growth in consumer web companies in both user adopting and revenue, the little secret that's gone unnoticed by most is that women users are the unsung heroines behind the engaging, fastest growing and most valuable consumer Internet and e-commerce companies. Businesswomen recognize the networking power of the behind offering online newsletters, discussion board and forums. They also participate in more online social networking and sharing not only business ideas but also advertising for products and services (Wolfe, n.d, eMarketer, 2007; Fisher, 2006)

Women also take advantage of online resources. They are quick to surf the net looking for resources and connections that will help them succeed in business. There are more "women helping women" websites than sites dedicated exclusively for male self-help websites. Women in business seem to have made the connection that easy access to services and product on the Internet makes for good business (Wolfe, n.d, eMarketer, 2007; Fisher, 2006). These strides are reports from the western countries like he united states of America and countries in Europe. However, these can be achieved in developing countries like Nigeria especially considering the growth in the penetration of Internet technologies and from this study the 43% digital business activities on the Internet.

Internet for mobilization is another area the study shows women engage the Internet for digital business activities. The hashtag advocacy/activism (use of hashtag (#) to stay in the public view) is a typical example of how women can use the Internet to keep their empowerment effort in the limelight and mobilize global support. For example the hashtag Internet activity has been associated with the 2014 Chibok Girls Kidnapping, with hopes that it would help keep the story in the news and attract international attention. Millions of twits and comments flooded the Internet on this issue.

CONCLUSION

These findings suggest that women spend more time doing leisure Internet rather than focusing on the serious business of women empowerment. It would be necessary for reorientation of women on the fact that not all Internet activity drives empowerment. Some are mere a "waste" of time and resources that could be channelled to harnessed to enormous benefits of Internet in facilitating the women empowerment. The social networking that dominates the Internet activities can also be channelled to empowerment drive such as using these social networking sites for advocacy on women related issues such as maternal health issues, girl child education, promoting small scale business, promoting products and services of fellow women, mobilizing women for political participation, prompting women organization and several other empowerment drives via the social media platforms.

The place of Internet is essential to women empowerment across Africa and women participation in meaningful online participation is a critical step towards reshaping economic, political and social condition to allow for equality in opportunities. These enormous benefits of transformative power of Internet can only be harnessed if and when Nigerian women engage the Internet in doing more digital business activities than leisure activities.

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KEY TERMS AND DEFINITIONS

Digital Business Activities: Internet-based activities that yield some form of economic and other benefits that are not mere enjoyable pastime. (Skills accusation entrepreneurial skills, political mobilization, advocacy, fund raising, promotion of business etc.).

Digital Leisure Activities: Internet-based activities that does not add any economic value but for ease and relaxation or pastime enjoyable activity.

Empowerment: To give quality or abilities. The process of enhancing the capacity of individual or group to make choices and to transform those choices into desired results.

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Chapter 68
Parent–Emerging Adult Relationships in the Digital Age:
A Family Systems Theoretical Perspective

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ABSTRACT

Emerging adulthood is a period of life characterized by increased individuation and independence. For emerging adults to successfully navigate this process, many aspects of the parent-child relationship must be renegotiated, including rules and expectations related to communication. The emergence of digital communication technology has provided an added layer to this process. This chapter summarizes research related to the influence of digital technology on parent-emerging adult relations. Early findings suggest that digital influence on this stage of development is complex. This chapter employs a Family Systems perspective to offer insight into how current and historical family functioning influences choices related to the use of digital communication technology and how these choices affect the development of emerging adults. Implications for practice as well as avenues for future research are offered.

INTRODUCTION AND BACKGROUND

Emerging adulthood, the time of life between the ages of 18 and 29, is characterized by exploration and instability. The goal of this period is the development of autonomy and self-sufficiency (Arnett, 2015). Though many emerging adults navigate the journey toward adulthood successfully (Arnett, 2007), the instability that coincides with self-exploration triggers increased stress (Arnett, 2015; Asberg, Bowers, Renk, & McKinney, 2008; Peer, Hillman, & Van Hoet, 2015) and self-doubt (Peer & McAuslan, 2016) for some. Social support is critical for buffering the negative impacts during this time (Masten, Obradović, & Burt, 2006). Parents serve as primary sources of such support, particularly during the early stages of emerging adulthood when individuals are beginning the process of establishing an identity independent of their family. As emerging adults work toward individuation, they maintain emotional connections with their parents (Lee, Mazaros, & Colvin, 2009). Moreover, healthy development during this stage of

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life is intimately related to family relationships, yet change and instability in these relationships are also part of emerging adult experiences (Aquilino, 2006).

Digital technology has revolutionized the manner in which emerging adults and their parents communicate with each other (Clark, 2011). As "digital natives," emerging adults consume approximately 12 hours of digital media per day (Arnett, 2015). Cell phone usage, text messaging, and social media websites have become the preferred methods of communication among emerging adults. Digital technology has also become a main platform for communication for families and has greatly expanded the opportunities and frequency for emerging adults and their parents to communicate. Digital technology allows emerging adults and their parents to be in contact constantly and nearly instantly, wherever they may be and at any time.

Digital communication technology acts as an "electronic tether" between emerging adults and their parents (Hofer, 2008), which may impact emerging adult development and adjustment (Ramsey, Gentzler, Morey, Oberhauser, & Westerman, 2013). On the one hand, digital communication can enhance autonomy through the provision of a tool that individuals can use to efficiently gain needed support from parents, sometimes making it easier and less stressful to make important decisions. Emerging adults, for example, have reported that they rely on the support that they receive from their family through digital technology modalities (Arnett, 2015). On the other hand, this "instant access" can also serve to stifle developmental progress through overreliance on parents and in some cases through a continuation of dysfunctional family patterns via a new means. It is therefore critical to understand how evolving digital technologies influence the changing nature of parent-child relationships and how they can support and/or hinder healthy development of the emerging adult. In turn, it is also important to assess various factors related to the quality of the parent-child relationship (i.e., level and types of support provided, emotional closeness, level of conflict, and attachment patterns) and how they influence the use of digital technology to communicate (Ramsey et al., 2013).

In this chapter, I explain the potential effects of digital communication on parent-child relations during this stage of development. I use a theoretical framework, especially the Family Systems Theory (Bertalanffy, 1968; Goldenberg & Goldenberg, 1996), for understanding the impact of various aspects of family functioning on the successful integration of digital technologies into communication between parents and emerging adults. Specifically, I point to the importance of parents and children renegotiating their relationship during this period by discussing and creating new rules, expectations, and boundaries. Finally, the chapter concludes with a discussion about applications for family life education and clinical practice as well as implications and opportunities for future research based on the current research findings.

THE POTENTIAL IMPACT OF DIGITAL TECHNOLOGY ON PARENT-CHILD RELATIONS DURING EMERGING ADULTHOOD

In Western society, adulthood is highlighted by independence and self-sufficiency. Emerging adults experience a sense of feeling "in-between," as they have achieved some level of independence that differentiates them from adolescents, yet they still require emotional, material, and financial support from parents (Arnett, 2015). To successfully navigate this time of life, emerging adults must move toward self-responsibility and away from dependency upon their parents. The very nature of their relationship with their parents must evolve for this to be fully realized.

The parent-child relationship during this period moves toward a relationship based on mutual respect between two adults, rather than a relationship based on authority and control between a parent and their dependent child (Aquilino, 2006). Emerging adults and parents see each other more as humans rather than simply as a "parent" or as a "child." As the parent-emerging adult relationship changes, a renegotiation of many aspects of the relationship is required, including expectations and patterns of communication. This is a bi-directional process. Parents should respect their child's growing maturity and privacy, while the emerging adult should be respectful of their parents' responsibilities and availability for communication. While the underlying foundation of emotional support remains, the parent-child relationship should evolve into one highlighted by parental support of their child's self-sufficiency and autonomy (Aquilino, 2006). Developmentally, the critical concern for emerging adults is their ability to balance personal autonomy and connection with their parents. For parents specifically, it is vital to acknowledge and support their child's growing sense of independence while also maintaining a strong connection and open line of communication.

As the emerging adult develops more independent decision-making ability, new and a wider range of topics of conversation between parents and emerging adults arise (Arnett, 2015). For example, more open and freer conversations involve financial, career, and child-rearing matters. Parents are also able to offer "coaching" on a variety of topics. Furthermore, the technological revolution has allowed contact between emerging adults and their parents to increase dramatically and these advances have made communication accessible and affordable for most (Arnett, 2015).

Digital technology has offered not only a new avenue for communication between emerging adults and their parents but also another area up for renegotiation as independence is established. The 24-hour, instant access that digital technology allows could provide a sense of parental support for emerging adults or could be an area of conflict if boundaries are not established or enforced. Digital social media (Facebook, for example) provides potentially both positive and negative impacts for parent-child relations (Child & Westermann, 2013). The upside to digital mediums like Facebook is that they provide a convenient and easy way for family members to maintain an open line of communication. However, there is also the potential for serious conflict stemming from parental privacy intrusions and/or poor respect for personal boundaries, which could be initiated by both parent and emerging adult. Furthermore, though digital technology may benefit the relationship through the almost instant accessibility offered, some theorists believe that technology could possibly hinder the emerging adult's maturational process through the emerging adult's dependence on this instant access to their parents for decision-making purposes versus actively problem solving and making decisions on their own (Miller-Ott, Kelly, & Duran, 2014).

In their book, *The iConnected Parent,* Hofer and Moore (2010) explore in detail the process of parents remaining connected with their college-aged children while also learning to appreciate their child's emerging independence. They define "iConnected parenting" as "a culture of parents deeply involved in their children's lives, even as they approach adulthood, that uses technology of instant communication to enhance their connection" (p. 2), and they argue that this represents a new age in parenting. They state that the instant access afforded by digital communication explains why the frequency with which emerging adults and their parents communicate has risen rather dramatically in recent times. Parents, for example, believe that contact with their emerging adult is significantly greater than the contact they had had with their parents during emerging adulthood (Arnett, 2015). It is important to note that this process is bi-directional. Parents are contacting their kids more frequently and emerging adults are also contacting their parents more often. Some emerging adults contact their parents using cell phones

multiple times per day and, in some circumstances, desire even more frequent contact with their family (Chen & Katz, 2009).

Hofer and Moore (2010) contend that the instant access that cell phones and computers allow creates a closeness conflict for parents. Although emotional closeness and communication are key to emerging adult development, parents must "stay in touch while letting them (their emerging adult children) grow" (Hofer & Moore, 2010, p. 12). They believe that this has become more difficult given the instant access parents have to their children through digital technology, as this instant access provides an "electronic tether" between parent and child that could hinder emerging adult autonomy. This could also lead to potential conflict and relationship dissatisfaction for the child and/or the parent. To avert this conflict, the renegotiation of digital communication rules and expectations for both emerging adults and their parents is of critical importance. The ability to effectively negotiate digital communication likely buffers relationship issues and positively impacts an emerging adult's ability to develop a sense of independence.

DIGITAL COMMUNICATION AND PARENT-EMERGING ADULT RELATIONS USING A FAMILY SYSTEMS PERSPECTIVE

Being able to successfully communicate through digital media is a process not solely determined by the current state of the parent-child relationship. This adaptation is occurring within a dynamic family system. Relationships are evolving and adjusting given the developmental needs of individual family members involved (both the emerging adult and parents). The quality of ties and the ability/willingness to discuss and integrate digital technology into their relationship is rooted within the complexity of developmental needs, as well as the functioning of the family historically. What occurs relationally between emerging adults and their parents currently, including the use of digital means of communication, mirrors explicit/implicit rules and roles utilized within the family unit over time. Understanding communication between emerging adults and their parents within this type of framework offers significant insight into the dynamics that contribute to successful integration of digital technology into family communication patterns. It complements the interplay between the family system and society, and acknowledges the bi-directional influences among family members within the overall family system as well as sub-components within this system.

Family Systems Theory, born from General Systems Theory (Bertalanffy, 1968; Goldenberg & Goldenberg, 1996), provides a framework for understanding how families are organized and the interdependence among members of the family system. Within this framework, the focus is on relationships between family members rather than on individuals in isolation. Structurally, family systems are usually composed of a generally stable set of relationships among members who tend to function in typical ways within that specific system. Interactions among family members serve to strengthen or weaken the stability (wholeness) of the family system. Family interaction "typically follows organized, established patterns, based on the family structure; these patterns enable each person to learn what is permitted or expected of him or her as well as others in the family transactions" (Goldenberg & Goldenberg, 1996, p. 44). In other words, individuals within the system are best understood through interactions with other family members. These interactions are governed by rules, boundaries between family members, and openness to change that all serve to maintain a sense of stability within the system.

The family strives for a sense of balance, or homeostasis, per this framework. Emerging adulthood and the developmental changes associated with it can create a sense of instability within the family

system. This is due to the changing needs of the individual during this stage. Family Systems Theory is an applicable and suitable framework for exploring the multiple paths through which digital media may affect family functioning (Lanigan, 2009). Though this theory is not sufficient for exploring the characteristics of a particular technology and its influence on family relations, through the emphasis on the family unit, Family Systems Theory does provide a useful framework for exploring the process through which families discuss, and potentially integrate, digital technology into their structure and routines. Further, it explains the effects that the integration of digital media may have on the family system and the ability of the system to adapt to these changes.

Only one known study (Lanigan, Bold, & Chenoweth, 2009) has directly applied a systems perspective to the impact of technology on family life. Within their study, Lanigan et al. (2009) found that families believed that communication through a personal computer (e-mail, instant messaging, etc.) increased the sense of family connection. The authors support that using a systems perspective provides a framework for understanding how computer use influences family dynamics. However, their study does not focus solely on the emerging adult-parent relationship nor does it consider other forms of digital communication. Applying this framework to a broader range of communication technologies provides a more detailed view of family processes during emerging adulthood.

STABILITY AND CHANGE IN THE FAMILY SYSTEM

Renegotiation and other necessary steps associated with emerging adulthood impact the sense of normalcy within the family, thus disrupting the system's sense of homeostasis. According to Family Systems Theory, the family takes part in multiple processes to assure a sense of balance. Through these processes, the family rules that define relationships within the system may become activated. Adaptability becomes a crucial aspect of functioning for families. The system's ability to adapt to the developmental needs, including those related to communication, of the emerging adult will predict how satisfactory and productive relations will become. A cardinal characteristic of the family system is that it is constantly evolving while attempting to establish a new sense of balance.

In family systems terminology, the parental struggle between supporting their emerging adult and "letting go" is described as a dilemma of "morphogenesis" and "morphostasis." In other words, it is the parent-child relationship's ability to adapt and grow (morphogenesis) while simultaneously maintaining a sense of emotional support (morphostasis) that potentially creates conflict (Goldenberg & Goldenberg, 1996). The family system must be flexible and open to changes within the emerging adult and responsive to their communication needs. Families that are able to achieve and maintain stability in the midst of change are thought to be stronger (Goldenberg & Goldenberg, 1996).

Parental monitoring of digital media should be considered within this context. As emerging adults mature, parents adapt by respecting the developing autonomy of their child. Part of this adaptation is relinquishing a sense of control related to how their children use digital media and what content they consume. Although not an active part of communicating through social/digital media, expectations around parental mediation can certainly impact quality of relationships within families with emerging adults. Mediation (including viewing media with emerging adults, discussing digital media, and actively monitoring bills and content that is viewed) could aid emerging adults as they transition toward adulthood. However, it could also negatively affect the parent-child relationship if parental mediation is not negotiated and is seen as a means of control (Coyne, Padilla-Walker, & Howard, 2013; Vaterlaus,

Beckert, & Bird, 2015). Minimal research has been conducted to thoroughly explore this area, but intuitively, it makes sense that for emerging adults to attain developmental and relational success, rules and expectations related to parental mediation of digital media must be discussed. Filtered through the family systems perspective, there are various reasons why a parent would or would not mediate their child's digital media usage. According to the principle of morphogenesis (Goldenberg & Goldenberg, 1996), a family that is flexible and open to change is responsive to the growth and development of their emerging adult. However, striving for familial balance must continue. Remaining sensitive to the stability of previously established, warm relationships with their child (morphostasis), the family adapts by accepting their child's budding autonomy and having a collaborative discussion regarding digital media (morphogenesis). Parents display adaptability through their willingness to discuss the use of media, content of media, and ways in which they could assist their child, seeking feedback from their emerging adult as part of this discussion. The emerging adult gains new insight regarding the use of digital media and new rules are implemented regarding how parents may monitor and be supportive of the child's digital technology use. Thus, the family has "grown" by establishing a new way of functioning that integrates continued parental support and monitoring (morphostasis) with education, rules, and expectations that support the emerging adult's autonomy (morphogenesis). This stabilizes the family and promotes healthy parent-child relationships. A dynamic balance in the midst of change allows for this to occur.

The sheer number of digital technologies available also must be considered within the context of stability and change. As the family unit evolves, the types and number of digital technologies utilized to communicate contribute to the complexity of the parent-child relationship, potentially impacting both quality and satisfaction. Schon (2014) found that the more technologies that parents and emerging adults used to communicate the more positive the impact was on communication satisfaction and relationship satisfaction. Though the total number of technologies used by participants in the study was low (mean number of 3.49 technologies for emerging adult/mother communications and 3.11 for emerging adult/father communications), there still was modest positive impact on relationship satisfaction. Findings relating satisfaction with the number of technologies utilized suggest that part of a healthy morphogenetic process should include negotiating rules and expectations around what is discussed via digital media, when it should be discussed, and through what means it is discussed. The Media Multiplexity Theory (Haythornthwaite, 2005) is based on the idea that people with stronger emotional/social ties to others will use media more to communicate than those with weaker ties. Based on this theory, those with "stronger ties" are going to use more forms of communication (Schon, 2014). Schon's study supports healthy morphostatic functioning as it was found that "communication competence" explained a greater amount of variance for relationship satisfaction than the number of technologies utilized. Communication competence is a collective term for multiple quality factors including supportiveness, empathy, and self-disclosure (Rubin & Martin, 1994).

Families who are unable to adapt, who remain rigidly tied to old rules, and who resist change within relationship dynamics are likely to experience an inability to grow and develop effectively. An overreliance on morphostatic functioning can be attributed to various factors. Dysfunctional roles and rules within the system, trauma, substance abuse, and mental illness are examples of variables that can contribute to the system's resistance to change. Even a parent's own anxiety, real or perceived, about their child's wellness may promote an unhealthy morphostasis through the parent's unwillingness to relinquish their monitoring role (Hofer & Moore, 2010). Overly rigid or porous boundaries between parent and emerging adult may also contribute to the family's inability to negotiate rules and related expectations regarding the use of digital communication. Relationship satisfaction in the digital world may also paral-

lel parent-child relationship quality in the "real world." Gentzler, Oberhauser, Westerman, and Nadorff (2011) found that emerging adults who experienced supportive and satisfying relationships with their parents spoke to their parents more often on the phone. But satisfaction with communication through digital technology differed based on the channel of communication utilized. Emerging adults who communicated with their parents through texting, e-mail, and social networking sites actually reported higher levels of loneliness, anxious parent-child attachment patterns, and conflict with their parents. Gentzler et al. (2011) explain this finding using the Theory of Electronic Propinquity (Korzenny, 1978), which is built on the idea that individuals use electronic devices as a means to maintain closeness to others. Using this theory, the authors state that the use of the cell phone as a method of communication with parents provides the optimal balance of independence and closeness that is developmentally appropriate during emerging adulthood.

Emerging adults and their parents must also consider the method of communication when negotiating rules and expectations. Families should not force emotionally laden cell phone conversations, for example, if this is not the preferred communication method among members within the family system. As the family adapts, attention and care should be given to preferences among all members. The system must "cut the wireless cord" (Lee et al., 2009) if a particular method is not preferred. Neglecting to do so may increase conflict and impede growth of both the system and the individual members within the system.

Additionally, the connection among non-cell phone digital methods of communication, anxious attachment, and parental conflict is efficiently explained through Family Systems Theory. Given that attachment relationships are determined through early parent-child interactions, relational issues and attachment problems at the emerging adult stage represent a remnant of historical role, rule, and boundary disturbances among members of the family system. The balance within the system was likely conflicted, which provided an atmosphere in which anxious attachment patterns could develop and persist within parent-child dyads. This pattern likely remained part of the equilibrium within the system and continues to be demonstrated in a novel way as emerging adults have reported higher levels of conflict with their parents (Gentzler et al., 2011). Further, utilizing these written methods of digital communication (e-mail, texting) may offer a way for emerging adults to avoid speaking to parents with whom they have an established anxious emotional connection.

Other researchers have also evaluated the influence of digital technology on parent-emerging adult attachment relationships. Lee et al. (2009) assessed the function of cell phones for emerging adult college students and its effects on their perceived attachment relationships with their parents. Individuals who were considered to be "connected" cell phone users reported greater attachment to their parents, particularly to their mother. Factors that identified a "connected" user were those who prefer the cell phone for social interactions, use the various functions that cell phones provide regularly, view the cell phone as a necessary component of living in modern society, and feel safer having access to a cell phone. Lee et al. (2009) suggest that "connected" users may feel more attached to their mothers based on their preference for using cell phones. "Connected" users may reach out to their parents for more reasons than those who use cell phones less frequently and are less reliant on this mode of communication. Talking to parents on cell phones, in turn, increases a sense of emotional attachment to their parents, especially their mother. Similarly, Ramsey et al. (2013) found that those parent-emerging adult dyads that used cell phones for regular communication reported the highest quality of parent-child relationships. Specifically, emerging adults who had regular contact with their parents via cell phone reported greater parental support, intimacy/closeness, and relationship satisfaction. The authors suggest that this may be due to the intimacy that is created through hearing a loved one's voice versus reading a text message, e-mail, or

other similar technology. Collectively, these studies address how historical systemic functioning relates strongly to current parent-emerging adult attachment, relationship quality, and satisfaction, among other important indicators.

Digital technology also serves to maintain and strengthen current relationships between emerging adults and their parents. In a study of the relationship between the use of electronic communication technologies and parent-child attachment relationships during the transition to college, Sarigiani, Trumbell, and Camarena (2013) found that students viewed electronic communication as a way to stay in touch with their parents, ease the negative feelings associated with missing their family, and "maintain a deep parent-child bond" (p. 53). The authors believe that electronic communication is a protective factor that helps students buffer the stress associated with the college transition and promotes healthy adjustment. From a systemic perspective, electronic communication technology serves as a method for maintaining healthy morphostatic functioning. However, digital communication technology could also play a role in increasing relational conflict between emerging adults and their parents if rules and expectations are not discussed. Digital technology may serve to maintain both positive and negative relationships among members of the family system.

RULES WITHIN THE FAMILY SYSTEM

Rules are established patterns of interaction that denote expectations of family members. Miller-Ott et al. (2014) argue that communication rules allow parents and emerging adults to standardize and organize their interactional patterns while also establishing healthy boundaries. Most family rules are unstated, are learned through experience within the family unit, and govern the effectiveness of family functioning. Family rules may exist where "children do not challenge their parents" or "children do not have a voice." These rules may follow a "redundancy principle" (Jackson, 1965) whereby they are repeated over and over during the family life cycle. The emerging adult's ability to renegotiate frequency and expectations associated with digital communication may be influenced by these types of rules. If the implicit rule within the home is "the child does not have a voice," then the emerging adult may feel distressed in relation to the potential of being perceived as "challenging" their parent regarding rules of communication. In a system where family rules are based on equality and openness, this is likely not an issue.

Privacy management within families is a prime example of an embedded family rule that could potentially affect parent-emerging adult digital communication satisfaction. In a study on privacy rules and emerging adult responses to parental Facebook friend requests, Child and Westermann (2013) state that "the interior family privacy orientation is cultivated through both direct communication within the family and the occurrence of such practices among sub-groups within the family as concealing secrets from one another" (p. 49). This orientation is reported to be positively related with family functioning and satisfaction. To support this assertion, the authors reference previous work (Hawk, Keijsers, Hale, & Meeus, 2009) that reveals that the level of privacy invasion relates reciprocally with conflict among parents and young adults. Consistent with Family Systems Theory, Child and Westermann (2013) found that emerging adults who accepted Facebook friend requests, primarily from their mothers, were from families in which rules allowing for the sharing of private information between family members were already established. These individuals accepted the requests without changing any privacy rule settings within Facebook before doing so. Interpreted through a systems perspective, family rules related to the open sharing of personal/private information were ingrained in the system and allowed to occur via

digital technology means. Within family systems with a closed line of communication and/or rules that discouraged open disclosure, the invitations would likely be ignored or turned down, potentially leading to conflict among members of the system. This suggests that embedded within family rules are values related to open versus closed communication practices. This is important as it helps to explain family dynamics in relation to the decision by emerging adults to allow/establish a line of communication with their parents via social media (Child & Westermann, 2013).

BOUNDARIES WITHIN THE FAMILY SYSTEM

Family systems are composed of various subsystems that carry out numerous tasks. The parental subsystem, one of the most enduring subsystems, serves the function of raising and nurturing children and moving them toward a sense of autonomy and self-determination. An integral component of the parental subsystem is boundaries, which are "invisible lines of demarcation" (Goldenberg & Goldenberg, 1996, p. 55) that differentiate family members and establish autonomy among the separate individuals within the subsystem. As within the larger family system, boundaries within subsystems must be flexible without becoming overly porous or rigid. Thus, rules should be established that govern the boundaries within the subsystem. Boundaries are directly related to negotiations of digital communication between emerging adults and their parents. If healthy boundaries are established and maintained, emerging adults and their parents engage in patterns of communication that are supportive yet respectful. In families where boundaries are porous and/or rigid, parents may be overly involved in the emerging adult's life, stifling their journey toward independence and creating an atmosphere that is conflictual and potentially highly dysfunctional.

Digital communication technologies, most notably cell phones, produce opportunities for boundary violations among emerging adults and their parents (Miller-Ott et al., 2014). Without establishing rules for how cell phones will be utilized for communication, the temptation of instant contact may weaken boundaries or exacerbate historical boundary disturbances between emerging adults and parents. In a study of relationship satisfaction related to having cell phone rules, Miller-Ott et al. (2014) explored the symbiotic relationship between rules and boundaries within the parent-emerging adult subsystem. They found that cell phone usage is frequent between emerging adults and their parents, particularly their mothers. The authors analyzed multiple rules (examples include availability, repeated contact, and arguments over the cell phone) related to cell phone communication and found that rules between emerging adults and their mothers were associated with relationship satisfaction and feelings of closeness. Miller-Ott et al. (2014) note that rules may counterbalance relational tension associated with autonomy and closeness within the mother-emerging adult dyad. They further described that, without rules, emerging adults may avoid parent phone calls or otherwise limit their access as a part of establishing a sense of independence. From a systemic perspective, this would disrupt homeostasis within the family system. Parents may respond to this disruption by actions designed to re-establish stability within the system. Parents may engage in intrusive behaviors—including monitoring their child's cell phone usage, making calls to their child that are not welcomed, and eavesdropping on calls to exert control—all conducted, from within the system's framework, in an effort to return the system to homeostasis. However, this behavior can lead to conflict and can compromise the emerging adult's drive for independence, further emphasizing the importance of role/rule negotiation and boundary establishment/maintenance.

HISTORICAL FAMILY FUNCTIONING

Current patterns of digital communication between emerging adults and their parents likely reflect both the quality of "offline" communication patterns and historical patterns of communication. Ramsey et al. (2013) suggest that parent-emerging adult satisfaction with the utilization of communication technology for correspondence reflects the quality of other relationship factors (support, intimacy, conflict) that occur outside of the digital realm. Members of the system rely on historical/redundant rules and patterns of communication with one another instead of opening the system to the full menu of behavioral patterns available to them. This explains the mirroring effect that the literature suggests, pertaining to satisfaction with digital communication between emerging adults and their parents. To understand how they will relate in the "digital world," the rules and expectations for communication in the "real world" must be clear. Analyzing rules, roles, and positive/negative feedback loops (information about past systemic functioning being "looped" back into the system as a way of controlling the system) in face-to-face interactions is likely predictive of systemic functioning when utilizing digital technology.

It is critical to consider historical systemic functioning when gauging the quality and satisfaction of digital relationships. Multiple studies (Gentzler et al., 2011; Lee et al., 2009; Sarigiani et al., 2013) describe the relationship between aspects of digital communication and the quality of attachment relationships between emerging adults and their parents. Given that attachment patterns are representative of early parent-child interactions and considered enduring (Bowlby, 1969), understanding the quality of current systemic functioning related to digital technology within the context of historical relational quality is important. From a systems perspective, this could again reflect redundancy within the system. Even more, the structure and organization of the system must be considered. Anxious or ambivalent patterns of attachment that persist from infancy into emerging adulthood may reflect a "closed system." A closed system is one that resists change, lacks constructive feedback to its members, and struggles to adapt (Goldenberg & Goldenberg, 1996). Opposing, "open systems" are flexible and adapt to change effectively, and are marked by open, constructive communications among members of the system. Current research reveals that present digital communication satisfaction is likely influenced by systemic functioning historically (Gentzler et al., 2011; Lee et al., 2009; Sarigiani et al., 2013). Attachment relationships represent, in this context, an indicator of how the system has functioned over time. The integration of digital technology serves to exacerbate and perpetuate the nature and quality of these attachments. Thus, to fully understand satisfaction among emerging adults and their parents, it is crucial to consider the historical context within which this relationship occurs.

SOLUTIONS AND RECOMMENDATIONS

Understanding parent-emerging adult relationships in the digital age is critical. Having knowledge of how digital communication and media impacts parent-child relations deepens our awareness of how completely technology has permeated our relationships. Not only does digital communication affect the quality of parent-emerging adult relations, but it may also directly and/or indirectly influence healthy psychological adjustment, independence/autonomy, and identity formation during this time of life. Although there remains a paucity of research devoted to this area of inquiry, the research that has been conducted speaks to the multifaceted ways that digital communication technology can influence parent-child relationship quality and satisfaction during emerging adulthood. This is not a linear relationship.

Satisfaction with digital communication relates to means of communication, current and historical family system functioning, parent-child roles within the family system, and expectations/rules for when contact can be made and what can be discussed, among other influential factors. The complexity of this relationship provides multiple implications for family life educators as well as clinical mental health professionals who work with emerging adults and/or their parents.

Preventatively, family life educators should provide information for emerging adults and/or their parents regarding the multiple ways that digital technology should be discussed and negotiated. Included in this information should be rules and expectations regarding when digital technology can be used, what can be discussed through digital technology, what is the preferred type of digital technology to be used to communicate, and how to competently utilize digital technology (primarily for parents) when communicating. Providing parents with information about the developmental goals of emerging adulthood and the importance of allowing for change while maintaining the stability of close emotional ties with their child, and considering how digital communication technology may facilitate and/or hinder this process, is important.

Mental health professionals (such as individual therapists working with emerging adults and family therapists) should assess the ways that relevant digital technology may be creating and/or perpetuating parent-emerging adult conflict. Further, aiding emerging adults and/or their parents to establish functional rules and expectations around the use of technology for communication purposes may help in reducing conflict and increasing a sense of cohesiveness and support within the family system. Professionals should also consider historical patterns of attachment when conceptualizing current family conflict regarding the use of digital communication technology.

For family life educators and mental health professionals, utilizing a systems perspective to conceptualize how rules, roles, boundaries, and historical functioning influence electronic communication on parent-emerging adult relations is useful. This perspective provides a framework for both understanding and explaining the nuanced ways that technology impacts the health and quality of relationships during this time. Further, it is critical for professionals to consider the implications stemming from the failure of the family system to renegotiate rules and roles, observe appropriate boundaries, and adapt to the use of digital technology effectively. The inability to adapt places the family at risk for entropy (Goldenberg & Goldenberg, 1996), which is marked by systemic decay, disorganization, and disordered functioning. It increases the likelihood of conflict within the family during a critical phase of human development. This conflict, in turn, may negatively influence the developmental trajectory of the emerging adult. From a broader perspective, the inability to adapt and grow effectively may hinder the family's ability to respond to demands in times of prolonged stress and/or crisis. During this time there may be a regression toward old, ineffective rules for communication. The professional plays a vital role in preventing this regression from occurring through the use of systemic assessment/intervention and the provision of information that aids the ability for families to clarify rules, roles, and boundaries related to technological integration successfully.

FUTURE RESEARCH DIRECTIONS

Though the current base of literature on the influence of digital technology on parent-emerging adult relationships provides foundational knowledge on the topic, there are still many unanswered questions that warrant exploration. This area of scientific inquiry is still in its infancy, and further quantitative and

qualitative research is necessary to enhance our knowledge of how technology influences parent-child relations during emerging adulthood. In a review of digital media and emerging adult development, Coyne et al. (2013) note that "we know almost nothing about how emerging adults and parents use media and this represents a particularly useful area for future research" (p. 133). Emphasized here is the importance of forging new lines of inquiry exploring various aspects of the relationship between digital media and family functioning during emerging adulthood. Doing so will potentially explain differences within different family systems and subsystems, as well as address the heterogeneity that exists within our emerging adult population.

One area of future research is analyzing the role of fathers in parent-emerging adult digital communications. Having supportive relationships from both parents likely increases the emerging adult's sense of comfort and confidence as they move toward independence. The literature base suggests differential relationships among emerging adults, mothers, and fathers in relation to digital communication (Child & Westermann, 2013; Hofer & Moore, 2010; Lee et al., 2009; Miller-Ott et al., 2014; Sarigiani et al., 2013). Research suggests a more active role being played by mothers, while fathers are more passive and distant in their digital relationships with emerging adult children. Hofer and Moore (2010) strongly encourage fathers to initiate and sustain contact with their children. Further research is warranted to tease out the factors that differentiate mothers and fathers and should especially investigate the roles, rules, and history functioning within the family system that contributes to the father's place within the periphery of digital communication with their emerging adult child. From a family systems perspective, understanding family organization is pivotal for understanding interactional patterns and overall functioning. Finding the underlying historical, cultural, and systemic reasons for this difference could provide answers that bring fathers into a more active role within their child's life and, in turn, increase both relationship satisfaction and successful developmental outcomes for emerging adults.

Future research should also expand the subject base. The literature base currently relies heavily, if not exclusively, on digital communication between parents and emerging adults who are making the transition from high school to college. Given that emerging adulthood ranges from ages 18 to 29, it is logical to assert that digital relationships may evolve as the emerging adult moves closer and closer to the independence, self-sufficiency, and personal responsibility associated with adulthood. Little is known about how digital relationships change during the course of emerging adulthood. Longitudinal and cross-sectional studies that compare the influence of digital technology on parent-emerging adult relationships across this entire period are needed. This could shed light on the stability of digital communications during this stage and could potentially highlight shifts in their use over time. Research in this area may emphasize the changing needs and expectations/rules related to digital communication for emerging adults as they mature.

The current research base relies heavily on the use of undergraduate college students, thus neglecting potential differences in digital communication quality, style, and patterns among parents and other subsections of the emerging adult population. Little, for example, is known about how emerging adults who do not attend college and their parents relate within this "digital age." Arnett (2015) describes the developmental period of emerging adulthood as one that contains significant heterogeneity among its members. There are multiple paths toward adulthood and differences within this group should be acknowledged and appreciated. Providing research attention to how digital technology influences relationship quality/satisfaction for non-college attending emerging adults and their parents is significant. Coyne et al. (2013) echoes the need for investigating digital media use among non-college samples. They suggest,

in line with Aquilino (2006), that researchers focus more on samples that contain emerging adults who do not attend college or who attend community colleges or vocational/technical schools. To offer even more depth and texture to the current base of literature, studies that sample emerging adults who live at home versus independently should also be conducted.

Finally, examining other forms of digital technology may lead to a greater understanding of emerging adulthood and parent-child communication. As forms of digital technology are ever evolving, future research should focus on how more recent social media platforms (Snapchat, Instagram, Twitter) serve to facilitate or inhibit parent-emerging adult communication.

CONCLUSION

Digital technology has revolutionized how individuals communicate with one another. We now enjoy instant access to others, regardless of their location. A primary developmental task of emerging adulthood is the renegotiation of rules between emerging adults and their parents. Rules for use of digital communication between emerging adults and their parents is a critical component of this renegotiation. The available limited literature suggests that digital technology undoubtedly affects the relationship quality and satisfaction between emerging adults and their parents. Research reveals that satisfaction with digital communication among emerging adults and their parents is related to various factors associated with the type of technology utilized, rules/expectations for media use, competence related to media use, and present and historical family functioning. Family Systems Theory provides a useful framework for understanding this impact. As the emerging adult strives for autonomy, the family system must adapt to accommodate this pivotal developmental goal. This framework aids in understanding how the family balances relational change and stability within the digital world. Further, it provides a solid theoretical foundation for future research, family life education, and clinical practice involving family communication during emerging adulthood as new technologies become available.

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KEY TERMS AND DEFINITIONS

Boundaries: Established limits that distinguish a family system and differentiate the members within the family system.

Closed System: A system that struggles to adapt, resists change, and lacks constructive communication between family members.

Digital Communication Technology: An electronic method of interaction among individuals, such as text messaging, cell phone calls, or social media websites.

Emerging Adulthood: A theory describing human development between the ages of 18 and 29. This period is marked by several distinctive features.

Entropy: Disorder or chaos resulting from lack of information or input from outside of the family system as a means of resolving a crisis or problem.

Family Systems Theory: A theoretical framework that suggests that the family is composed of a variety of relational subsystems that influence each other and the family unit as a whole. The system organizes to adapt to the changing needs of its members while simultaneously working to maintain a sense of balance.

Homeostasis: The ability of the family system to use outside information and feedback processes to maintain internal stability.

iConnected Parenting: A cultural trend in parenting in which technology is utilized to communicate and enhance parental connection with their child.

Morphogenesis: The ability for the family system to adapt and grow.

Morphostasis: The ability for the family system to maintain a sense of balance and stability.

Open System: A family that is flexible, adapts to change, and has open, constructive communication between members.

Redundancy Principle: The tendency for family members to interact using rules/roles in a repetitive sequence.

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Chapter 69
Designing Pervasive Virtual Worlds

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ABSTRACT

Virtual worlds can be approached in a broader sense of that which refers to common conceptions of virtual reality and immersive environments. This chapter explores the design of virtual worlds in a time when much contemporary media is accessed through and simulated by software. Today, the main extensions of man are cognitive skills and experiences. Software is a way of seeing the world; it plays a central role in media design and distribution. Software and perception of reality are intertwined and pervasive: media not only exist in form of software but the shape and properties of media are also designed with software. In order to understand the implications of computational media, it is necessary to re-articulate problems in a creative and virtual manner. At the end of the chapter, the author speculates on design approaches and presents some examples developed by him.

INTRODUCTION

Today, many types of media have been translated into electronic forms and formats. One of the main consequences of this situation is that most forms of media are now created, accessed, distributed, shared and modified by electronic means. In this scenario, the computer has become one of the most important media because it allows not only to simulate old media but also to extend and virtualize them. The interrelationships of hardware, software and code are the fundamental basis of modern media.

But mastering a computer is not the only necessary skill for media design. It does not fully encompass the complexity of the medium. In a reverse direction, the challenges for designers of media have broadened. Among other complexities, we mention three. First, media is designed with software, which implies to learn how to use software but we also need to understand how the computer works in order to create our own software and different manners to design media. Second, as the massive adoption of computing and human-computer interaction evolve, it also comes with the establishment of conventions, i.e., determined structures based on patterns and practices. To what extent is it useful to move outside

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these conventions? How can we identify conventions? How can we embrace and criticize them for the sake of creativity? Third, software shares some features with natural language and culture, specially regarding its evolution. It happens that some changes can be observed easily but some others are more difficult to notice. For instance, in the fashion industry trends can be celebrated from year to year, but this is not the case in natural language where changes occur at the level of idioms, jargon, syntactic and semantic models of language (new words, new meanings, new languages, etc.). In software, we can observe new features and styles from one version to another, but it is more difficult to detect evolutions in data structures, programming paradigms, algorithms or abstractions.

In this chapter we revisit the notion of pervasive virtual worlds, as previously investigated in 2011 (Reyes, 2011). Our intention with this notion was to understand the emerging environment that combines analog and electronic media. Our focus was on everyday life, where we are constantly extended by portable devices but also by amplified objects in the environment. The ecosystem of connected objects and the processes and actions we can perform on them give rise to electronic realities, which are as real as the 'real world'. So the task is to take advantage of the coupling of analog with electronic in order to design augmented experiences by creatively and constantly questioning the virtual and real worlds. The notion of 'virtual world' is approached in a broader sense of that which refers to common conceptions of virtual reality and immersive environments. We rather consider the virtual as a state of being, thus making reference to the philosophical strand.

In the following section we start by reviewing the notion of 'pervasive virtual worlds'. Then we discuss software as medium, taking as a departing point the definition of media elaborated by Marshall McLuhan, which observes them as technologies that extend or restrain man. From here, we will then put particular attention on media within the continuum of technological evolution and innovation. And to conclude the first section of this chapter we present and discuss two analytical maps of the computing medium, which were created from of its main forms and structures. Through these maps, we try to identify patterns and trends in the era of cultural computing.

The last section of this chapter explores a couple of examples inspired by the idea of pervasive virtual worlds. Our examples are informed by research on digital humanities, speculative computing, aesthetic provocations, design by disruption, experimentation and media art. The projects and experiments selected for the discussion serve also as conceptual tools to think about the virtualization of man.

BACKGROUND: PERVASIVE VIRTUAL WORLDS

The classic definition of virtual worlds, also referred to as 'artificial worlds' or 'virtual environments', comes from research on computer virtual reality. The first innovations in this field started during the 1960s. Prominent examples of pioneering systems include the "Sensorama Simulator" by Morton Heiling in 1960, and the "Ultimate Display" by Ivan Sutherland in 1965. Short after, the first artistic virtual worlds were developed. David Em, while artist in residence at NASA, created "Aku" (1977), "Transjovian Pipeline" (1979) and "Persepol" (1985). From this tradition, a virtual reality system has been defined as

… an interface between a man and a machine capable of creating a real-time sensory experience of real and artificial worlds through the various human sensory channels. These sensory channels for man are: Vision, Audition, Touch, Smell, and Taste (Burdea 1993, cited by Boulanger 2008).

From the context of our contemporary ecosystem of electronic media and devices, we believe it is necessary to understand virtual worlds as something more like 'pervasive virtual worlds'. The term 'world' should be understood in a broader sense, both physically and metaphysically, as a reality, a context and an environment; as it is known and experienced by a series of actors; as a unit or whole containing its own forces and rules in a transcendental way. As we will develop further below, the world exists independently of humans. Following recent works on the philosophical tradition of 'realism', humans are only one actor among others in the world. There are also things, objects, ideas, in the world, and all should be granted equal ontological status, what has been called 'flat ontology' (Bryant cited by Bogost, 2013). This approach to the world is valuable because it tries to move beyond a human-centered tradition where the world is only seized and understood by humans and its possibilities (sensory channels, language, cognition), what has been called 'correlationism' (Meillassoux, 2012). If we humbly accept that the world is more than we know, 'realism' allows to speculate on the phenomenology, ethics, politics and aesthetics of all things in general.

Regarding the term 'virtual', we use it from a philosophical perspective, that is, as one of the four states of being that coexist together: the real, the possible, the actual, and the virtual. The notion of virtual derives from the work of Gilles Deleuze, inspired by Henri Bergson. Pierre Lévy has summarized and discussed, through examples of digital culture, the virtual mode of being in the world. First of all, the virtual is not opposed to the real, however the former is latent and the later is manifest. The four different states of being are noted as manifest or latent. The real and the actual are manifest; they are the result of events. The possible is the latent state that tends to the real (realization) and the virtual is the latent state that tends to the actual (actualization). The opposite direction, from the manifest to the latent state also exists. From the real to the possible it is the potentialization and from the actual to the virtual is the virtualization.

The relevance of considering these four states of being resides in identifying two different modes of creation. For example, when something is created, it can be done either in: first, a more innovative or, second, in a more standardized form. This is not to say that there is no creativity in the standard, but only that its focus is on the practical achievement of something and not in the questioning of the existent. Of course, innovation may rise from standards and when the standard was first invented it was once a creative type, but as it is widely adopted it becomes more and more a repetition and not a difference (Deleuze, 1968). However, when something is created in a creative manner, it explores and approaches a solution in a different way. This is the actualization. The creative thinking implies to refashion, modify, remix and combine elements. And when this creative solution is questioned and re-articulated it is being virtualized.

The given example might suggest that the virtual state is an exclusive feature of the human specie. However, we believe it is not. In that case, it would be a contradiction with the realist perspective of the world. We are rather inclined to think that other actors perform virtual processes that indeed cannot be fully understood by humans due to the fact that we perceive them only through our senses and capacities. For instance, consider biological evolution, which studies how new species appear and evolve to better adapt to the environment (Darwin, 1859). Perhaps the natural process acts instinctively and modifies ADN accordingly, but it certainly cannot foresee in advance which changes will happen in the environment. It is difficult for a human to perceive and note directly when and how such changes occur. The scale is very small (molecules, cells, atoms) and the time is very slow (millions of years) for the human senses. But, can evolution of species be related to virtuality? It is not our intention to speculate on answers about this question, we only want to recall the importance of the philosophical questioning of virtuality from a

realist perspective. In this direction, we point the reader to the work of Manuel De Landa. He identifies himself as a 'realist' and has devoted a book on virtuality based on Gilles Deleuze (De Landa, 2002).

The notion of 'pervasive virtual worlds' is also an attempt to describe the analogical and electronic world that is mixed, extended and mediated through media. As we will see later, media will also have to be understood broadly, something more related to techniques and technologies than to mass communication media. Pervasive virtual worlds are made of concrete and simple forms, but also of abstract and complex ones, produced by the interaction of heterogeneous actors: individuals, things, objects, machines; these forms can be physical but immaterial as well. Furthermore, recalling the idea of the world as larger than human perception and understanding, some forms can even be unknown for some actors of the world.

An example of pervasive virtual world could be all those projects that rely extensively on the ecology of portable devices and communication networks. As it has happened, the explosion of cell phones has overpassed personal computers, so there is a portable device with almost everyone, everywhere. These devices do not only function as telephone but also as text machines, typewriters, game platforms, multimedia centers, to mention some. Such ecology of media has virtualized actions of individuals and places. We can extend our presence into several places simultaneously: while we are physically in a geographical location, we can be acting in a remote place at the same time. Accordingly, the type of action we perform remotely can be very similar to those we perform in the physical space. Of course, the type of presence is electronic, however this is as unique feature of computer virtual worlds. Pierre Boulanger has identified 'virtual reality systems' as general-purpose presence-transforming machines. The importance of presence, says Boulanger, deserves greater attention as recent psycho-physiological studies show that participants exhibit similar reactions to presented situations as they would in similar situation in real life, e.g., they behave the same: show fear reactions, perform tasks in 'normal' manner, show socially conditioned responses (Boulanger, 2008).

In a pervasive virtual world, presence can be simulated through media or experienced physically. One of the fundamental changes in media design (of both content and interfaces) has been precisely to translate old media into digital formats, but at the same time new kinds of media are invented in the process. At the center of this turnover, software, hardware and code play a decisive role in the materialization, perception, understanding, creation, evolution and virtualization of media.

Media, as we mentioned earlier, needs to be studied in the largest possible sense and allowing different entry points for their analysis. For example, media has proven to be a rich objet of study through the seminal notion of 'remediation' (Bolter and Grusin, 1999), a term inspired by Marshall McLuhan's understanding of media as 'extensions of man' (McLuhan, 1964). But there are other interesting notions related to media: 'artifacts' and 'devices' in the sense of Michel Foucault and Gilles Deleuze; 'artwork' or 'text' for semioticians like Roland Barthes and Umberto Eco. And what about virtuality? Indeed, Pierre Lévy has revisited McLuhan's notion and formulates that media are really virtualizations of actions, organs and things (Lévy, 1998).

To discuss an example let's take the act of hammering, also commented briefly by Lévy. Hammering is a virtualization of the act of pushing or pressing a surface against another one. From the point of view of McLuhan, the stone could be seen as an extension of the fist and the hammer as an extension of the arm. Once the action has been virtualized, it can be accomplished with other things and communicated even in the absence of stones and hammers. To adventure in a further step, we can advance that hammering has influenced the act of 'buttoning', i.e. pressing buttons as implemented in machines and their following remediations in digital user interfaces. These two actions are both related to 'contact' and we will explore them in more detail in following sections. For Lévy, he observes that in the

history of virtualizations there is a small number of virtualizations but a large number of realizations: How many times the act of hammering has been discovered in opposition to how many times people have hammered throughout history? For those readers familiar with semiotics, this idea finds echo in the distinction between type and token; the invention of a word and its utterances. Moreover, it is also related to the concept of 'technical object' as elaborated by Gilbert Simondon:

… the technical object is specified by the convergence of structural functions because there is not, at a given epoch or time, an infinite plurality of possible functional systems. Human needs diversify to infinity, but the directions of convergence of technical species are of a limited number (Simondon, 1969:23, our translation from French).

To conclude this part we want to argue that the notion of pervasive virtual worlds offers a different view for designing media simulations and exploring new communication models. Virtual worlds are pervasive because there is an ever-increasing quantity and types of devices connected between them: from mobile handhelds to ambient intelligence to the internet of things. But simulation, communication, extension and virtualization do not depend on those artifacts to flourish because they are latent. As we have seen, organs and actions are being virtualized in artificial worlds from the perspective of human beings (such as teleporting in Second Life or changing perspective in physical world trough an Oculus Rift), but there is still a lot of work to do if we approach virtualization from the vantage point of things, objects and ideas for example. This is to suppose that we could speculate on virtualizing acts done by things and then to apply them or combine them with human or object actions. Moreover, actions have become more and more simulated in digital environments (representations and digital restitutions), and it is interesting to note that these virtualizations can in turn re-enter the process of virtualization and be actualized again; something like an n-degree of virtualization. In these terms, potentially anything can be used as media: either to communicate with it or to study its communicative possibilities or to analyze its effects at other human and non-human levels. If we come back to some claims from the speculative realism, an actualization of these acts would follow a similar path of what Ian Bogost has called 'alien phenomenology' or to approach what is like to be a thing (Bogost, 2013). In a more modest endeavor, we can start by understanding media and techniques as the result of visions of actors and events that were influent at their origin and through their evolution. These visions have often had different and multiple sources of inspiration, such as a passions, needs, problem-solving. In the end, media and techniques represent modes or ways of seeing and acting in the world, they shape *ways of being* (Winograd and Flores, 1986). The invitation is to start tracing and documenting media, technologies, sciences, and art by taking into account aesthetics, politics, ethics, technics and material aspects. If a catalog of virtualizations of organs, actions, and things could exist we could not only understand media better but also consider different approaches to creative innovation.

SOFTWARE AS MEDIA

In the evolution of digital computers there has been a major revolution regarding their social and cultural role: the development of human-computer interaction, mainly led at Xerox PARC in the 1960s. It is safe to situate at that time various inventions still in use today: among the most popular, the mouse, the pointer, hypertext, videoconferencing and graphical user interfaces. It is interesting to recall the fast

pace at which computers evolved afterwards. In the following decade, during the 1970s, two of the most influential programming languages were developed: first, Pascal, designed by Niklaus Wirth between the universities of Stanford and Zurich, influential in procedural programming; second, Smalltalk, at Xerox PARC, influential in object-oriented programming. These languages, together with the advancements in hardware and operating systems, allowed computer designers to create another kind of software: software to design media. For instance, one of the most influential software in cultural digital imaging has been Photoshop, developed in 1987 mainly with Pascal (at least 75% of the source code was written in Pascal) for the Apple Macintosh by Thomas and John Knoll.

By the 1990s the computer was already seen as a media machine and a variety of media software started to be used and sold (Manovich, 2013): Aldus Pagemaker (1985), Adobe Illustrator (1987), Director 1.0 (1988), 3D Studio (1990), Pro Tools 1.0 (1991), After Effects (1993), Maya 1.0 (1998), etc. Nowadays, we believe there are at least two greater impacts of this cultural computation turn. First, media is primarily designed with software, which implies that media designers must learn how to use computers and software, and even at to some point to write scripts and to install plugins to extend the basic options of software applications. Second, if media is designed with software, what about the design of software to design media? Why does software includes this or that function? Why should it be used in the way it exists? Indeed, as we mentioned before, media, software and technologies in general, represent the actualization/realization of the visions of actors (a complex that includes humans, things, worlds, simulations, events, technical objects) that identified and developed a way of seeing the world and acting through it. Software is thus what needs to be learned if we want to go further in the design of new media.

In this section, we explore these two impacts: the design of media with software and the design of media software. This task is of course enormous, thus the scope of the present chapter will only be to sketch some directions that require further research and development. In some cases we will be able to give empirical examples from experimental projects in digital humanities. So instead of describing a design methodology, we rather discuss four main dimensions that should be taken into account in the design of pervasive virtual worlds: 1) technical-archaeological; 2) standard-conventional; 3) cultural-cognitive; 4) computational-digital. We need to remark that there is no hierarchical value behind this list, all items are equally important.

First Dimension: Technical-Archaeological

The first dimension sees media as technology. The aim of this approach is to adopt a similar perspective of media archaeology, which has been elaborated by academic researchers such as Siegfried Zielinski, Jussi Parikka, Friedrich Kittler and Oliver Grau, among others. Media archaeology attempts to uncover histories of media "through insights of past new media, often with an emphasis on the forgotten, the quirky, the non-obvious apparatuses, practices and inventions" (Parikka, 2012:2). In our current context, the importance to consider media archaeology is to investigate the several virtualizations of actions, organs and things as well as their implementation through technological means.

As we mentioned earlier, in this chapter we consider media in its largest possible conception, which is necessary to analyze it from different angles. In relation to technology we have already remembered that Marshall McLuhan defined media as extensions of man. In his famous book "Understanding Media" (McLuhan, 1964), he analyzed television, radio and comics, but also the wheel, garment, money and fashion. So media is a vast field which most of the times cannot be seized in its totality because we are

immersed into it, both physically and cognitively. As media archaeologist Siegfried Zielinski suggests: "all we can do is to make certain cuts across it to gain operational access" (Zielinski, 2006). For him, these cuts are of two kinds: built constructs (interfaces, devices, programs, technical systems, networks) and media forms of expression and realization (film, video, books, websites, machine installations).

To discuss the relationship of media and technology, we will mainly concentrate on those 'built constructs'. The design of media with software has been largely inspired by previous media, but also by general-purpose devices and techniques. The software available to design media has envisioned the functions of previous media. For instance, a software like Photoshop has remediated operations from the field of painting, drawing and photography. Of course, we cannot say these functions are mere simulations of ancient techniques, they have been translated into computational forms where they interact with techniques from other domains. For instance, while an artist who uses analog tools may paint and draw on canvas using brushes, pencils and other inscription technologies, in the computer environment she disposes of simulations: icons representing those tools that can me customized with parameters. Both domains create a new hybrid medium: multiple types of brushes in a single software application, accessed through buttons, sliders, menus, panels and other conventions.

To conduct media archaeology with the intention of analyzing the design of media with software requires looking back at representations of previous tools and techniques but also the virtualizations of actions, organs and things. In other words, it assumes that there are actions that have already been virtualized and that those virtualizations have been translated into technical objects and then to computing forms. It will be interesting to put special attention in turnover cases, i.e when a radical new tool and/or a way of being is introduced, because it points to a state of actualization of a virtual idea. The evolution and analysis of media software is a complex matter because those virtualizations arrive when new problems are explored that, in turn, could only emerge through the translation of past new media into computational forms.

To exemplify the complexity of layers intertwined inside a media software, let's come back to our previous case of hammering. As we said, the act of hammering is a virtualization that, in terms of McLuhan, extends the fist and the arm. We mentioned earlier that hammering is related to buttoning, given that both actions are based on contact. Allow us now to reveal some situations that should be considered if we want to study push-buttons as elements of the graphical interface in media software.

It seems we need to start by addressing the hand. Sigfried Giedion has made important observations about the human hand, which can point, seize, hold, press, pull, mold with ease. It can search and feel. Flexibility and articulation are its key words (Giedion, 2013:46). However, the hand has limitations and, above all, the main limitation is it cannot act endlessly. For Giedion, "the first phase of mechanization consists in transforming the pushing, pulling, pressing of the hand into continuous rotation" (Giedion, 2013:47). One may wonder about the reason why motion is evoked. In fact, Giedion makes the argument that 'movement' is closely linked to 'rationalism'. He stresses how often contradictory visions of the world have influenced our understanding of science and techniques: temporal vs eternal, rational vs irrational, internal vs external. For a society in the quest of progress, the last state to reach is perfection, so it is in a temporal mode rather than in an eternal one. In order to reach this goal, it needs to capture and dominate movement, to control it and to fix it, not to liberate it.

Would it be possible to say that our graphical user interfaces are virtualizations of pushing, pulling, pressing? The case of push-buttons might tell us some clues. As we know, push-buttons are almost ubiquitous in today's GUI. Buttons function along with pointers. The basic case of use is: the user manipulates the pointing device, she moves it and clicks on it (press, hold, release). These actions are

represented on the screen: the pointer moves around the screen and, if it is accordingly positioned over an electronic representation of a button, it launches an action in the system. We believe one of the first virtualizations behind this simple scheme is the action of switching states and their associated processes.

The virtualization of pushing, pressing and pulling is at the heart of inventions such as the hammer and the bow. Many implementations of these actions can be found in objects such as springs, which were adapted for first mold-based locks in XVIII century. Other virtualizations can be found in pipe organs. During the XIV century, organs constituted one of the most complex inventions of that time. The basic components of pipe organs are very telling for us: the arrangement of pipes, a wind system and a key desk. The place where the user controlled the whole system was the key desk, and comprised manuals, pedals and stop controls. In order for the organist to perform a musical piece, some actions were performed. First there was a secondary user who fed the system with wind. Then the organist relied on the tracker action, which is the mechanical connection between the key desk and the wind system. The series of acts of pressing and pushing on manuals and pedals functioned along with the combination of stops, which was basically turning on or off the passage of air.

Yet another virtualization in the history of push-buttons can be seen in first electric telegraphs, which virtualized some operations and mechanisms of the pipe organ. Not only the user interface of the first telegraphs resembled pedals and manuals, but also the basic principle of switching on and off, however in this case the detection of electric current.

Switching states is one of the virtualizations behind push-buttons. But now let's consider the 'play button' as it exists in media players such as Apple Quicktime, in media authoring software such as Adobe After Effects, Autodesk Maya, Adobe Acrobat, and in programming environments such as Processing. It is possible to identify the play button as a remediation of previous buttons that appeared in recording devices that required to playback recorded signals. In this case, the act of switching on/off conveys movement from different angles: play a movie (QuickTime), preview a film montage (After Effects), go forward or go next (Acrobat) or compile a programming code (Processing). What happens now is that the action of pushing a button in an electronic environment is associated with larger series of processes and algorithms. This means that switching between 0 and 1 corresponds to modifying the entire system, from state A to state B, which may alter state C, and in turn state D.

To pursue our example, the task now would be to identify those processes and the virtualizations of actions, organs and things. But to do that it is necessary to conduct more research and to document empirical results. Today, media archaeology is still in its early stages. We need more projects that tackle the relationship between media and technology in an evolutionary perspective. We need to interrogate where do our tools come from? How are they related to past new media? What was at stake at the origin of the invention? How the invention altered other technologies? How media virtualizes us and things? An example of such endeavor is the Media Archaeology Lab, presented in 2011 by Lori Emerson. The project aims at documenting hardware, software, peripherals and individual collections that explain how tools were used in the past (MAL, 2013).

Second Dimension: Standards-Conventional

There are a series of passages that occur in the life of inventions. The time in which those passages is accomplished could take years or even decades, and sometimes the passage might not take place until centuries later. Those passages go from the latent state to the manifest, from the virtual to the actual. The process starts in small scale. Gilbert Simondon has called the 'abstract object' to that moment of

technical species when they are only known to their direct actors involved with the invention. Then, as the object interacts with others and the actualization of actions and transformations gets recognized, it could be that technical objects tend toward its 'concrete' phase. To be 'concrete' means that the object has evolved intrinsically and externally, within its parts and to its users and ecosystem. In the concreteness, the technical object couples in equal ontological manner with the user. No one is manipulated by the other, rather both cooperate for the same purpose.

The case of media design of course does not escape standardization and conventionalism, however we believe we are still far from the concreteness state of digital media. Standards and conventions allow media to consolidate a vocabulary, its syntax, its rules, its semantics; that allow to be communicated and foster the exchange of parts and modules. On the other hand, if pervasive virtual worlds would tend to full concreteness they would no longer be virtual, but possible, from the philosophical perspective that we discussed before. The point of virtual worlds is precisely to remain in constant dynamism and to motivate creative questions about them.

In the last section we borrowed from Zielinski the terms 'built constructs' and 'media forms of expression and realization' with the intention to make evident the distinction between media container and media content, respectively. As we will see, conventions and standards exist for both forms.

Let's take a brief look at conventions in media content. The investigation about conventions in film, radio, TV, games and other kinds of mass media has been done mainly in the field of humanities and social sciences, particularly in media studies, communication, information, humanities, literature, etc. From the moment a technical object or a new media is released to public at large, there has been noted a gap of thirty years until the first conventions appear. Alexander Galloway calls this gap the 'thirty-year rule', starting from the invention of a medium and ending at its ascent to proper and widespread *functioning in culture at large* (Galloway, 2006:85). In film studies, to mention an example, we can observe this gap between the introduction of the cinématographe, by Louis and Auguste Lumière in 1895, and the use of visual narrative techniques by David W. Griffith in a film like "The Birth of a Nation" (1915) or in rules of montage posited by Sergei Einsenstein in films such as "The Battleship Potemkin" (1925).

We use the notion of convention in similar terms as Janet Murray does: "social practices and communication formats shared by members of a culture or subculture, as well as media formats shared by artifacts within the same genre" (Murray 2012:415). This definition also considers the distinction between media content and media containers. For Murray, digital media is still in its immature phase, so its conventions have not yet fully been settled. As it has not yet passed the thirty-year rule. While other more established fields look for refinement, media designers deal with invention: "inventing something for which there is no standard model" (Murray 2012:3).

According to Murray, the move towards convention must follow a direction in which the four affordances of digital media are best exploited. These affordances are: encyclopedic, spatial, procedural and participatory. The method to follow is to design media by doing new media and, at the same time, to search for an increase of awareness in design choices, cultural traditions, cultural values, human needs and media specific conventions. While all these questions are deeply important, we also suggest that pervasive virtual worlds should adopt an open point of view in regard of conventions. Virtualization and actualization require to be informed by actions, organs, components of the widest range, even going further than human perception.

Murray is right in adopting a more professional standpoint where conventions need to solve human needs. Do we really have needs? Instead of debating around questions that go beyond the scope of this

chapter, we prefer to review three existent models that seem oriented toward the installation of conventions in digital media, if not fully in content and container, at least focused on the latter, the 'built constructs'.

First, perhaps the most advanced efforts on standardizing digital media come from software guidelines and specifications, best-practices, international recommendations, consortiums and, more recently, design patterns. Among the most acclaimed software guidelines we may cite the Macintosh Human Interface Guidelines, later changed to Apple's Human Interface Guidelines and more recently also making available the iOS Human Interface Guidelines. In those documents, Apple describes the notions of WYSIWYG, metaphors, direct manipulation and how to use the interface elements (i.e. menus, windows, dialog boxes, controls, icons, colors, behaviors and language) the Mac way (Apple Computer Inc., 1993). Regarding specifications, in 1993 the International Organization for Standardization released the ISO 9241 titled Ergonomic requirements for office work with visual display starting with requirements for Visual Displays and Keyboards. Today, ISO 9241 covers ergonomics of human-computer interaction around eight levels, going from software ergonomics to environment ergonomics and tactile and haptic interactions (ISO 2014). Another example of standardization is the World Wide Web Consortium (W3C), initiated by Tim Berners-Lee in 1994, and which is focused on standards for the World Wide Web: languages, technologies, protocols and guidelines (W3C 2014). Finally, in a more user-oriented and content-oriented fashion, we have seen recently the development of design and programming patterns. An example is the online repository Yahoo Design Pattern Library which categorizes user interface patterns around layout, navigation, selection, rich interaction and social categories. A pattern, in terms of Yahoo, "describes an optimal solution to a common problem within a specific context (Yahoo! Developer Network, 2014). Any pattern is defined by a title, a problem, a context and a solution". Although Yahoo gathers and promotes the resources, it is a social-driven catalog, where users can submit and contribute with their own discoveries.

Second, one of the underlying principles that has allowed media software to flourish and expand is the availability to interchange files and data between applications and operating systems. This is possible because data structures and data formats are common in several environments. For example, although the Graphics Interchange Format (GIF) started as a proprietary technology developed and owned by CompuServe in 1987, it can be used free today, that is to say that the technique of data-compressing with the algorithm LZW and its packaging in a GIF file can be freely used by developers. As we know, GIF animated images have gained popularity with the explosion of web-based social networks so they can be opened, distributed, embedded and produced with many different software. Conversely, the MP3 format (MPEG-1 Audio Layer III), popular for compressing audio files, is not free and media software developers would need to pay a license to the Fraunhofer Society in order to distribute or sell encoders/decoders. This is one of the reasons why, for instance, a web browser like Mozilla Firefox does not support MP3 files. Instead, Firefox relies on the open format Ogg Vorbis.

Third, it seems that many required professional skills to access to job positions influence on the establishment of 'de facto' standards. This is also true for other cultural and conventional factors such as popularity and acceptance. We can refer once again to Adobe Photoshop as an example. Despite de fact that it is proprietary and commercial media software, it remains the number one choice among graphic designers, photographers and visual artists. Recently we have witnessed that alternative solutions exist, tools developed by the open-source community: the GIMP or the online Pixlr editor. However, the Adobe culture is still dominant.

The importance of taking a look at conventions and standards from the point of view of the design of pervasive virtual worlds is to embrace a reflexive thinking about our practices and tools. If we make the

effort to detach ourselves from the continuum of everyday life and conventions, we can reinvigorate a critical and creative posture of our media. This is like natural language in culture, we don't often realize when a change was produced and suddenly we are using the same convention.

We would like to observe a final case that we believe makes the bridge with the following section. A large part of contemporary web design is done through content management systems (also called by the acronym CMS), for example WordPress; they can be extended with frameworks, plugins and libraries like Bootstrap. In the end, it seems like the design of web sites is based extensively on models and de facto standards. As a result, the web experience is more or less the same in a navigation session. Against the use of conventions, we react sometimes delighted when we see a piece of net art while navigating the web. As it occurred in the twentieth century with the installations by artists like Marcel Duchamp and Nam June Paik, who questioned and rearranged everyday objects, technologies and media, today media artists constitute an important community that questions the conventions of our electronic worlds.

Third Dimension: Cultural-Cognitive

In this section we adopt an approach more centered on the design of media software, and not on the design of media with software. The main focus is now on tools to create software. As we have seen, media is designed with software and this software constitutes the vision of actors that conceive a way of acting and accessing the world. We will now explore the design of software especially created for media production.

Media software can be broadly divided into media player software and authoring media software (Wardrip-Fruin, 2009). In this section we will focus on the latter and more specifically in those systems designed for desktop computers, instead of portable devices. The reason of this choice is twofold. On the one hand, software applications for desktop computers have existed for a larger time, so there are more lessons that can be learned from the implementation of computing forms, processes and interfaces. On the other hand, we believe mobile applications is an exciting field that requires a deeper investigation and we should accord it its own space in a further contribution.

Authoring media software, as we mentioned, inherit visions from pioneers who understood the computer as a media machine. We have also said that media software is a combination of conventions from past new media with properties exclusive of digital treatment of signals and information. In that manner, not only the established conventions should now be accessed and manipulated through graphical user interfaces, but also those conventions are informed by techniques from other domains and create new forms of designing media. Lev Manovich, in his recent book "Software Takes Command" (Manovich, 2013), observes how filters in Photoshop are varied and combined techniques from photography, painting and drawing such as blur and artistic effects. And there are also other filters that borrow actions developed in electrical engineering such as noise.

The design of media software is complex because there is always a dialectic relationship between conventions and new features. For instance, if we create a plugin, a script or a new menu for an experimental feature in already existing software, we must make it available through the given arrangement of the software. Conventions such as menus and submenus, property panels and inspectors, buttons and icons, are closely related to the operating system and middleware available to access components of the computer.

The case of software for media art is appealing because we have seen different conceptions of how to be in the world. The cooperation between digital artists and software developers has produced prominent

examples of how to remediate past new media, to access to their features and to add new combinations, actions and processes. Software like Pure Data (1996), SuperCollider (1996), Processing (2001), Cinder (2010), NodeBox (2010), qualify in this category. Reas and Fry account for the importance of software in arts: "software holds a unique position among artistic media because of its ability to produce dynamic forms, process gestures, define behavior, simulate natural systems, and integrate other media including sound, image, and text" (Reas & Fry, 2007). Reas and Fry not only talk about media and software but they are also the beginners and main developers of Processing, a programming tool specifically created for artists and designers.

In their book, Reas and Fry dedicate a useful appendix to present other development tools oriented toward art and design; and they are all programming languages. Media art software could be then better seized if understood as an authoring system where software applications and programming languages interrelate and cooperate. As we know, the great majority of software applications users mainly communicate with it though its GUI, but a lot of those programs can also be extended with scripts and computer code. This means that GUI and programming languages lay in the same container; they are like two creative modes and/or layers that can be used separately or integrative.

We must add another remark regarding this particular software dedicated to create media art. Artists have always explored and combined new materials (Shanken, 2009). In the digital terrain this often means hacking, modifying, disrupting, connecting, and remixing software components, scripts, source code and binary files (besides hardware and devices). In that form, media artists may consider any software as a potential environment and laboratory to create media artworks, even if it is an accounting application or an office suite.

What are the effects of media art software? One of the pioneers of digital art, Jack Burnham, curated in 1970 one of the first exhibitions devoted to digital art: "Software, Information Technology: Its New Meaning for Art". As Edward Shanken points out, Burnham's idea of software was of a metaphor for art: "He conceived of 'software' as parallel to the aesthetic principles, concepts, or programs that underlie the formal embodiment of the actual art objects, which in turn parallel 'hardware'" (Shanken, 1998). We agree. Most studies on art movements understand art mainly from the aesthetics standpoint, concentrating on the experiences from the visitor side, on the dialogue that was established, and the altered effects that remain at the end of the day (most of the time in the viewer, and for Burnham, also in the manipulated artwork).

Is it possible to say the similar about media art software? Is there something like an aesthetics of media art software? To tackle this question we have to direct our discussion towards 'software criticism', which completes the aesthetic approach. Software critics reflect on ethical, political and socio-historical questions.

For example, Matthew Fuller understands software as a form of digital subjectivity (Fuller, 2003). The accent is put on the human-computer interface as the window and mirror of software, but also of a series of ideological, historical, and political values attached to it. To study the HCI implies to investigate power relations between the user and the way the software acts as a model of action. This idea goes along, although not exactly formulated as software criticism, with Winograd and Flores: "We encounter the deep questions of design when we recognize that in designing tools we are designing ways of being" (Winograd & Flores, 1986).

In a recent essay, Alexander Galloway thinks about the question of interfaces and claims that they are not objects, but rather processes and effects (Galloway, 2013). He observes the computer as a set of actions that relate to the world, so he embraces the philosophical standpoint of ethics to develop his

arguments. For the author, the interface is a functional analog to ideology. Hence, the interface is not the object, but it is within it. It is manifested at the surface level of digital media, devices, and graphical representations.

Later, Galloway claims that software inherits some properties from interfaces. Software would be an allegorical analogy to ideology, i.e. more a simulation than a vehicle of ideology: "What is crucial in software is the translation of ideological force into data structures and symbolic language" (Galloway, 2013).

These brief insights into software criticism allow to think about 'media art software' differently. First, following Galloway, software functions in a dialectical fashion that requires visibility and invisibility. While computing code might be hidden as it is, only to be interpreted and parsed, at the same time, the artist/developer has a high degree of declarative reflexivity (variables, functions, etc.). This resonates with our earlier coupling of software applications and programming languages: media art can also have two entry points for software criticism and should take into account the dialectical logic between invisibility and syntax formalism.

Second, following Fuller, our practice as media artists could also be thought in terms of 'speculative software'. If software simulates ideology, then such simulations might be interrogated. Speculative software would be software that reveals its processes as it enacts them:

What characterizes speculative work in software is, first, the ability to operate reflexively upon itself and the condition of being software (…) to make visible the dynamics, structures, regimes, and drives of each of the little events which it connects to. Second, (…) to make the ready ordering of data, categories, and subjects spasm out of control. Third, it is to subject the consequences of these first two stages to the havoc of invention (Fuller, 2003).

Finally, let's come back to digital subjectivity. Nake and Grabowski seem to summarize Fuller and Burnham. They see 'aesthetic computing' as the introduction of subjectivism into computing… with all its consequences. They recall a very important aspect of software and computers:

… the computer does not directly operate on the pixels on the screen. It operates on their representations in the display buffer, and further down on this scale of manipulability are representations of other entities that form the real stuff of programs (Nake & Grabowski, 2008).

For any speculative effort on software, it seems necessary to go further down the GUI. The more we know the software, the more we can interrogate its simulations. But before simulations, there are bits and bytes, functions and classes, visual representations, etc. How can we access to them? How they relate between them? These are some questions that need to be addressed by designers of digital media and media software.

To summarize, the design of pervasive virtual worlds demands to ask deeper questions about the selection of processes and data formats that we implement in any project. Software is the reflection of cultural choices by its designers, who often take into account the cognitive framework of the final user. As we have showed with the example of media art software, the development of our tools should be accompanied by a reflective thinking that looks at ethical, political and aesthetical considerations. Furthermore, it is also pertinent to be aware of recent research on cognitive sciences and cognitive semiotics because they consider the coupling of meaning, mind and perception. Unfortunately we are not aware of

any empirical project that links software design and cognitive semiotics, however we can point to studies that are interested on 'translations' from the visual to the audio realm by using software (AGI, 2014).

Fourth Dimension: Computational-Digital

The fourth dimension in the design of media software puts attention on software and its computational aspects. It is about understanding software and computation themselves, as an object of study. So far we have traced a line of study that goes from the archaeology of media to conventions and standards to cultural and ideological aspects of media software. In this part the focus is on material properties of software. If media is created with software and if we must regard how media software is designed, then a further step is to investigate which are the components of software and how they work.

Traditionally, this area has been the subject of computer science, which explores the theory and practice of computer systems, methods, languages, structures and processes. Most of the efforts in computer science have been directed toward the optimization and performance of computer systems. However, the implication of humanists and artists has also motivated creative innovations. The case of artists in residence, like David Em at NASA in the 70s, is an example of advances and uses from the creative and artistic standpoint.

For humanists and social scientists, perhaps one of the most notable crossings between computer science and history, literature, philosophy, and cultural studies, has been the emergence of the 'humanities computing', or as it is known today: digital humanities. The first practices that emerged from this interdisciplinary convergence were based on text and its statistical processing in order to distinguish patterns and features that could assist in issues of stylometry and lexicography. More recently, digital humanities increasingly use computing methods to produce information visualization, network analysis, text mining, databases, digital publishing and even the design of software especially dedicated to assist the work of digital humanists.

As it can be perceived, art, social and human sciences hold a close relationship with computer science. Humanities have made contributions in the sense of reflecting on the human effects and consequences of computing. Recently, Bruno Latour has insisted on considering the effects of the digital on the environment (Latour 2014). For Latour the materiality required by digital data has often been neglected and created a myth around the immateriality of the digital. Digital media is very material. To put it simply, software and data are stored in devices that process information. This information can be digital, saved as binary data, but in the end it needs to be rendered analogically for human consumption. The acquisition, processing and restitution from digital to analog requires electricity to power up computers and this source of energy has direct incidence in the environment: nuclear plants, massive hangars to store hard drives and servers, together with all infrastructure necessary to maintain our current state of affairs. Materiality cannot be disregarded any longer, but in this section we will inspect another type of materiality of software, the 'real stuff', in terms of Nake and Grabowski. These material properties are their constituent elements.

Where to start in order to grasp the complexity of software and its place within the computer sciences? As an entry point we will use the Computing Classification System elaborated by the Association for Computing Machinery (ACM, 1998) with the objective to index articles and publications in conferences, journals and books edited by the ACM Press. The ACM has a three-level classification system and their descriptors. At the top level there are eleven domains: A. General Literature, B. Hardware, C. Computer

system organization, D. Software, E. Data, F. Theory of computation, G. Mathematics of computing, H. Information systems, I. Computing methodologies, J. Computer applications and K. Computing milieux.

As the computing machinery field has evolved and as researchers have published and documented their results, the categories and subcategories have grown. Is it possible to say that subcategories represent refinement in the domain? Can we say that the computing filed is dynamic instead of static, i.e. in continuous expansion? Which are those categories where refinement has taken place? Figure 1 shows a flow diagram connecting the first level with the second.

As we can see, I. Computing methodologies is the largest region and has 7 subcategories at the second level. From these subcategories, the most abundant are I.2 Artificial intelligence, I.4 Image processing and computer vision, and I.3 Computer graphics. The second largest category is D. Software, with 4 stronger subcategories within D.2 Software engineering. The third largest is B. Hardware, which has 8 subcategories mainly concentrated in B.4 Input/output and data communications, B.1 Control structures and B.6 Logic design.

In Figure 2 we show a network map with the connections between the first level and the last one, that is the descriptors. In this diagram it will interesting to note how descriptors appear in several different categories. For example, Interactive systems, Nonprocedural languages, and Standards exist both in I. Computing methodologies and D. Software. The link between I. Computing methodologies and B. Hardware is given by the descriptors Algorithms and Parallel. D. Software and B. Hardware are related by Diagnostics, Simulation, and Virtual memory. It would be curious to note there is no single descriptor that relies the three largest domains (I, D and B). The only descriptor that relies more than two domains is Standards, which is the link between C. Computer system organization, D. Software, I. Computing methodologies and K. Computing milieux. A deeper analysis will have to investigate what and why are those relationships? What are the topics and problems that scientific papers regard? Or, is it possible that more links between domains appear in the future?

While a brief analysis like this can help approaching trends in computer science, we can also try to explore a different angle directly related to media software. For this matter we will follow Manovich's definition of media: *media = data structures + algorithms* (Manovich, 2013). For him, the most fundamental constituents of media software are algorithms and data structures. For his formula, Manovich declares inspiration from Niklaus Wirth, designer of the programming language Pascal, and particularly from his book "Algorithms Plus Data Structures Equals Programs "(1975). Our intention at present will be precisely to explore data structures and algorithms in more detail.

Which are the major algorithms? And which are those algorithms particularly dedicated to media, for example images? Which techniques have been introduced by those algorithms? What kinds of data structures they use? What is the relationship between data structures and algorithms for digital imaging? How have they influenced our conception of digital media and the operations we can perform with them? Is there a place for virtualization of digital media?

Algorithms and data structures are in constant development. A field such as computational geometry, for instance, considers among its interests the systematic study of geometry algorithms, observing the "realization that classical characterizations of geometric objects are frequently not amenable to the design of efficient algorithms (…) computational geometry must reshape –whenever necessary- the classical discipline into its computational incarnation" (Preparata & Shamos, 1985). So far, we can say that the existing types of data structures are more reduced in number than the amount of algorithms. For computational geometry, Preparata and Shamos recall that the most common complex objects in the design of geometric algorithms are sets and sequences, so they must use data structures particularly suited for

Figure 1. Flow diagram of first two levels of ACM classification system (Everardo Reyes, 2014).

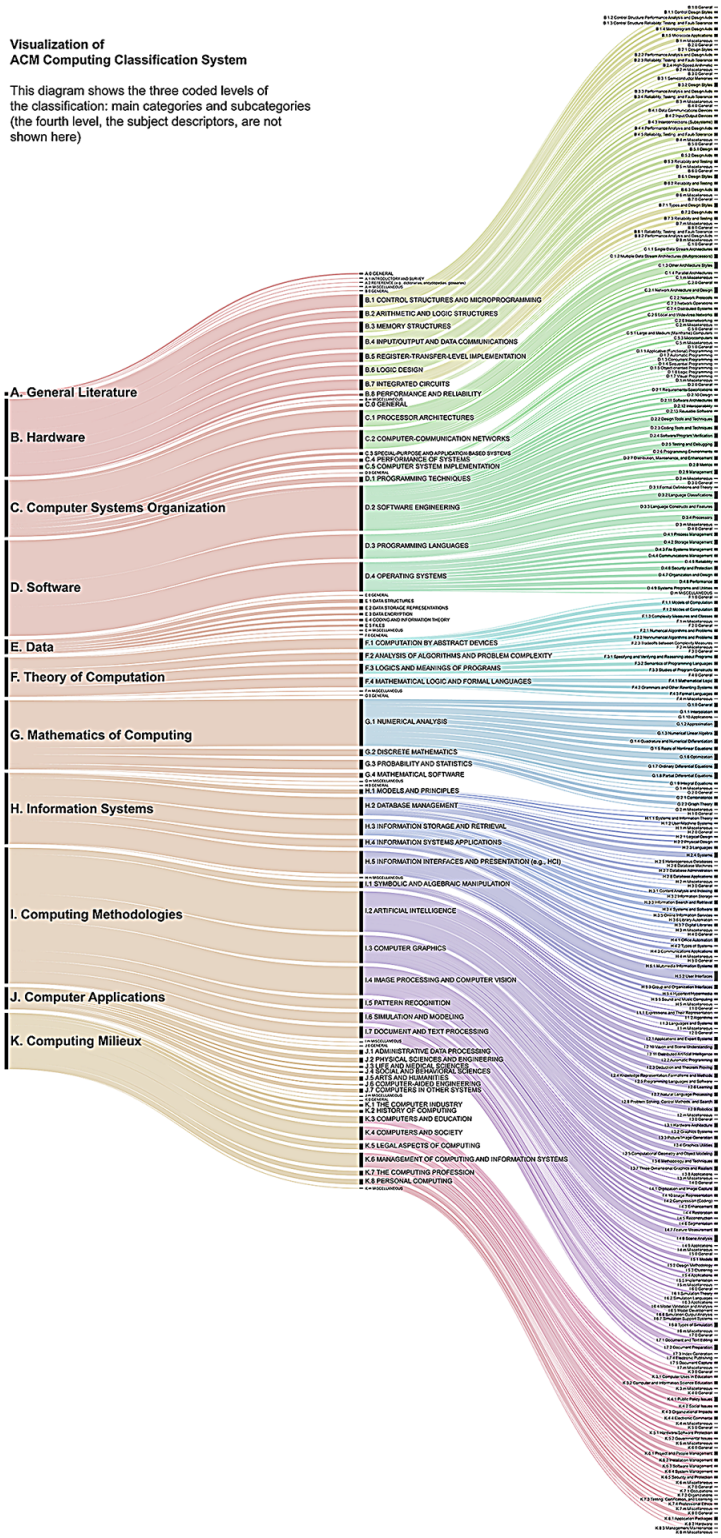
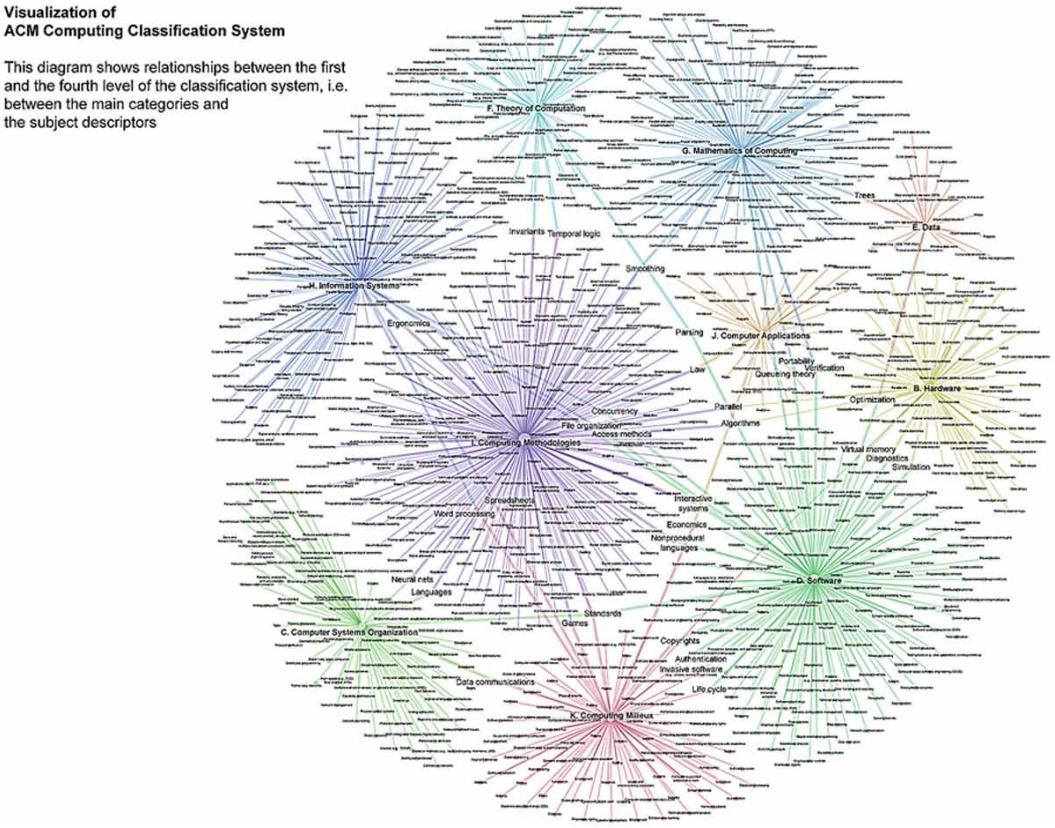


Figure 2. Network diagram of ACM classification system
(Everardo Reyes, 2014).



these objects. This situation can be explained in a similar manner as the relationship between letters and words in natural language. There is a limited number letters and words, but a relatively infinite number of combinations and techniques to use them.

According to the ongoing classification by Wikipedia's users and editors, there are five major kinds of data structures: data types, linear data structures, trees, hashes, and graphs (Wikipedia 2014a). (Although the information available in Wikipedia is in constant change, we believe it is pertinent for the sake of our argument because it reflects the current understanding of the field by a community constituted by both specialists and non-specialists.) The primitive types of data types are perhaps the most well-known types to beginners and first-comers into computer science: Booleans, integers, floats, strings, arrays, matrices, bitmaps. Other lesser-known structures are: trees, heaps, tries, hashes and graphs. It is important to notice that data structures determine how information is structured and stored, in order to be processed by algorithmic techniques.

Algorithms, as it can be guessed, have larger types and classifications. Following Wikipedia, algorithms are classified in five types: 1) combinatorial (network analysis, routing for graphs, graph search, string metrics, etc.); 2) computational mathematics (collision detection, triangulation, discrete logarithms, computation of PI, eigenvalues, etc.); 3) computational science (algorithms of astronomy, bioinformatics, geoscience, linguistics, medicine, physics, and statistics); 4) computer science, and 5)

software engineering (database, operating systems, memory allocation, distributed systems -all of them are interesting entry points to search deeper the relation between the ACM's categories B. Hardware and I. Computing methodologies evoked before) (Wikipedia 2014b).

The fourth category of algorithms, called computer science, is particularly exciting to study because it contains many operations behind techniques in software for media design. Within the subcategory of 'digital signal processing', for example, we find image processing algorithms: contrast enhancement, dithering and half-toning, feature detection, segmentation, which are familiar in digital graphic design and scientific visualization. Other media techniques can be found in different subcategories, computer graphics algorithms (clipping, ambient occlusion, beam tracing, ray tracking), shading algorithms, coding theory algorithms (image and video compression).

The manner in which these algorithms act and are implemented in software is varied: it could be through the graphical user interface; or it could be in parallel or in sequential series; or they can be invoked by the click of one or a combination of buttons; or by parametric adjustments; or even automatically programmed upon an indirect action. Within this context, virtualizations of media may arrive by combining different algorithms and data structures. But at another level, virtualizations might also occur in the creation of new data structures and new algorithms. To put an example, let's imagine an engine to visualize the fourth spatial dimension. How to represent something that goes beyond the grasp of our senses and cognition?

TWO EXERCISES IN THE DESIGN OF PERVASIVE VIRTUAL WORLDS

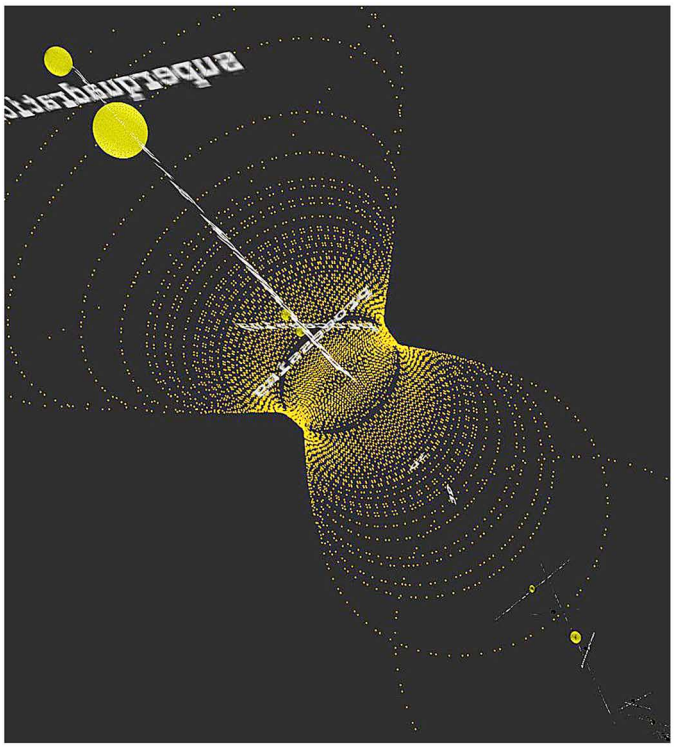
In this part we present a couple digital works developed by us. The intention is to inform the reader on the creative strategies put in practice behind our productions. In all the cases, we have tried to question standard and conventional paradigms of information visualization. Our practice is thus more related to speculative computing, aesthetic provocations, design by disruption, experimentation and media art.

Messages Vers Le Futur

'Messages vers le futur' was an installation presented at the event 'La nuit de chercheurs' at the IUT Bobigny, Paris, in September 28, 2012. The main intention of the event was to introduce science and technology to public in general. We decided to propose an installation consisting on a video projection and a computer station. In the projection the visitor saw the representation of a hyperbolic figure floating in a dark digital 3D environment. This figure was inspired from the theoretical concept of 'wormhole' in physics, coined by John Wheeler in 1967, also known as the Einstein–Rosen bridge, described as *a hypothetical shortcut for travel between distant points in the Universe* (Thorne, 1994:484).

The idea of 'Messages vers le futur' was to invite visitors to metaphorically send a message to the future. Through the computer station or through their mobile devices, they could send a message about they feelings or sensation of the present time: something appealing to them, or a recent event they lived, or something they would like to do in the future. This message could contain de hashtag #messagesfutur and so it appeared on screen in form of a 3D sphere along with the text of the message. The sphere crossed the wormhole and then disappeared from the projection. For every message sent, the user registered her email address and received the message sent one year later into her email inbox. Figure 3, shows a screenshot of the electronic wormhole and a message passing by.

Figure 3. Graphical projection from then installation Messages vers le future (Everardo Reyes, 2014).



Technically speaking, the projection was made with Processing, enhanced with the libraries Twitter API, TwitterStream, PeasyCam and Box2D. For the design of the hyperbolic figure we translated into the Processing language the mathematical formula of super-quadratic figures. We started from the main algorithm by Kostas Terzidis (Terzidis, 2009), who kindly agreed to be used as the base for 'Messages vers le futur'. Some assistance should also be credited to Eleanor Dare, who made suggestions to refine the algorithm and implementation in Processing.

The metaphor of space-time traveling was interesting to be studied. During the exhibition, it was well-received mainly by young visitors (teenagers and younger) who got the idea immediately. We received few questions about the graphical rendering. Instead, the questions were about the content of the message: what can I write? As the answer is open, users evoked the fact of messaging to a future self.

Another thing to note was the implementation of mathematical formulae. Because Processing does not have a function to draw a one-sheet hyperboloid, it was necessary to code the figure. This single aspect led to think on what other mathematical figures and surfaces does not have a computational representation though software. What are we missing because there is no access through software? Where can find alternatives to standardized software which already proposes different figures than those in Euclidean geometry? And ultimately, can we represent a fourth spatial dimension? This has been a real question in science and astronomy. Recent research at UC Santa Barbara demonstrated that, at very small nano scales, there are particles that exist in two places at the same time (Cho, 2010) or that time moves slower as we separate from the Earth's surface (Reinhardt, 2007).

In any case, what is interesting to evoke at this point is that virtualization of digital media has an opportunity with computers and electronic representation. Designers can obtain inspiration from the vantage point of objects and environment. How do objects perceive? What is like for an environment to be connected with multiple devices at the same time? How does the environment perceive the transmission of signals?

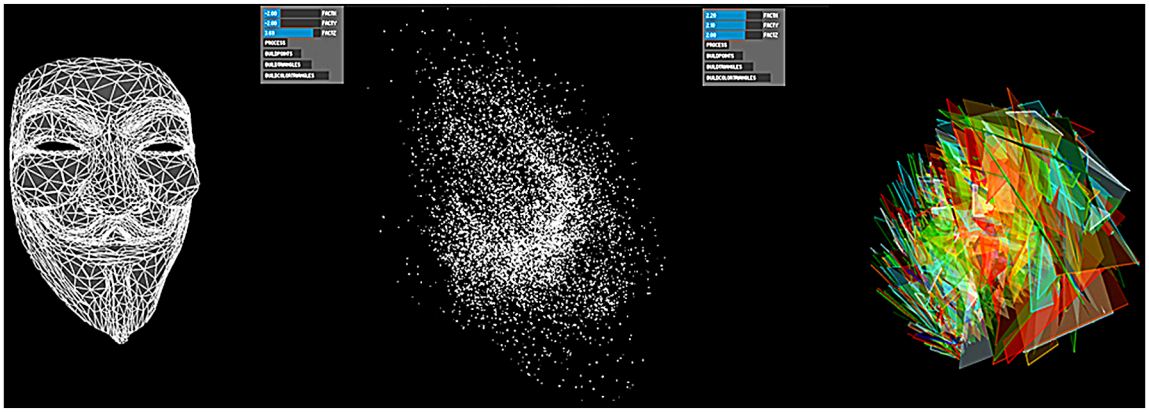
Disrupting 3D Models

3D models are generally considered as digital objects made of geometry that simulate width, height and depth inside a computational environment. Although their origins can be traced to computer graphics during the 60s, when pioneers created computer simulations, virtual reality, virtual worlds and visual effects in film, nowadays we encounter them in graphic design, video games, architecture, art, advertising, Web, industrial design, scientific visualizations, and digital humanities.

In 2012 we have developed a simple application that allows users to interact with 3D models. Technically speaking, we used Processing with ModelBuilder and ControlP5 libraries. The application basically takes a STL model and renders it in the 3D digital environment. For us, the importing process implies to read the original geometry in the STL file and to render it in its organized 3D spatial layout in form of a series of points or a formation of polygonal shapes (triangles). Once a file has been loaded, the user is able to interact inside the 3D view environment. A series of GUI sliders indicate modifications upon three factors. Additional buttons apply transformations, change mode view (points or triangles), and reset the model to its original state. Figure 4 shows an original model, the user interface and the resulting transformation.

The idea of the system is to invite users to perform transformations on the models. The resulting images from transformations are basically non-figurative. Some would be appealing but disrupting at the same time. They show how the same quantity of triangles in a model may be recomposed. Of course because STL relies heavily on tessellation, triangles are never broken apart. That means, geometry is not spread, they rather create new solid forms. If a transformation is made on the view mode of POINTS, then the result looks like a particle explosion.

Figure 4. Disrupting 3D models
Everardo Reyes, 2014).



As we mentioned earlier, we used Processing to develop our viewing/transformation system. Regarding the acquisition of 3D models, we used several different software applications depending on the input kind of model. Before developing our own application, we asked ourselves if it was possible to produce our generative transformations with existing software. Although Maya and Blender, among others, allow to enhance their functionalities with scripting code, we decided to create our own system mainly because we wanted to deploy a simple user interface to interact with objects. Indeed, Maya and Blender are complex environments that cover topics from modeling to animation and rendering. Furthermore, they handle their own file formats. It is possible to export/import to other formats but the main workspace remains the same. For us, we used STL format, which is widely adopted for 3D printing and would accordingly satisfy the desire of printing a complex and disordered model. But perhaps the main reason behind the production of this experimental system was the cultural practices that it supported. A complex and integrated environment, such as Maya in the case of 3D modeling, is suited for many tasks required by cultural industries but not precisely for a particular artistic approach and research need.

How could the approach on disruption be used for virtual worlds? We believe disrupting software could foster creative practices, but in a virtual world we can also disrupt reality, or the simulations of the physical world, or even fictions, plots and sequences of events. The task would be to challenge human perception, to adopt existing processes from other fields (science, astronomy, neurology, archaeology, etc.). But because software and digital media have the inherited intention of extending our senses, we have to consider the world at large, beyond our senses and experiences, from the transcendental perspective.

CONCLUSION

In this contribution we have explored the notion of pervasive virtual worlds in order to describe the analogical and electronic world that is mixed, extended and mediated through media. Media was understood in its largest sense: as technique and technology. Pervasive virtual worlds are composed of concrete and simple forms, but also of abstract and complex ones, produced by the interaction of heterogeneous elements: individuals, things, objects, machines; these forms can be physical but immaterial as well. Furthermore, recalling the idea of the world as larger than human perception and understanding, some forms can even be unknown for some actors of the world.

Pervasive virtual worlds is an idea aiming at opening opportunities for new design and communication processes. Virtual worlds are pervasive because there is an ever-increasing quantity and types of devices connected between them: from mobile handhelds to ambient intelligence to the internet of things. But simulation, communication, extension and virtualization do not depend on those artifacts to flourish, principally because they are latent. As we have seen, organs and actions are being virtualized in artificial worlds from the perspective of human beings, but there is still a lot of work to do if we approach virtualization from the vantage point of things in general, for example.

We proposed to study the design of media with software and the design of media software by taking into account four perspectives:

1. Media archaeological;
2. Standards and conventions;
3. Cultural;
4. Computational.

The main intention was to rethink media within a larger context and to point to design strategies for new media in creative manners. Media are the result of the vision of a series of actors, they are manifest in the form of representations, simulations, devices, graphical interfaces. These are for us examples of pervasive worlds that can be virtualized and actualized.

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KEY TERMS AND DEFINITIONS

Analytical Maps: A material and graphical support that tries to make evident and easy to identify patterns and trends about a domain. It consists of digital processing of data and its rendering in visual form. It is a tool for research and study. It could assist researchers that work in digital humanities, speculative computing, aesthetic provocations, design by disruption, experimentation and media art. The projects and experiments in analytical maps, as well as other forms of graphical representations, might also serve as conceptual tools to think about the virtualization processes and archaeology.

Computing Medium: Also related to the notion of 'software as medium'. It describes the computer as a media machine, that is, an virtualizing tool for creating media content, but also as a tool to create media software (software to create other media). The complexity of the computing medium relies in its combination of conventions from past new media with properties exclusive of digital treatment of signals and information. In that manner, not only the established conventions are now accessed and manipulated through graphical user interfaces, but also those conventions are informed by techniques from other domains and create new forms for designing media.

Media Archaeology: A recent approach elaborated within media studies that investigates the several virtualizations of actions, organs, and things as well as their implementation through technological means throughout historical periods. It assumes that there are actions that have already been virtualized and that those virtualizations have been translated into technical objects and then, more recently, to computing forms. It asks, among other questions: where do our tools come from? How are they related to past new media? What was at stake at the origin of the invention? How the invention altered other technologies? How media virtualize us and virtualize things?

Pervasive Virtual Worlds: A vision of the world from a creative and innovative standpoint, mainly for design and communication. It considers the emerging environment that combines analog and electronic media as the ground and sandbox to experiment with new forms of design and communication. It is an attempt to describe the analogical and electronic world that is mixed, extended and mediated through media. A pervasive virtual world is complex. It recalls the importance of taking into account concrete and simple forms, but also of abstract and complex ones, produced by the interaction of heterogeneous actors: individuals, things, objects, machines; these forms can be physical but immaterial as well. Furthermore, recalling the idea of the world as larger than human perception and understanding, some forms can even be unknown for some actors of the world.

User-Interface Convention: Generally referred as those graphical elements that have been embraced and acknowledged because they facilitate using a computer and software by a common person. Broadly speaking, UI conventions can be elements from the WIMP paradigm: windows, icons, mouse, pointers. But they is also related to visual and language metaphors, where the software applications reside: operating systems, middleware, etc. The most famous metaphor related to the computing medium remains

the desktop, but others can emerge in a time when portable devices, ambient intelligence and different kind of artisanal and experimental software develop.

Virtual World: In its traditional meaning, informed by the computer sciences, it can also be referred to as 'artificial worlds' or 'virtual environments'. From a different perspective, that is, from a philosophical one, a virtual world is approached as a state of being. Following the work by Pierre Lévy, Gilles Deleuze, Henri Bergson, there are four states of being: the real, the possible, the actual and the virtual. The virtual and the possible are latent, while the real and the actual are manifest. The main difference between the virtual and the possible is that the virtual questions a creative solution to a problem: it tries to problematize it again, while the possible only executes and repeats already existing solutions.

Virtualization: The passage from the actual state of being to the virtual. The actual is a manifest state that tries to solve a problem in a creative manner, but when this creative solution is questioned again it is re-articulated and virtualized. It is a process of dematerialization but at the same time of thinking, inspiring, reasoning, and connecting different (and often non-obvious) actors.

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Chapter 70
New and Strange Sorts of Texts: The Shaping and Reshaping of Digital and Multimodal Books and Young Adult Novels

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ABSTRACT

Dennis Baron (1999) writes about the impact of digital technology on literacy practices and thus is a good exemplar for considering how communication technologies are changing the ways in which stories are told. In this chapter, we argue that young adult literature authors and readers are currently in what Baron terms an inventive stage as they devise new ways of producing storied texts. Young adult authors, aware of their readers as avid, exploring, and savvy tech users, experiment with text formats to appeal to readers growing up in a digital "participatory culture" (Jenkins, Purushotma, Weigel, Clinton & Robins, 2009). In a cultural climate where the very notion of what constitutes a book is changing, our chapter responds to Baron's (2009) claim that readers and writers are in the process of "[learning] to trust a new technology and the new and strange sorts of texts that it produces" (p. x).

For many of us, the computer revolution came long ago, and it has left its mark on the way we do things with words. (Baron, 2009, p. 15)

Books as cultural tools are part of the shaping and reshaping of cultures and the stories those cultures tell. Recent changes in communication technologies have raised the alarm that *the book* as a format is in danger. Readers accustomed to the terse prose of Tweets and the speedy delivery of ebooks to their tablets, the worry goes, may lose interest in the long form of literary prose. However, the book per se is not as fragile and unchangeable as many fear; books have already proven that they can both cause and survive cultural shifts. In observing the power and resilience of the book, Richard Nash (2014) pointed out

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Books withstood the disruption of new modes of storytelling—the cinema, the TV set. And books have been the disruptor themselves many times, disrupting the Roman Church and upending the French aristocracy, the medieval medical establishment, then the nineteenth-century medical establishment. (para. 35)

Thus, as Nash asserted, the tensions surrounding contemporary developing communication technologies and their ongoing influence on the shape and form of the book echo the tensions expressed in previous moments of cultural change.

Two videos, both available on YouTube at the time of this chapter's writing, demonstrate this current moment of cultural tension surrounding the book. The first video, a piece of Norwegian sketch comedy originally broadcast in 2001 called "The Medieval Helpdesk" (NRK, 2007), shows a befuddled monk seeking expert advice on how to use the new technology of the codex. He expresses delight and frustration as he labors to understand the page-turning functions of the unfamiliar format. The second video, a more recent ad by Ikea (Ikea Singapore, 2014), features a serene speaker explaining the ease of use of the company's paper-and-ink catalog, referred to as not an iBook or an ebook but as a "bookbook."

The popularity of both videos (YouTube views combined are in excess of 20 million) points to the contested present in which practitioners of the book form--both readers and makers--find themselves. The videos' humor hinges on the ongoing anxious relationship between the book community and the technolog(ies) at its creative disposal. In the 2001 "Medieval Helpdesk" video, social satirists reflected the helplessness readers felt towards perplexing new digital formats and related practices (D'Arcens, 2014); in the 2014 Ikea work, marketers tapped into a perceived consumer nostalgia for the out-of-fashion process of turning a page. In less than 15 years, readers went from bewildered babes in the woods to wistful old hands.

But while readers and writers today are increasingly turning to portable technology for the consumption and distribution of texts, discussions within book communities over the nature and role of the book in the digital era are by no means settled. Instead, they continue to intensify. At the heart of the discussion is the very structure of texts and modes of content in the digital age and, as a result, the qualities and types of experiences available to readers and writers. Print-based books, by the nature of their physical make-up, are predominantly linear, ordered, and bounded while digital and electronic texts--which feature multimodal communication and linking capabilities--can be multi-sensory, changeable, impermanent, flexible, and unbounded. Creators, academics, publishers, and users wrestle with this overarching problem: Given that the book form is a technology that directs extensive aspects of human experience, what are the effects when that technology is radically altered, when the components of "bookness" are profoundly disrupted? Said differently, what happens when the structure of the book, which Marshall McLuhan (1960) argued was responsible for human constructs ranging from the assembly line to romantic love, is displaced by newer technologies of knowledge? Underlying these concerns is an even more daunting inquiry: If, since its inception, the technology of the book has guided how humans make knowledge, then how can the features of digital communication technology support humans "to begin to think differently" (McLuhan, 1960) and what repercussions might that thinking differently bring?

The scope of these questions is vast, which perhaps adds to the current jitteriness of the discussion. Dennis Baron (2009) comfortingly reminds us that we are in the process of learning to "trust" these emerging communication technologies and the "new and strange sorts of texts" (p. x) made possible by them. In this chapter, we start by looking at some of the tensions surrounding the impact of digital technologies on the book format and how those tensions might be framed within stages of technological development. We give an overview of early electronic literature as a response on the part of authors

wanting to experiment with what new literacy technologies make possible. Recognizing the impact of Internet and computer use on young people, we position readers of young adult (YA) literature as integral to literary experimentation taken up by creators of YA novels seeking to engage and respond to their Internet-fluent audience. We will look at how such text-related trends as transmedia and user-developed content point to the need for research, particularly educational research, to inform practices around the cultivation of students as text participants (Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009). Finally, we will examine conversations around standards and policy that suggest educators can create generous spaces of learning that include young adult literature and digital media so that students can participate in and eventually lead this present technological moment.

WHAT IS A SUCCINCT OVERVIEW OF THE RESEARCH?

Stages of Communication Technologies

We find it useful to view the changes impacting notions of the book and other textual formats through Baron's (1999) stages of literacy and communication technologies. Baron argued that with new technology, "we are thrown into excitement and confusion as we try it on, try it out, reject it, and then adapt it to our lives—and, of course, adapt our lives to it" (p. 16). He posited that literacy technologies go through similar stages of development, whether they involve making marks in clay or displaying pixels on a screen: the stages of invention, accessibility, function, and authentication.

High costs and small numbers of early adopters usually mark the beginning invention stage of new communication technologies, when "practitioners keep [the technology] to themselves...either on purpose or because nobody else has any use for it" (Baron, 1999, p. 16). After periods of relatively exclusive use, this "priestly" class adapts and mediates the technology so that it becomes more generally functional, primarily by presenting the technology as similar to existing communication practices. Costs drop, and as the public recognizes the usefulness of the technology, they respond by developing new literacy practices. "Only then does the technology come into its own, no longer imitating the previous forms given us by the earlier communication technology, but creating new forms and new possibilities for communication" (p. 16). As the practices associated with the new forms become prevalent, the technology undergoes an authentication stage, where segments within a given society negotiate appropriate use and work to establish trustworthiness of the technology by combatting fraud and other illegal operations.

As an example, Baron (1999) used the pencil. Early pencil production involved "proprietary secrets as closely guarded as any Macintosh code" (p. 18) and required increasingly fine-tuned experimentation in lead mixtures, wood selections, production equipment, extrusion processes, and finishing elements, such as built-in erasers and painted exteriors. Over the 250-year course of its development, "the humble wood pencil…developed from a curiosity of use to cabinet-makers, artists and note-takers into a tool so universally employed for writing that we seldom give it any thought" (p. 18). As part of the pencil's incorporation into social use, users experimented with it, making decisions about where it was useful and trustworthy (e.g., in schools) and where it was not (e.g., in legal documents).

Like pencils, Baron (1999) argued, computers went through their invention and "priestly" stages when only a few used them, but their access and functionality expanded as users acquired the emerging technologies, experimented with them, and expanded their function. Currently, computer-based technologies are in the midst of an intense authentication stage as users—including institutions such as

governments, educational bodies, corporations, and religious entities—engage in negotiations around possible and acceptable practices. Trustworthiness is an ongoing development; the International Society for Technology in Education (ISTE) sets standards for technology use in schools that include "safe, legal, and responsible use of information and technology" (ISTE, 2007) and cyber crime is listed by the U.S. Department of Justice as a top priority (United States Department of Justice, n.d.).

Viewed Through Stages: Early Hypertext Fiction as Invention

Baron's stages are recurrent, concurrent, and inexact, as can be seen in the varied cycles between contemporary technological innovations and the users who adopt, adapt, and distribute them. With this entanglement noted, the stages nonetheless provide a useful lens for considering the impact of digital and electronic technologies on the form of the book. In moving from printed page to pixeled screen, authors in the last quarter of the 20th century entered a "curiosity of use" stage (Baron, 1999, p. 18), akin to the experimentation Baron attributed to 16th century cabinet-makers exploring the affordances of the newly invented pencil.

In 1987, author Michael Joyce plunged into the inventive stage of digital book forms when he wrote what is generally considered the first hypertext fiction, *afternoon, a story*. Hypertext fiction takes advantage of the linking functions available via computer codes and software to create an interactive text. Instead of the assumption made by print authors that readers will follow a word-by-word, sentence-by-sentence path through a piece of writing, hypertext fiction authors programmed hyperlinks into their writing that allowed readers to move from site to site (or node to node) within a text. In *afternoon,* Joyce used a nodal textual architecture (via the early hypertext software Storyspace) to construct a network of multiple pathways through the story. Depending on the links readers chose, the narrative--and the experience of the story--changed.

Joyce (1991) envisioned a flowering of hypertext fiction where the reader-as-writer would "[give] birth to the true electronic text" (para. 25). This reader was better termed, Joyce said, as an interlocutor who would have a "reciprocal relationship" (para. 32) with the author and co-construct the text as she read. In this way, hypertext fiction put the author's authority under pressure. The architecture of hypertext fiction, which relied on the reader to make choices and to retrace pathways for different effects, encouraged a deliberately different alliance between author and reader than the one engendered by fixed and linear print texts. Writing about the impact of hypertext on fiction, Joyce said, "The book is dead, long live the book" (para. 9). In this statement was the recognition of transformational writing technology, the prediction that while *the book* might be disappearing, it would be remade based on the interactive possibilities afforded by electronic and digital technology.

Around the same time, new media theorist Jay David Bolter (1991a) also saw the impact emerging electronic technologies would have on traditional print books, placing the development of electronic literature within a historical context:

Electronic technology remakes the book in two senses. It gives us a new kind of book by changing the surface on which we write and the rhythms with which we read. It also adds to our historical understanding of the book by providing us with a new form that we can compare to printed books, manuscripts, and earlier forms of writing. (p. 3-4)

As an example of such comparisons, Bolter cited the period following the invention of the printing press, during which printers continued to produce texts bearing the same characteristics as handwritten manuscripts. "It took a few generations," Bolter noted, "for printers to realize that their new technology made possible a different writing space" (p. 3), one that allowed them to present written words in ways that were markedly different from earlier manually scribed texts.

Hypertext as Laboratory

Bolter and Joyce were both writing during what author Robert Coover (1999) described as the golden age of literary hypertext, the decade before the development of commercially available browsers that made the Internet--and its increasingly multimodal, user-produced content--widely accessible. In the 1980s and 1990s, hypertext was taken up by several authors as a new technology of reading and writing that could change the textual landscape. Hyperfiction writers such as Stuart Moulthrop (*Victory Garden*), Judy Malloy (*Uncle Roger* and *its name was Penelope*), and Shelley Jackson (*Patchwork Girl*) created hypertexts that were nodal and linked, but primarily print-based, a hallmark of early writers experimenting with the new electronic technologies. George Landow (1992/2006) and other early hypertext theorists (e.g. Bolter, 1991a, 1991b; Joyce, 1995; Moulthrop, 1994) saw hypertext as a "laboratory in which to test…ideas" regarding "textuality, narrative, and the roles or functions of reader and writer" (p. 2). This laboratory produced a variety of metaphors to describe hypertext: non-linear text (Nelson, 1981), a structure of structures (Bolter, 1991a), an event (Morgan, 2000), and a network of possibilities (Hayles, 2002), among others.

The energy behind the early days of hypertext fiction pointed to the profundity with which emerging technologies were impacting notions of the book and, along with it, literacy. James Gee (2003) maintained that "we never just read or write…we always read or write *something in some way*" (p. 14). Hypertext, with its focus on text architecture, interactivity, indeterminancy, and reader-as-writer authorship, changed both the *something* (product) that was written or read and the *some way* (process) in which that product was created and consumed.

Hypertext as Transformational Technology

The enthusiasm with which early hypertext authors and theorists engaged in their inquiries point to the transformational nature of the electronic technologies they were employing. Landow (1997) argued that hypertext "calls into question ideas of plot and story current since Aristotle" (p. 181). Instead of the traditional novel's fixed page and predictable order of printed words, hypertext resisted closure by offering readers a "field of linkage and associational play whose meaning depends upon permutations" (Moulthrop, 1991, p. 260). Instead of the traditional book's claim of a clear differentiation between author and reader, hypertext intentionally fused the two, requiring the reader to make overt decisions to navigate the text. Instead of the absolute authority of the lone author, hypertext exploded the boundaries of text by not allowing a single point of view. Hypertext permitted authors to demonstrate that the notions of plot and story in Western culture, made so commonplace as to be considered common sense, were the function of print technology, and therefore open to transformation by new technological developments.

"Print fiction," wrote Bolter and Joyce (1987), "is proud of its rigidity," and since hypertext could not depend on fixity as a core attribute, it "must therefore draw its aesthetic strength from its capacity for change" (p. 49). Communication researcher Johndan Johnson Eilola (1994) saw the impact of hypertext thusly:

[Hypertext provided the] opportunity to remap [our] conceptions of literacy, to reconsider the complex, interdependent nature of the ties between technology, society, and the individual in the acts of writing, reading and thinking. Adding the concept of hypertext to theory does not replace other definitions or conceptions of writing and reading; it opens those definitions up to debate and change." (p. 204)

During the golden age of hypertext, the debate was enjoined. The traditional book was to be disrupted as authors took into their artistry the affordances and constraints of emerging electronic communication technologies.

Tensions in the Accessibility Stage

Using Baron's (1999) stages of literacy technology, the experimentation that is fertile during the invention stage undergoes pressure as a technology becomes more widely accessible and adopted. As more people take up a technology, it spreads into general use, but some of the earlier innovations may be dampened as adopters map it onto familiar, existing practices. With digital literacy technology, this movement can be seen in Coover's (1999) description of hypertext fiction's transition into what he called the silver age:

Silver ages are said to follow upon golden ages as marriage and family follow upon romance, and last longer but not forever. They are characterized by a retreat from radical visions and a return to major elements of the preceding tradition — while retaining a fascination with surface elements of the golden age innovations, by a great diffusion and popularization of its diluted principles and their embodiment in institutions, and by a prolific widespread output in the name of what went before, though no longer that thing exactly. (para. 4)

In Coover's view, the silver age of hyperfiction was ushered in "almost overnight" (para. 14) by the emergence of Internet accessibility, along with browsers, html code, laptops with large memory banks, and other technological developments that made hypermedia--with its multimodal, massively linked social networks--a practicable avenue for human expression.

Influence of the Internet

Whereas the 1980s had seen hypertext fiction develop from a "daring" and "frivolous" form to one that was "a serious and sensible" use of computer technology (Bolter & Joyce, 1987, p. 41), by the dawn of the 20th century, hypertext was "used more to access hypermedia as enhancements for more or less linear narratives, when it's not launching the reader out into the mazy outer space of the World Wide Web, never to be seen again" (Coover, 1999, para. 15). Coover argued that such an environment, where hyperlinks were synonymous with surfing the Web, was not conducive to the kinds of literary thinking taken up by early hypertext authors.

[The Web] tends to be a noisy, restless, opportunistic, superficial, e-commerce-driven, chaotic realm, dominated by hacks, pitchmen and pretenders, in which the quiet voice of literature cannot easily be heard or, if heard by chance, attended to for more than a moment or two. Literature is meditative and the Net is riven by ceaseless hype and chatter. Literature has a shape, and the Net is shapeless. The discrete object is gone, there's only this vast disorderly sprawl, about as appealing as a scatter of old magazines on a table in the dentist's lounge. (para. 15)

As the multimodal, hypermedia features of the Web became more usable, Coover claimed, writers (and readers) would generate texts that did not privilege the word but were constructed to share space with images and sound. While these "wondrous and provocative invasions of text by sound and image" (para. 22) were not wholly welcomed by Coover, he nonetheless saw them as opportunities for authors to experiment and develop the technological tools at their disposal.

Response to Born-Digital Literature

The stage seemed set, as it were, for a maturing of electronic literature into more general use as authors and readers accepted digital and multimodal texts as commonplace literary forms. However, that maturing did not necessarily take the form or occur with the speed that the early hypertext community predicted. One expectation was for a robust industry of born-digital literature, defined by Katherine Hayles (2008) as a "first generation digital object created on a computer and (usually) meant to be read on a computer" (p. 3). In the first 15 years of the 21st century, the development of the field of born-digital literature has been uneven. YouTube (n.d.) reports that 100 hours of video are uploaded daily to viewers who watch 6 billion hours a month, but the growth of born-digital literature has been less secure. In the emerging field of transmedia, for example, technological barriers and wary publishers are among the challenges transmedia creators navigate as the form strives to take hold (Piesing, 2012). Numbers of readers who purchase e-books may be growing, but it is harder to get a handle on numbers of readers of born-digital literature (Bell, 2014). In a reflection on the field of electronic literature, Scott Rettberg (2009) wrote, "Electronic literature has not found a large popular audience, and it is entirely possible that it never will" (para. 6).

Referencing the popularity of the e-book platform, where many books are electronic versions of print texts, Bolter (2010) noted that the introduction of new technology does not necessarily mean that new forms will be taken up.

You could say that e-books change everything. You could say that they are magical and revolutionary. You could also say that they change nothing. In much the same way the digital cinema could be said to be simply the perfectly projected digital version of traditional Hollywood film, the e-book could be said to be .... the digital remediation of the printed book. (Bolter, 2010)

Through remediation rather than transformation, Bolter posited, "the community may accept this change of technology without rethinking the form or cultural position of the book at all." This resistance to rethinking the book, he argued, can be seen by the muted response to born-digital literature by the traditional academic and literary establishment, which has remained committed to print forms. In this light, Joyce's earlier ironic statement becomes commutative: the book is dead = long live the book.

ONGOING STAGES OF INVENTION AND AUTHENTICATION

Despite an expressed disappointment by early adopters of hypertext literary forms, contemporary users continue to take up new communication technologies and manipulate them for their own purposes. Indeed, in terms of novels and other storytelling media, computer-based technologies are arguably still in an ongoing "curiosity of use" stage, in which authors, illustrators and creative teams are experimenting to see just what is possible. As Rettberg (2009) observed,

Electronic literature has forked down a multitude of paths, so many in fact that it has become difficult to describe the field in terms of distinct genres. In comparison to other literary cultures, e-lit culture is still marginal, produced by a comparatively small group of writers dispersed around the globe, often working in isolation. (para. 4)

And yet, Rettberg continued, the field is growing as indicated by the increasing number of dissertations, festivals, and examples of work being produced. Whereas early hypertext blended new capabilities (branching and linking) with more familiar forms (established patterns of print texts with few images and sounds), born-digital literature now encompasses a full range of multimodal features and exists in multiple formats and platforms as creators continue to challenge the form and structure of the print novel.

In the midst of this literary experimentation, issues of trustworthiness and authentication are also in play. A National Endowment for the Arts report (2007) queried the role of technology in American reading trends within the context of those trends' "considerable consequences" (p. 5). Educators are examining the role communication and literacy technologies play in reading practices through the affordances of multimodal digital texts (e.g., O'Brien & Voss, 2011), in relation to students with disabilities (e.g., Schneps, Thomson, Chen, Sonnert, & Pomplun, 2013), and in regards to national literacy standards (e.g., Dalton, 2012/2013, 2013). Awards and recognitions tackle questions of literary quality and merit (e.g., Electronic Literature Organization, 2014). In this way, participants in the field of digital texts find themselves navigating through recursive--if messy--stages of development to gain permanence.

WHAT ARE THE CURRENT ISSUES IN THE FIELD RAISED BY THESE STUDIES?

To discuss the current issues involving the impact of digital technology on the book, we focus on one literary field--the young adult novel. Writing in the 1960s, McLuhan (1960, 1964/1994) argued that electronic media had transformational effects on its users, and because young people of his era grew up as television viewers, they engaged with the world differently than previous generations whose experiences were molded by print technology. We take up McLuhan's construct of youth in the electronic age to suggest that audiences for young adult novels, having grown up as computer users, have different expectations of and experiences with texts than readers from previous generations. As a result, young adult literature has become a site for a rich curiosity of use stage as authors experiment with text forms and practices aimed at these readers.

In this section, we look to young adult literature--in its curiosity of use period--to consider how technology is impacting the form and function of contemporary narrative. We give an overview of data as evidence of adolescents as avid users of digital technology. We examine specific examples of young

adult literature to consider how technology-derived subgenres are incorporated within print-based narratives, how technology is used to disrupt and replace narrative structures, and how technology allows new ways to read and participate in narrative formats within storyworld and across platforms.

Adolescent Readers as Technology Users

Considerable data indicates the prevalence of online participation by teens and young adults. Recent Pew reports shed light on the amount of time young people spend on the Internet and the types of activities in which they engage while online. Ninety-five percent of American teens ages 12-17 use the Internet, while 76% of respondents in that age group report using social networking sites and 77% report having cell phones. In the 18-29 age group, 96% report being Internet users, while 84% use social networking sites, and 97% report having cell phones (Anderson & Rainie, 2012). In addition, 57% of teens are "content creators" who employ the Internet to make blogs and web pages; distribute personal artwork, narratives, and videos; and craft mash-ups (Lenhart & Madden, 2005).

With their audience so connected to digital technology, it is not surprising to see YA authors experimenting with digital-related features in their texts, effectively engaging in an invention stage. In a recent newspaper article, publishing experts laid out two trends in the production of digital texts that, if taken together, can point to how digitally-derived young adult literature is in a generative curiosity of use period. The first is the emergence of Tumblr as a venue for creative work, particularly for fanfiction. Tumblr has developed into "a co-creation, self-publishing platform" (Rafferty, qtd. in Flood, 2014, para. 2). Oftentimes working collaboratively, "thousands of people are...producing a lot of short-form, episodic fiction and hundreds of thousands more are reading it.... Tumblr allows this creativity to explode, making it very easy for readers and publishers to discover real talent and energy there" (para. 2). Industry observers note that the site's image-based orientation makes it "increasingly important" for people in creative fields (Bercovici, 2013). Industry data indicates that Tumblr users skew toward a younger demographic, with 46% of the 34 million contributors/users worldwide between the ages of 16 and 24 (Smith, 2013). Whether these young adult users are posting individually created content, working collaboratively to generate content, or engaging with and reposting other users' content, they are involved in a complex fertile sphere of content creation.

A second trend identified by digital publishing experts is the continued struggle of "anything involving location-based storytelling, intrinsic and overt gamelike interactivity, augmented reality, and 'born digital' fiction" (Franklin, qtd. in Flood, 2014, para. 4). However, experts noted, "these experiments" can be commercially viable if done well (para. 4).

We see in these two trends an incentive and logic for young adult literature authors to be experimenting with digitally-related and born-digital texts. An audience that is actively engaged online and who makes up approaching 50% of the users of a noted creative site are more than readers. Many of them are part of what Henry Jenkins et al. (2009) termed a "participatory culture:"

A participatory culture is a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one's creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices. A participatory culture is also one in which members believe their contributions matter, and feel some degree of social connection with one another (at the least they care what other people think about what they have created). (p. xi)

These participatory teens are not only reading online, they are reposting and linking. They aren't only consuming, they are taking the tools of production into their own hands, sometimes in commentary, sometimes in collaboration, sometimes in individually created works in which they seek out and reciprocate with feedback. This atmosphere is fast-paced, public, and messy--and it is into this oxygen that young adult literature authors enter, curious and motivated, trying to find formats, textual elements, and narratives that will reach their readers.

Echoing McLuhan, Ong (1982) contended that "[t]echnologies are not mere exterior aids, but also interior transformations of consciousness, and never more than when they affect the word" (p. 315). Miskec (2007) argued that today's adolescents "have lived a distinct way of knowing the world because of their connection to technology--a very different experience than those in the generations that preceded them" (p. 7). The digital connection that shapes adolescents' way of seeing the world also shapes how they see books and stories told across multiple media. Texts no longer are defined as words on paper, presumably (and falsely) created by a lone author. For adolescent readers, texts can be multimodal, interactive, hyperlinked, dispersed, revisable, rhizomatic, and nodal, which renders insufficient the concepts of print-only modes of text production and bounded, fixed texts.

But, as Jenkins et al. argued (2009), "the computer does not operate in a vacuum" (p. 7). Incorporating digital technologies into text creation "necessarily affects our relationship with every other communications technology, changing how we feel about what can or should be done with pencils and paper, chalk and blackboard, books, films, recordings" (p. 7). Changing familiar formats and creating new possibilities for stories by shifting from words on paper to more multimodal and digital formats changes the tools people use to structure consciousness. YA authors are involved in this consciousness restructuring as they use media that transforms text into new shapes and forms, thus building on the ways their readers--media-savvy teens--engage with and make sense of the world.

New and Strange Books and Young Adult Novels

The affordances of digital media—linking, interactivity, connectivity, sound, animation, and immediacy of information—provide opportunities for readers to explore and engage with texts in an expanded textual landscape. The pervasiveness of digital media and the ease with which readers can navigate digital texts allows for different kinds of movements through texts. The linear movement through a text, facilitated by the familiar structure of a book, is shifted when the text is moved to a digital format; modes can be combined within the same framework; navigation among and out of screens can be as easy as following a link. This redefines the structures of the story and challenges the expectations for what readers do as they read. This remaking of a path through a book challenges the linear structure of the book as well as the long-established traditions associated with linearity—tension, transitions, etc. Glazier (2002) noted that what "writing *is* becomes altered by how it is physically written through its production technology" (p. 4). What is necessary in one format becomes obsolete in another as the way in which text is created alters and shapes what stories can be told.

The use of digital technology in and for books and YA novels is increasingly complex as authors explore the composing possibilities of digital technologies. "Many young adult authors utilize the affordances of digital media—non-linearity, lack of closure, narrative dispersed across multiple genres, disrupted narrative flow, and images that carry narrative weight—to situate their texts in larger digital contexts" (Parsons and Hundley, 2012, p. 242). These affordances provide young adult authors with other tools, not bounded by the shape and form of the book, to tell their stories. Changing the tools of storytelling

illustrates Bolter's (1991a) argument that technology allows for a "new kind of book by changing the surface on which we write" (p. 3-4). Thus, what stories can be told and what tools can be used to tell them reconstructs expectations of the book. As readers become more and more fluent in social media such as texting, Facebook, blogging, etc., authors are beginning to incorporate those reading experiences into the texts they create. Authors are also considering the ways in which multiple media formats can be combined to tell stories; for example, authors may use print and video side-by-side to tell a particular story. Additionally, some authors are experimenting with digital only text structures and exploring what stories can be told using web-based storytelling. In this section, we will examine ways in which technology is currently shaping and reshaping the narrative structures authors are using to construct the novels.

Technology Subgenres Within Print-Based Narrative

The description of today's teenager often discusses the ways in which that teenager engages with the digital world, focusing, in particular, on teen participation in social media. Sweeney (2010) argued,

The students that we teach today are products of a very different environment, one in which the ability to stay connected with others is constant and communication takes many forms. Writing, for adolescents who live in an age of digital communication, has taken on new importance and plays a prominent role in the way they socialize, share information, and structure their communication. (p. 121)

The texts these adolescents create and the narratives they construct across media provide an alternative paradigm for the structure of the book. This way of knowing the world, connected, interactive, and immediate, shapes their expectations of text and media. The influence of social media—Twitter, instant messaging, texting, Facebook, Instagram, etc.—shape the teen as both reader of multiple media texts and also as creator of those texts. The tropes and protocols of social media become a part of their expectations of composing for that media.

Social Media Tropes Used in Narrative

Authors such as Todd Strasser, Alex Bradley, Adele Griffin, Ken Baker, and Mari Mancusi incorporate the tropes of social media into the structure of their narrative. These authors use email, blogs, Twitter, and instant messaging (IM) within what are essentially traditional print texts to explain events, provide conflict, and push their characters to action. The role and use of social media in the context of the story relies on a reader who is familiar with the protocols of that media. Incorporating social media as a component of the text adds to the complexity in two ways; it disrupts the narrative flow and it challenges the reader to construct the story across multiple genres. Understanding social media as different genres of communication requires a reader who is relatively fluent in how those media are used in daily interactions. While many students "do not recognize this type of communication as writing" (Sweeney, 2010, p. 124), they are familiar with the expectations of a Facebook status update, an instant message, a Tweet, etc. "Writing," Sweeney (2010) acknowledged, "is an integral part of students' lives today due to their use of texting and social networking sites" (p. 124). YA authors recognize their readers' engagement with these forms of social media and make the choice to include these formats. This increases the authenticity of the adolescent characters' experiences in the text while also providing composing tools for the author.

Strasser's (2011) murder mystery *Kill You Last* uses texting and email in the narrative structure to provide both clues to the mystery and to create suspense for the reader. The novel opens with a prologue that provides an example of each. Shelby, the main character, receives a text from a boy she is interested in dating and a short email from someone who tells her, "I like you, Shelby Sloan. If I have to kill you, I'll kill you last" (prologue). The tone of the text and the email provide immediate contrasts; the text is friendly and uses text speak while the email is threatening and uses complete sentences. When Shelby receives the second threatening email, she shows both to her friend who asks, "Who sends e-mails?" (p. 2). This question establishes the expectation that texting is new and current while email technology is older, providing a clue to the identity of the person making the threats. Later, some emails from that character feature text speak but others do not. Shelby confronts Ashley, a classmate who has admitted to sending her threatening emails, and learns that there are two people sending threats using similar screen names. Shelby and Ashley compare the patterns for texting and the use of sentences. The emails that use text speak are clearly from a teenager. The emails that actually threaten Shelby are written in more formal speech. This important clue is hidden in the text expectations; Ashley treats the short emails as though they are text messages and uses the accepted protocols for texts; the killer treats emails as short letters and uses the accepted format for letters. Recognizing the protocols and expectations of different subgenres as both a tool for storytelling and as a clue within the narrative requires a writer who is familiar with textual expectations and knows how to manipulate social media features. It also calls upon readers to know and recognize those protocols and expectations in order to engage with the story.

Wish You Were Dead (Strasser, 2009) builds on the expectations of social media and the ease with which online participants can hide their identities. The novel, another murder mystery, uses layers of social media to create the story. Blogs, blog comments, screen names, text messages, and Facebook are embedded in the narrative. An anonymous blogger posts how much she hates a popular girl, and the popular girl disappears. Characters text each other, post comments to the blog, and refer to Facebook. The juxtaposition of the social media tools that are used by the characters or referred to by the characters establish authenticity. Social media is employed in multiple ways and in multiple contexts by teens so the layered use of social media in this novel contributes to an interactive feel as well as a sense of reality. The readers see the blog posts that detail a very stressed teen girl's struggles at fitting in; the accompanying comments mirror the kinds of typical blog responses seen in online spaces. The blog comments range from caring to hostile. The ability to hide or create different identities is an intrinsic aspect of social media, and authors use this ability to create/recreate their characters.

24 Girls in 7 Days (Bradley, 2006) uses the anonymity of social media to explore how protagonist Jack can connect with multiple girls in a short period of time. Jack openly acknowledges that his love life is awful; his friends decide to help him find a date to the prom. While he is talking to, emailing, and meeting the girls on his friends' lists, he receives emails and instant messages from Fancypants. Over the course of the seven days, he falls in love with Fancypants without knowing who she actually is IRL (in real life). When her identity is revealed, it challenges his established relationship with her because he has to re-examine it with the lens of what he knows about Fancypants. This ability to hide one's identity behind a screen name in order to develop a relationship challenges the expected social mores.

The destructive power of social media is highlighted in Cann's (2004) *Text Game*; in this novel, a devious fellow student uses insidious text messages to break up Melissa and Ben just as they start their relationship. The texts interrupt Melissa's day, and this highlights both the anonymity of texting and the immediacy of the messages. The texts continue over several weeks; Melissa doesn't know who is sending them or if she can trust Ben. The constant comments about how Ben is going to break up with her, how

ugly she is, and how she can't trust him disrupt Melissa's life as well as the narrative flow of the story. Visually, the texts are in bold and inset from the other paragraphs. Each text is preceded by a symbol for a text message. The visual style signals the use of social media and the interruption of the narrative flow.

Facebook and texting take center stage in Griffin's (2010) *The Julian Game*. Raye is a new student at an elite private school. On a whim, she creates a Facebook profile for the imaginary Elizabeth, describing her as an exchange student from Poland. Raye creates such a believable profile that Elizabeth is suddenly "friended" by most of the popular people at her new school. This set up, which eventually leads to Raye's duplicity being discovered, allows the author to depict the ease with which social media can be used in cyber-bullying. When presented with the opportunity to "destroy" another character, Raye muses that she is "[p]rotected and anonymous, a ghostwriter without fingerprints" (p. 191). The author relies on the reader to bring certain knowledge and experiences to the text: an understanding of the protocols of social media such as posting, following, commenting, friending; familiarity with cyber-bullying through news stories or personal experiences; and awareness of the ubiquity and inescapability of social media.

Mancusi's (2008) *Gamer Girl* incorporates the instant messaging components of a gaming environment. The author weaves a traditional narrative, game play--including the instant messaging between players--and manga to create a story about identity and relationships online. This story relies on the reader's understanding of the role of instant messaging in game play and recognition of how closely players identify with their characters. The main character Maddy moves in and out of identities and uses gaming plots to create a fanfiction manga, reflecting similar practices by adolescent readers. Without an understanding of these digital literacy practices, the reader would not be able to weave the storylines together to see how integral the gamer identity is to those who participate. The adolescent reader, as a participant in these forms of digital practices, is able to construct meaning across the texts.

Incorporating social media into more familiar narrative structures allows authors to bring to bear multiple levels of engagement and understanding to the narrative; this level of experimentation with the tools requires not just author exploration but also reader fluency.

Blogs and Blogging as Tropes Used in Narrative

Like other social media tools, blogs provide an opportunity for a character to express his or her opinion or to comment on what someone else has posted. The characteristics of blogs provide an opportunity for authors to explore the private/public nature of social media, the longer structure of blog posts as opposed to Twitter or Facebook, or insight into a character's secret thoughts. Shana Norris, Cathleen Davitt Bell, and Robynn Clairday are authors who use blogs to reveal secrets and explore character motivation.

In Norris's (2008) *Something to Blog About*, main character Libby has had a pretty rough few weeks. She's set her hair on fire in a horrible chemistry lab accident. Not only that, she did it in front of the boy she really likes. Her mother is dating her arch-enemy's father. Libby does what many teens do when they feel overwhelmed by their lives--she writes about it in a blog. Norris incorporates Libby's blog into the narrative, building on the expectations that blogs are places for characters to explore the way they are feeling about events; in this particular text, the author equates blogs with diaries. Just as a teen expects her diary to be secret, so too does Libby expect her blog to be secret. When this expectation is violated and the blog becomes public, Libby recognizes a key aspect of online posting; nothing is ever really private. In this way, the author engages with the public/private nature of writing.

The speed in which the divide between public/private writing can be dismantled is illustrated in Bell's (2011) *Little Blog on the Prairie.* Main character Gen begins blogging as a way to vent her feelings

about being forced to participate in a pioneer summer camp. Her blog gradually increases in popularity until she has over 500,000 followers. The author uses the rapid rise in popularity of Gen's blog to show how social media interactions can become news stories themselves. For example, the author picks up on how blogs can lead to social activism when Gen writes about the possibility of having to kill Pumpkin, a chicken that lives on the farm, and almost immediately someone a creates a "Save Pumpkin" Facebook page with almost 20,000 followers. Gen's blog takes on a life of its own, spawning Facebook pages, news stories, and a reality television show. In this way, the story explodes the public/private nature of blogging and demonstrates how online texts can become memes or other social markers.

Genesis Bell, the main character in Clairday's (2005) *Confessions of a Boyfriend Stealer*, knows exactly how public blogs can be and uses that to her advantage. She writes her blog posts, not to deal with her emotional issues with her family, but rather to tell her side of an ongoing battle with her ex-best friends. Genesis uses the public nature of the blog to control the public story of how she "stole" her two best-friends' boyfriends. She also uses the blog to explore her thinking behind the movies and documentaries that she makes as class projects. She talks explicitly to the reader of her blog, and, while there are comments on her blog, she does not have a dramatic moment where her blog is shared with the other characters. Clairday's Genesis differs from Norris's Libby and Bell's Gen because she understands how blogs can be used. She tells the reader in the first post that she is there to tell her side of the story. In this instance, the author uses the reader's understanding that blogs and social media are ways to talk directly to the public in order propel the story.

In these examples, we can see how readers must be familiar with the tropes of social media in order to figure out how to situate the media within the context of the story. Young adult authors play with the reader's understanding of the media to provide authenticity to their teen characters but also to challenge traditional narrative formats.

Technology to Replace the Narrative

Just as some print authors eschew paragraphs and chapter structures and choose to write novels in verse or in diary or letter formats, some young adult authors choose to use the formats of social media as the tool to tell their story. Authors such as Lauren Myracle and Elizabeth Rudnick do more than incorporate social media into the narrative structure of their novels; they use social media to replace the traditional narrative format. For readers who are not active users of social media, this can be disorienting. The visual layout of the pages of these novels resembles the on-screen look of instant messenger, Twitter, emails, and blogs. For the reader, this establishes how the novel should be read and seamed together. The visual cues are necessary to provide the roadmap for the novel.

Myracle's (2005) *ttyl* is the first in a four-book series about Maddie, Angela, and Zoe; what is unique about this series is that each book is told entirely in IM format. There are no paragraphs or chapter breaks. The conversations are divided by dates rather than chapter headings. Tools such as narration, description, and transition are replaced by IMs. The use of IMs as the way in which the story is told alters how the reader learns about characters and how tension is developed. Choosing a different platform for constructing the story both limits and expands what the author can do in the telling of the story. Relying entirely on what Maddie, Angela, and Zoe say in their IMs means that everything that happens in the story is reported action occurring off-screen. If the characters attend a party, the reader does not see them at the party, rather the reader sees what the characters say about the party. The characters have screen names, use emoticons, and visually represent their actions with short phrases framed by asterisks. This method

of storytelling relies on a reader who is a fluent user of instant messaging and understands not only how to read IMs but also how to combine multiple people's IMs into a coherent story.

Rudnick's (2010) *Tweet Heart*, like *ttyl*, requires readers to seam parts of the narrative together. However, *Tweet Heart* does not rely on a single format of social media to construct the text. Rather, it combines IM, Twitter, emails, and blogs. *Tweet Heart* is a multi-genre, multimodal text constructed entirely of multiple forms of social media. The story is built across several platforms of social media, and when "media platforms converge, the varying platforms provide opportunities to tell different parts of a story in different ways" (Groenke and Maples, 2010, p. 40). *Tweet Heart* relies on readers who are as familiar with social media as the characters are.

Technology to Reshape the Narrative

The incorporation of video and animation in a more traditional print text allows for the technology to reshape the story that is being told. Multi-platform novels are texts in which more than one platform are used to tell the story; the platforms work together to create the story but components of the text exist only in a single platform. For example, *Skeleton Creek*, Carman's (2009) multi-platform novel, follows Ryan and Sarah as they try to solve a mystery in their small town. The story, told in both print and video, requires the reader to seam those two platforms together to create the single story. The readers get part of the story from Ryan's journal and part of the story from Sarah's videos. Neither is complete without the other. The print component of the novel is designed to look like a journal; the cover is marbled to resemble a composition book and the font looks like handwriting. The pages are lined. Images and typed notes look as though they are pasted or taped in. At certain points in the novel, readers are directed to an online site where they type in a specific password to gain access to Sarah's videos. The videos exist only online; however, there are references to them in the print text, and all of the passwords that a reader needs in order to access the videos are in the print text. The interaction between print and video and the juxtaposition of the two platforms create a story that exists in the intersections of each platform. The two platforms do not retell what happened in the other; rather they build on or contradict the other. The reader constructs the story from the two platforms. The narrative in this novel is dispersed across the two media formats, raising questions about how the media work together, how the author constructs the text, and how the reader reads across media. Additionally, the text challenges the physical idea of a book as it exists in both print and digital formats.

While the *Skeleton Creek* series uses print and video to create the story, *BZRK* (Grant, 2013) and *Virus on Orbis* (Haarsma, 2008) use digital media to build and supplement the world of the novel. *BZRK,* the story of a group of rebellious teens who are fighting for their right to be human in a world in which biotechnology and nanotechnology control people, is accompanied by an app that allows the reader to play in the world created by the book. *Virus on Orbis,* the adventures of Johnny Turnbull as he negotiates an alien world, has a companion video game that lets the readers play in the world of the novel but requires them to bring information from the novel to the video game. With both *BZRK* and *Virus on Orbis*, the novel can exist without the app or game, but the game does not work without the text. The world of the book gives shape and form to the games and, in order to play the games, the reader must have read the book.

Like *BZRK* and *Virus on Orbis*, *The Survivors* (Havard, 2011) uses technology to supplement the world of the print novel; however, this novel has both a print and app version of the text. The actual text of the novel and the text of the app are the same; however, the app layers on additional information,

extending the text. A reader can click on watermark symbols embedded in the text to see a Google map of the setting, hear referenced songs, see a character's Facebook page, or follow a character on Twitter. Additionally, the reader can see the author's notes, supplemental information on a historical event, and reference materials the author used to research and develop the story. The considerations of authorship and the boundaries of a text are challenged by the ways in traditional narrative formats are reshaped by the inclusion of technology as components of the narrative structure.

Ruby Skye, P.I. (http://rubyskyepi.com/) produced by Karen Walton, Jill Golick, and Steven Golick (2010-2012) is a series designed to be an online, video version of familiar girl detective stories. Ruby, a modern-day Nancy Drew or Trixie Belden, solves mysteries in her local neighborhood and school. The video series takes on the tropes of both print detective series and television detective series. Each season is divided into short episodes that serve as a video-chapter that readers can access on the teen detective's home page. The video-chapters follow the kinds of chapter patterns that teen detective novels follow; each one ends with a question, cliffhanger, or clue that may or may not turn out to be significant. The main character talks both to the other characters and to the viewer. While the story itself exists in video format only, the web site and accompanying media provide transmedia extensions of the story. The reader can follow particular characters, learn about other girl detectives, read blog posts about female activists, and participate in social media interactions with other viewers. The structure of this text challenges the expectations of traditional print narratives.

Technology to Read, Co-Construct, and Explore the Narrative

Authors, particularly young adult authors, have embraced the communicative aspects of digital media to create stories that exist across multiple platforms, to connect with their readers, and to allow for reader participation. Many authors have extensive web sites designed to support the storyworlds created in their novels. Authors such as Laurie Halse Anderson, Rick Riordin, John Green, and J.K. Rowling take advantage of the affordances of digital media to engage with their readers; they provide additional information about their stories and their characters as well as interactive sites for the readers to engage in the texts. Readers expect authors to give them more—more story, more access, more connections. The expectation is that the book is one format of the story situated in a larger digital world. Readers follow authors and characters on Twitter and Facebook and respond to author blogs; they play games and interact with other fans of novels on online sites. Adolescent readers expect more than a book.

Participating in Storyworlds

Texts such as *The Collider Comics (*Garley, Stewart, Gowran, Tempest, Pickering, and Simmonds, 2012), and *The Collider Quest* (Bernardo, Scott, Neves, Gomes, Azevedo, and Cantwell, 2012) exist as a constellation of online graphic novels, apps, games, and web sites. Each individual media format contains a rich and complete story; however, these stories interact to create a larger, interconnected storyworld. Experiences with the graphic novel give the players information to guide gameplay and interactions on the web sites. The narrative is not a singular story extended across multiple media formats as in *Skeleton Creek*; the juxtaposition of text and video game play does not extend the narrative as it does in *Virus on Orbis.* Instead, each media format in The Collider world stands alone. The formats, however, are stronger when read together.

As more authors, artists, and game designers come together to create storyworlds, this kind of multiplatform storytelling and world creation will become more common. The kinds of reader participation in the storyworld of the text opens up new composing opportunities as well as for reader creation and connection. Because the storyworld of a novel extends beyond the text, it creates a larger participation space for the reader. The reader may read the text, play a game, read the graphic novels, or write fanfiction. Because the world exists in multiple formats and platforms, the reader has greater opportunity for choice. The question for the reader to consider is not how to read the multiple formats to create stories but rather how to consider multiple storylines within a storyworld.

The multiple sites that support storyworlds designed to extend reader experiences with an author or authors' work allow spaces for readers to create fanfiction. Fanfiction, as a component of these large storyworlds, extends the worlds of the novel and allows for the participatory creation of story. In digital environments, the lines between author/reader/composer are blurred and fluid, illustrating Jenkins' (2006) argument that we can't "talk about media producers and consumers as occupying separate roles" (p. 3). Jenkins explained that we should "see [producers and consumers] as participants who interact with each other according to a new set of rules that none of us fully understands" (p. 3). Jodi Lynn Anderson (2010) allowed readers of her online novel *Loser/Queen* to vote on particular plot elements and included their responses in subsequent installments. This invitation to participate in the creation of the novel "pushes the boundaries of reader co-construction to a new level" and builds on some of the key features of social media—interactivity, connectivity, and participation (Parsons and Hundley, 2012, p. 243). The final print version of the novel incorporated the readers' collaborative choices into the text. While Anderson's choice to allow her readers to co-construct the text does not explicitly connect to the readers' creation of fanfiction, it blurs the lines between author and reader by opening up the participatory possibilities. Fanfiction extends this participation and further blurs the lines, although the author's invitation to create is not necessarily a part of that format. Readers can develop stories based on characters and worlds created by authors without the author's explicit invitation to do so.

Transmedia

Jenkins (2007) explained that

… [t]ransmedia storytelling represents a process where integral elements of a fiction get dispersed systematically across multiple delivery channels for the purpose of creating a unified and coordinated entertainment experience. Ideally, each medium makes it own unique contribution to the unfolding of the story. (para. 3)

This definition focuses on the ways in which the familiar components of fiction get taken up and used in stories spread out across several media—video, web sites, games, text, image, etc. What is particularly interesting about the definition is the emphasis on how each medium is expected to carry narrative weight in the ways in which the story develops. Each medium provides a way of looking at the story through a new lens and level of participation, bringing with it the genre-like expectations about what this medium can do for the story. What does a video make possible in the narrative that a single image does not? This expands the composing options for the writer while also expanding the participation options for the reader. *Collapsus, Inanimate Alice, The Cainsville Files*, *The Julian Year,* and *The Memory Machine* are narratives that push at structural boundaries; they exist in electronic format as

apps, e-books, and online stories. These stories exist across multiple platforms, genres, and modes and require reader participation to construct the narrative.

As writers, artists, and composers experiment and play with the composing possibilities for storytelling, readers are provided with a dizzying array of "texts" with which to play and participate, raising questions such as, Is this a story or a game? Is this a movie or a game or a story? The either/or binary are subsumed in transmedia storytelling into an and/and/and construction.

For example, *Collapsus* (www.collapsus.com), directed by Tommy Pallotta, is an online multimedia text ; the director of the text describes *Collapsus* as "transmedia story" and as an "annotated film" (Pallotta, 2011, np). The story is told through a mix of character videos, graphic-novel style animations, documentary clips, blogs, articles, and text. There is also an interactive component that forces readers to make choices on the issues surrounding energy usage. The screen is divided into three panels with the central panel providing the fiction component of the story. The reader is introduced to characters through a mix of video, text, and animations. The panels to the left and right of the central screen contain additional components of the story—an interactive panel that pushes readers to make choices and a panel that contains blogs, articles, documentaries, and other texts that provide character development, additional data about the issues, and plot components that ratchet up the reader's stress level. The multiple media formats in this story work together to create the story.

Kate Pullinger and Chris Joseph's (2011) *Inanimate Alice* (http://www.inanimatealice.com/), an online serial story about young Alice and her growing up in various countries, uses words, images, sounds, movement, games, and animation to create a story that exists across the modes. This story, read on screen, is structured in episodes that provide glimpses into Alice's family life, her friendships, and, among other events, her father's disappearance. The complexity of the story depends on the interactions of the modes. For example, the episodes' strategic use of sound both foregrounds tension and supports the other events happening in the story. The use of whispering, knocking, and wind are subtle and powerful. As a reader, the sounds often blend into the background and at strategic moments increase in volume or completely disappear. In either case, the sound becomes an integral part of the narrative structure.

In *The Cainsville Files* (2014), Kelley Armstrong, author of adult and young adult fantasy novels, explores the storytelling possibilities of graphic novels, animations, sound, and explicit game-like reader choice. Just as early hypertext incorporated linking and allowed readers and writers to "reconsider the writer's use of sequence in order to control the passage of readers through the text" (Snyder, 1996, p. 66) so, too, does the use of explicit reader choice in sections of this story guide the reader's navigation. The app opens with a scene of protagonist Jenn's new office; we learn that she is a former police office now turned private investigator. At several points in each section, the reader is given the option to choose how Jenn will respond to another character's actions or whether or not she will explore particular locations for clues. This use of choice, often a component of video games, allows the reader to co-create the narrative; some choices will end the story within just a few screens while others will take the reader deeper into the mystery. The table of contents for this story is a series of visual images of locations in which some action in the story occurs. The story can be read and reread and the story itself will change as the reader chooses a different path through the mystery.

Like *The Cainsville Files*, Gregory Lamberson's *The Julian Year* (2014) relies on explicit reader choice to construct the narrative. The use of the visual table of contents for *The Cainsville Files* provides a way for the reader to orient herself in the text; *The Julian Year* uses a technology called Tree Branching technology to provide the reader a visual map of where she has been in the text. Tree-branching, like hypertext linking, is based on nodes and branching pathways. *The Julian Year* must be read using

MMG Sidekick, an app that allows the reader to read and participate in the text. While the choices in *The Julian Yea*r are not as extensive as *Collapsus* or *The Cainsville Files*, the use of the tree branching technology provides a way for authors to reconceptualize narrative as fluid, branching, and not fixed.

Denise Chapman Weston's (2014) *The Memory Machine*, a multigenre, multimodal ibook, tells the story of Anna, her autistic brother, and her grandfather. The text uses journal entries, sound, images, and video to construct a story about memory, memory loss, and family. The reader of this story does not choose to construct the story path, rather, she chooses to explore small tangents and moments that bring richness and depth to the idea of memory and the small details that create a life. The narrative spine of *The Memory Machine* is a journal format, but the entries incorporate more than text. The reader must figure out the arch of the story via the intersections of modes and genres created by the author. The author provides navigational directions for the reader as well as color coded text markers to indicate additional information.

WHAT ARE THE GAPS IN THE EXTANT RESEARCH AND DIRECTIONS FOR FUTURE RESEARCH?

The participatory and transmedia texts described here are textually subversive because they form and "[re-form] with successive readings, no two readings are alike" (Snyder, 1996, p. 93). Readers may or may not start and end at the same point in the text in successive readings. Because the texts shift based on reader choice, they are not fixed; they are performative. Each iterative reading is a new performance, an event in the making. Morgan (2000) contended that "hypertext is always an event—a text just in the process of becoming as we read and ceasing to exist in that sequence when we quit the program" (p. 133). The idea of text as an event contrasts with the seeming fixedness of traditional print texts.

As the digital tools used to create these kinds of texts become more ubiquitous, more writers will work to create texts that exist across platforms and incorporate multiple paths, genres, and modes. The contrast between the apparent fixedness of traditional print formats and the text-as-event formats of these kinds of digital texts provide both a current issue for authors and readers as well as areas of future research. Learning to construct a text that is performative is challenging for the author; applying the reading and participation strategies that are part of the participatory culture in which they are engaging is challenging for readers; redefining what authorship, reader, and text means in this environment provides a challenge for researchers as well. Just as the use of the codex reshaped the work that authors and scholars could do and provided opportunities for new text forms such as the novel, so, too, will these participatory and transmedia texts provide new ways of composing for authors and readers, and raise new questions about form and authorship for researchers.

Gee (2003) made the case that video games are "a new form of art. They will not replace books; they will sit beside them, interact with, and change them and their role in society" (p. 204). Similarly, the authors described above are exploring digital media tools to develop "a new form of art" and storytelling, one that sits beside and interacts with the more familiar forms of text. They are situating multiple platforms beside and within texts to explore narrative possibilities. As Jenkins (2006) argued, "Old media are not being displaced. Rather, their functions and status are shifted by the introduction of new technologies" (p. 14). Due to the current exploration of what is possible, new digital technologies have become part of the author's and reader's toolkit.

What this means for researchers is multi-faceted. Drawing from McLuhan's (1960) assertion that communication technologies are implicated in a wide-range of human constructs, what relational practices and structures will digital text formats generate? Do communication technologies, as McLuhan posited, propel people to think differently, and if so, how might that difference be conceptualized? What discourses and organizing structures might develop around the changing notions of the book? How might the ways in which people create and use emerging text formats impact such institutions as media, government, and education—and vice versa? In a partial consideration of that last question, we give a brief overview of how educational discourses are being impacted by the social practices arising around text forms made possible by communication technologies.

WHAT ARE THE RECOMMENDATIONS/IMPLICATIONS FOR EDUCATION, CIVIC ENGAGEMENT (GLOBAL AND LOCAL), SOCIAL PRACTICE, AND POLICY?

In the current intense curiosity of use stage, YA authors are experimenting with form and participation, responding to the perceived media literacy practices of their readers. They draw from established technology tropes, remixing them with print conventions and within print formats. They explore and try out the affordances of computer-based technologies, including the Internet, to test the elasticity of narrative. As literacy educators, we posit this question: If authors and creative teams are engaged in a curiosity of use stage as they make moves within their art form to reach their young adult audience, what are the implications for educators concerned with the cultivation of students' literacy practices in the digital age?

We respond to this question by taking up Jenkins' et al. (2009) work on participatory culture to suggest that engagement with these "new and strange sorts of texts" (Baron, 2009, p. x) could be a critical component of students' in-school and out-of-school education. We will explore the ideas of participatory culture as it relates to adolescents who are reading, writing, communicating, and composing within a participatory culture. We will suggest that notions of a parallel pedagogy (Leander, 2009) can be used to productively consider the tensions emerging between "old" and "new" literacy practices in K-12 instruction and the role digital-related literature can play. Finally, we will look briefly at current structures operating within U.S. education--explicitly the Common Core State Standards--and how digital young adult literature can be harnessed to aid in the development of students' digital literacy practices.

Learning in a Participatory Culture

In their influential MacArthur Foundation report entitled "Confronting the Challenges of Participatory Culture," Jenkins et al. (2009) offered a general overview of youth digital practices for educators concerned with new media literacies. They suggested a definition of 21st century literacy that built on earlier constructs:

A definition of twenty-first century literacy offered by the New Media Consortium (2005) is "the set of abilities and skills where aural, visual, and digital literacy overlap.These include the ability to understand the power of images and sounds, to recognize and use that power, to manipulate and transform digital media, to distribute them pervasively, and to easily adapt them to new forms" (p. 8). We would modify this definition in two ways. First, textual literacy remains a central skill in the twenty-first century. Before students can engage with the new participatory culture, they must be able to read and write. Youth must

expand their required competencies, not push aside old skills to make room for the new. Second, new media literacies should be considered a social skill. (p. 19)

Noting that educators frequently focus on the digital divide--that is, students' equitable access to digital technology--as a dominant topic, Jenkins's team argued that more crucial was the question of participation. "A focus on expanding access to new technologies carries us only so far if we do not also foster the skills and cultural knowledge necessary to deploy those tools toward our own ends" (p. 8). Instead of the digital haves and have-nots that were the concern of digital divide conversations, students are more likely to be divided into groups "for whom the Internet is an increasingly rich, diverse, engaging and stimulating resource...and those for whom it remains a narrow, unengaging, if occasionally useful, resource of rather less significance" (Livingstone & Bober, qtd. in Jenkins et al., p. 17).

Engaging in the participatory culture of the Internet allows students to develop "cultural competencies and social skills needed for full involvement" (Jenkins et al., 2009, p. xiii) in their own era. This engagement may include participating in online communities, creating and posting individually- or collaboratively-created digital works, developing new knowledge in formal or informal teams, and contributing to the circulation and form of media through blogging and other venues. The effects of the participatory culture creates "a new form of the hidden curriculum" (p. xii), whereby some students are prepared with the skills needed to be active and effective members of their societies and others are not. While traditional curriculum has frequently focused on individual achievement and work, a participatory culture perspective privileges community involvement and social skills over individual expression. This shift creates different types of skills that students should cultivate. Among these, according to the authors, are play (experimenting to solve problems), appropriation (sampling and remixing content), multitasking (scanning to identify details), distributed cognition (interacting with tools to expand cognition), transmedia navigation (following information and narratives across modalities), and networking (searching, synthesizing, and disseminating information).

Jenkins et al. further noted that some educators argue students will learn digital media practices outside of school and on their own. The authors countered, however, with three issues that they claimed make concerted pedagogical attention necessary:

1. **The Participation Gap:** The unequal access to "opportunities, experiences, skills, and knowledge" needed for societal participation (p. xii)
2. **The Transparency Problem:** A need to focus on students' awareness of how "media shape perceptions of the world" (p. xii)
3. **The Ethics Challenge:** The need for socialization and professionalization processes to support students as they develop ethical norms as "media makers and community participants" (p. xiii)

To respond to these issues and to support students as they cultivate new cultural competencies requires a systemic and creative approach on the part of schools, policy makers, community organizations, and families.

Working and Expanding School Learning Structures

Literacy education in schools has long addressed the three concerns identified by Jenkins's team, albeit primarily in the context of print literacy. Literacies are conventionally understood as social practices

and engagements, media (texts) as motivated shapers of perception and knowledge is the backbone of critical literacy, and the ethical norms of reading and writing are part of standard language arts curricula. Now, however, schools are tasked with considering those concepts anew within the digital environment.

Kevin Leander (2009) posed a question no doubt opined by many educators:

[How] can we possibly fit more into an already overcrowded curriculum, even if we do decide to buy into an expanded definition of what it means to be literate (Kinzer and Leander, 2003)? Behind such [a question] is a key issue with important consequences: how do we imagine the relationship of so-called 'new literacies' (Lankshear and Knobel, 2003) to more conventional print-based literacies? (p. 147)

Leander noted four "stances" toward the incorporation of new literacies into language arts classes: resistance, replacement, return, and remediation. The resistance stance privileges the reading and writing of print-based texts. The replacement stance takes the position that print-based texts are essentially antiquated and should be replaced with the kinds of texts that are among the "native, everyday practices of youth" (p. 148), such as blogs and multimedia genres. The return stance has a print-centric focus that understands new literacy practices as means to develop print-based literacies; in other words, print genres are valued as the ultimate guide to knowledge production. The remediation stance reflects an understanding that elements of conventional media are "communicated, or mediated once again" through newer forms. In other words, "the new is never entirely apart from the old" (p. 148).

Remediation also entails recognizing that we are currently in need of understanding the modes of thinking and learning that we want our students to engage in, and consider which media, including print, still and moving images, music, voice, embodied performance, or other that might best 'mediate' such modes of thinking and learning. (p. 148)

Educators taking a remediation stance are "agnostic" (p. 148) in the face of multiple media, more interested in the processes, meanings, and effects of media than a favoring of a single form.

Adopting a remediation stance, Leander went on to describe the concept of a parallel pedagogy, in which "old and new literacy practices, including print texts and visual texts, may be fruitfully taught side by side, rather than the 'old' being a precursor to the new or being replaced by it" (p. 149). This move to a parallel pedagogy works at a meta level. Rather than focusing on the specific products of specific media, Leander's notion of parallel pedagogy asks students to explore how certain aspects of texts have "powerful purchase across media" (p. 160). How, for example, might argument be conveyed through image without a reliance on words (Hundley & Holbrook, 2013)? How is time conveyed differently through visuals, transitions, or print? By taking up a parallel pedagogy, Leander suggested, teachers might be able to address the scheduling issue that makes adding digital literacy instruction so daunting.

Other educators have also argued for the importance of making instructional space for new literacies (e.g., Hicks, 2013; Hundley, Smith, & Holbrook, 2013; Selfe, 2007; Wysocki & Lynch, 2012). As one example, Troy Hicks and Franki Sibberson use the conventional reading/writing workshop model to create time and structure for digital composition in their classrooms (Hicks & Sibberson, 2015).

The question of the place of digital-related literature in language arts classrooms can be found in the arguments presented above. If students need to develop the competencies and social skills to navigate and affect the cultural currents of their time, then should literature generated in response to technologi-

cal affordances be part of that work? If online communities have developed around the stories told in transmedic young adult literature, should the social practices that govern those communities be seen as both in-school and out-of-school learning? If it is important for students to engage in critical literacy, understanding that no text is neutral and that texts shape cultural perceptions, should the hypermedia/multimodal texts in which they engage be open to their informed scrutiny? And finally, if students are already participating in a curiosity of use stage as they craft and distribute their own works, should these practices be brought under the auspices of their classroom curriculum? Undergirding these questions is the belief that schools have a responsibility to support students' cultural competencies around technology as they explore literature as a means of constructing themselves and the societies in which they live.

Digital Literacies and the Common Core

Considering those questions cannot be done outside the structures of assessment and standards, including the Common Core State Standards (CCSS). While the CCSS standards are used in the United States, they were developed within a global context and raise issues relevant in international educational settings. Educators and educational researchers have examined how the CCSS seemingly position digital literacy and technology, noting that the standards in these areas are vague and broad, which can be both a bonus and a problem (Avila & Moore, 2012; Dalton, 2012/2013; Pandya & Auckerman, 2014). In addition, some see tensions in language arts instruction that stem from the kinds of assessments mandated by educational stakeholders and policymakers, nationally as well as internationally. For example, Leander (2009) surmised that the resistance stance toward new literacies curricula may be less a fear of technology than a pragmatic response to standardized assessments that favor conventional print literacy practices.

In the face of what could be seen as moves to restrict and deprofessionalize teachers, educators are advocating ways of reading the emerging standards for flexibility and space. Jessica Van Cleave and Sarah Bridges-Rhoads (in press) encouraged teachers to ask "different questions of the CCSS" by positioning it

> *… as a living document that can be read again and again with an eye toward all sorts of literacy teaching and learning in classrooms….[We], as teachers, can begin to think and speak ourselves as authors of the CCSS and thus become participants in writing its history. (p. 42)*

By engaging in conversations about what the CCSS can be, teachers can actively make the standards in the talking and teaching of them.

In this vein, educators are finding ways of navigating these institutionalized structures to bring digital and new literacies into the classrooms. Expressing an emerging view, Dalton (2012/2013) wrote that while the CCSS does not include an explicit standard addressing technology, "the standards assume that being literate means being digitally literate." The standards can be read, she maintained, to understand technology as not supplemental to literacy development, "but rather...deeply infused throughout teaching, curriculum, and learning" (p. 333). Working with the notion that digital literacy is an assumed aspect of curriculum, Dalton operated within the "open-endedness" (p. 333) of the standards to design projects that permitted students to develop as digital composers.

JuliAnna Avila and Michael Moore (2012) argued that looking at the CCSS with critical and digital literacies in mind could "offset some of the stifling aspects of standardization" (p. 28). Noting that digital literacy held a "relatively low profile" in the standards, they maintained educators nonetheless had the

power to "shape the standards toward a stronger inclusion of both digital and critical literacies" (p. 29), thereby helping students prepare to be active agents in civic life. Similar to Dalton, Avila and Moore enacted the stance that the Common Core's language arts standards can be read to include--even assume--digital and new literacies, a position which then opens opportunities for teachers to create classrooms in which students explore and craft digital multimodal texts.

Drawing from Luke and Freebody's work on the four resource model, Jessica Zacher Pandya and Maren Aukerman (2014) argued that the CCSS were written to promote some aspects of technology use but not others. Luke and Freebody (1999) posited that readers and writers rely on four types of competencies or families of practices as they engage and produce texts: coding, pragmatic, semantic, and critical. Each of these families of practices are necessary but not sufficient in and of themselves, Luke and Freebody argued, for the development of literate citizens. The practices also change depending on prevailing notions of literacy, impacted by the communication tools adopted by societies.

In their examination of the CCSS, Pandya and Aukerman (2014) maintained that the standards promote technological use in the development of pragmatic ("the ability to use texts to get things done" [p. 429]) and semantic ("the ability to make meaning from and with texts" [p. 429]) competencies. However, the standards provide less focus on coding ("the ability to decode words, including knowledge of...keyboard layout and keyboarding" [p. 429]) and critical ("the ability to critique and analyze texts...[and] the knowledge that texts are never neutral" [p. 429]) competencies. While they acknowleged that "optimistic" (p. 431) educators see room in the CCSS for critical literacy around technology use, Pandya and Aukerman are less encouraged, concerned that teachers may not be able to find space if such foci are not required.

If, as many researchers argue, digital and new literacies are assumed in the CCSS, then how can educators find that space in their day-to-day teaching so students can develop as active, involved, responsible participants in the digital age? Like Pandya and Aukerman, we find reason to be skeptical as we watch schools enact mandated instruction and narrow interpretations of the CCSS. However, we also believe that teachers can work against constricted understandings of the standards in their selection of texts and related practices. We suggest that bringing digitally-derived and born-digital literature into English Language Arts classes can involve students in complex and productive literacy practices. Referring to Jenkins et al.'s (2009) list of key technology-related skills, we see that by engaging students in the types of experimental texts created by young adult literature authors, teachers can support students as they cultivate such skills as play, appropriation, multitasking, distributed cognition, transmedia navigation, and networking.

Furthermore, reading/writing workshops that immerse students in not only the reading of such texts but the creation of them as well can go far to address Jenkins et al.'s gaps in participation, transparency, and ethics. Instead of relying on out-of-school and home-based spaces to provide students access to online participation, schools can engage student participation through the affinity groups that develop around young adult literature, immersing them in online communities that critique and expand the narratives, positioning students as active co-creators of texts and the shapers of discourse. By engaging students in critical conversations around young adult literature, including experimental texts, they can explore the systems of power and normativity that make no text neutral. And by incorporating these texts--and the online communities and practices they include--into classrooms, teachers can support students as they explore the ethics of being content producers and responsible participants in digital environments.

In this chapter we have posited that YA authors are engaged in a curiosity of use process in response to their tech-savvy adolescent readers. But it's interesting to note that as they experiment and invent,

their work may, in time, reach other audiences. A recent study discussed in *Publisher's Weekly* (2012) explained that

… fully 55% of buyers of works that publishers designate for kids aged 12 to 17 -- known as YA books -- are 18 or older, with the largest segment aged 30 to 44, a group that alone accounted for 28% of YA sales. And adults aren't just purchasing for others -- when asked about the intended recipient, they report that 78% of the time they are purchasing books for their own reading. (para. 1)

While young adult authors are exploring the options for digital media in storytelling and using tools that their intended audience are employing in their daily lives, their audience extends beyond just adolescents. Over half of the books identified as books for young adults are bought by adults, purchased for themselves. As authors experiment with digital media in storytelling, they are reshaping reader expectations and helping determine which storytelling tools will become more than a curiosity of use, not just for a segment of readers but for larger audiences. Similarly, Jenkins and other scholars working in the intersections of digital technology and the literacy practices of adolescents and young adults point to inquiries that can be taken up by researchers looking at the larger question of the changing nature of the book. For example, more research is needed on the shifting relationship between author and reader in the digital age: *In participatory cultures, what counts as authorship? When books are reconceptualized within notions of transmedia, how is the author function taken up and performed? How do reading practices--and the construct of reader itself--change in the context of transmedia and/or dispersed texts?*

As Nash (2014) noted, books have been a part of culture and a disruption of culture. The jitteriness of the current era, therefore, is nothing new; extending back to the Greeks, observers have fretted over the effects of new communication technologies, including the at-one-time new technology of the book. While, as Coover (1992) worried, contemporary digital technologies seem fragile in their short life cycle, the book is not fragile. Books are extraordinarily resilient. Put to use by motivated humans, books do change the world.

That said, some of the forms and features of texts do change, and in those changes are new possibilities for human agency. One of the exciting aspects of living in a time of curiosity and inventiveness is seeing those possibilities erupt. It could be said that readers and composers of young adult literature are in the business of eruptions. In critiquing the publishing business, Nash (2014) reminded,

A business born out of the invention of mechanical reproduction transforms and transcends the very circumstances of its inception, and again has the potential to continue to transform and transcend itself--to disrupt industries like education…. By defining books as against technology, we deny our true selves, We deny the power of the book. Let's restore to publishing its true reputation--not as a hedge against the future, not as a bulwark against radical change, not as a citadel amidst the barbarians, but rather as the future at hand, as the radical agent of change….(para. 52)

What we see in the work (and play) of adolescent readers and young adult authors as they actively explore and authenticate digital media tools is the remaking and remixing of what a book can be. The book is dead; long live the book.

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KEY TERMS AND DEFINITIONS

Codex: Early text form comprised of stitched sheets or pages.

E-Book: Short for "electronic book"; e-books are accessible on digital devices such as computers, tablets, and smart phones and may either be electronic versions of print texts or texts designed to be published in an electronic format.

Hypermedia: An interactive digital or electronic text that includes hyperlinks to other digital or electronic media such as print, videos, image files, and sound files.

Hypertext: An interactive digital or electronic text that includes hyperlinks to other digital or electronic texts; sometimes used synonymously with hypermedia.

Interactive Book: An electronic or digital book designed to include active reader participation via links or embedded reader-enacted functions.

Non-Linear Text: A text designed to disrupt chronological flow or conventional textual sequencing.

Participatory Culture: Term developed by Henry Jenkins to describe contemporary cultures where members of a society do not only consume media content but also create and distribute it.

Story App: Digital application designed to tell a narrative or story, usually employing print, images and sound. Frequently, story apps are also interactive and non-linear.

Transmedia Storytelling: A form of narrative in which the story is told across multiple media platforms (e.g., books, films, websites, story apps) and usually across multiple media forms (e.g., video, audio, print).

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Chapter 71
Home Media Access with Heterogeneous Devices

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ABSTRACT

The intensive use of social content anywhere and from any device presents new challenges for current systems and networks particularly when they are used by novice users. One of the most places where social channels are used by non-expert users and with a wide range of devices is at home. Unfortunately, current digital home systems lack of intelligent components that help terminals and users to find, configure and connect devices for using media content (video, audio, etc.) in an intuitive, transparent and optimized way. In this paper, the author discusses how the user's experience is negatively affected in existing digital home systems. Particularly, in heterogeneous environments with terminals and networks having different capabilities. The author discusses the home media access using a real-world evaluation of existing home systems. The author compares these evaluations to a Web-based approach and show how the use of the home network resources can be significantly improved for sharing and browsing media items and folders.

INTRODUCTION

Digital home systems were designed to offer an interoperable network that ensures sharing media content in a seamless environment regardless: media sources, location, delivery methods and protocols, formats and existing terminals. With the success of different social networks and channels, digital home systems -used mainly by non-expert users- represent an important place where the home users can share and use different media and data coming from different sources. Unfortunately, actual digital home systems do not meet this objective yet (Socher, 2008). Furthermore, many users are still unaware about the existence of digital technologies. Let us consider, for instance, one representative example of a digital standard such as the Digital Living Network Alliance (DLNA). The Digital Living Network Alliance is already integrated in about 74% of existing CEs. This standard knows only 6% of real users that are aware about the existence of the digital functionalities and are able to use them intuitively (In-Sat, 2010). Many rea-

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sons explain this situation. Mainly we cite the complexity of the proposed technologies inside the home network, the inter communication and cooperation between different industrial and standard norms, the heterogeneity of media formats and devices. Finally, the lack of intelligent components or services that help terminals and users to find, configure and connect their terminals in order to use the media content in the best possible and automatic way.

Many previous works have studied reducing the overhead traffic on services advertisements for example with the UPnP protocol. Digital homes represent an interesting challenging context especially for social applications and home residents that are usually novice. Services are mainly related to sharing, discovering and rendering items such as music, videos and pictures. Also, at home, the residents may use, in the same time, a wide variety of devices and access methods that are heterogeneous in terms of network and rendering capabilities. In order to qualify and quantify the *user's satisfaction* about the *use* of the different services (i.e. the *user experience*), we generally use the concept of *quality of experience*. This concept is widely used to describe how users experience the available services (e.g. the ability to find home media content, the available bandwidth for their applications, the rendering capabilities of their device, etc.). An efficient digital home system should enable the access to media content and services with heterogeneous terminals and without preliminary configurations and settings. Also, it should optimize the network traffic generated by digital homes components by using only necessary traffic when it is really needed by the user and its social applications. This paper shows how the home network resources and the user's experience are affected in existing digital home systems. Particularly, in a heterogeneous environment where users are usually connected through a wireless access using handheld devices.

Based on real-world evaluations, we identify useful lessons for optimizing the media access and network resources. We show and measure how a client-server based approach, like UNIVERSALLY (Lemlouma, 2013), can improve digital home systems by using the Web and the HTTP protocol for heterogeneous devices with limited capabilities. In a heterogeneous environment, many devices are still not compatible with the advanced digital home functionalities (Jovanovic et al., 2012; Ilkic et al., 2013) such as content discovery, multicast dialog, verbose XML parsing and heterogeneous media decoding. We believe that moving toward a client-server model guarantees that no home traffic will be generated if the user does not ask the network for something. This approach ensures that any transmitted data will be an answer of the user's request and avoids unnecessary traffic and bandwidth consumption.

The remainder of the paper is structured as follows. We review the related works and present an overview of a representative case of the current digital home systems. We then discuss the negative impact of current digital home systems. We discuss our measurements regarding the home network traffic used in background and while browsing media items. We identify a set of relevant guidelines in order to optimize the media access at home and evaluate the optimization in terms of bandwidth consumption and media access time after the presentation of a client-server web based approach.

RELATED WORK

The use and the improvement the home media access within heterogeneous mobile devices have been explored in research work over the past few years. Lai et al. (2010) propose a UPnP based content sharing system for supporting multimedia devices in a digital home network. The work uses a server to which devices must be directly plugged in order to be integrated in the sharing system. The approach simplifies the content discovery, reduces the overhead but limits the location of the content that should be

ideally possible anywhere in the home. In (Kim et al., 2007; Oh et al., 2007), a simple proxy's system is proposed for searching and streaming the media contents. The impact and the performance of digital home networks has been a concern in some previous works that studied, for instance, the DLNA impact either directly inside the home network or indirectly by evaluating separately the performances of the used protocols such as the multicast, UPnP and SOAP. We cite the work for Bluetooth (BT) Personal Area Network (PAN) inside the home (Liong & Ye, 2005) and in large home networks (Mills & Dabrowski, 2003). Many other works have studied similar digital environments based on service discovery and multicast (Al-Mejibli & Colley, 2013). Liong and Ye (2005) have shown the negative impact of SSDP (Simple Service Discovery Protocol) advertisements in PAN such as for BT power cost -when advertisements are spread- and channel's bandwidth usage especially for large SOAP messages, transfer and media streaming. The work in (Mills & Dabrowski, 2003) evaluated the UPnP M-SEARCH messages (used to discover devices and services) by varying the jitter bound (MX field of M-SEARCH) and network size. The used simulated model (Mills & Dabrowski, 2003) showed that when the number of root devices increases (generally above 50), the network knows negative performances regarding: the discovery effectiveness (percentage between announcement and real discovery), discovery latency and buffer overruns. The reasons are mainly the responses loss, the explosion of response at the level of control points (CPs) and collision periods in a large network. The work outlined new algorithms for adapting the MX field and an approach for replacing M-SEARCH queries in UPnP. Unfortunately, in heterogeneous and dynamic digital home networks, we should expect several and different implementations (different values of MX fields that are compatible with the UPnP standard) and hence we must take them into consideration in a universal media access approach in order to coexist with existing digital home networks whatever their size.

Other related works have concerned the impact of using SOAP used in the invocation of services in the digital home. For instance, in (Newmarch, 2004) and (Newmarch, 2005) an alternative of SOAP was proposed based on REST (Fielding, 2000). This implies some strong requirements in the digital home system. In particular, media servers should be able to process the new REST URLs and to add a new mime-type in order to distinguish native SOAP POST and REST POST messages. Another consequence is that all the resources and data (even variables included in XML files) must follow a new addressing scheme that should be implemented by DLNA components. Moreover, the description of resources and XML data access are already possible using standards such as the W3C POWDER, XPath and XQuery languages.

The objective of Digital Living Network Alliance technology is to manage and distribute digital content from a source to all the compatible devices (DLNA, 2007; DLNA, 2014). The key functions of Digital Living Network Alliance are: connectivity and networking, device discovery and control, media management, media formats and media transport. Connectivity and networking use the existing network platform at home. Device discovery and control is based on the UPnP Device Architecture (DA) 1.0 (UPnP Forum, 2008a). Media management is based on the UPnP AV (UPnP Forum, 2008b).

Three entities are specified: devices, services and control points (CPs). Services are functions provided by a device, found and invoked by a control point. The main functions of a UPnP device are: IP addressing, discovery (periodic advertisement of services), description of services and capabilities, control in response of CPs requests and eventing to notify registered CPs. SSDP (Simple Service Discovery Protocol) messages are sent over HTTPMU (HTTP Multicast over the *User Datagram Protocol*-UDP) in order to discover resources in the network (UPnP Forum, 2008a). SOAP allows to specify available operations. In the audio video (AV) digital home, the three main entities are: the MS that offers media

content, the media renderer that plays content and CPs that control what and how contents are played. Digital Living Network Alliance defines two main entities: Digital Media Server (DMS) and Digital Media Player (DMP). Digital Media Server is a UPnP/AV Content Directory Service (CDS) device that provides media resources. DMP is a UPnP/AV Content Directory Service (CDS) control point that can discover resources and render them (DLNA, 2007).

DRAWBACK OF CURRENT DIGITAL HOME SYSTEMS

In a digital home, when a media server is added to the network it advertises services and embedded devices to all the connected devices. For instance, in a DLNA-like digital home, servers use a set of multicast NOTIFY messages sent, using the *User Datagram Protocol* (UDP) to the group of all the digital devices (UPnP Forum, 2008a). Three advertisement messages are sent for the root device, two for each embedded device and one message for each service type in each device. Consequently, at each announcement interval, $3+2d+k$ messages are sent (one root device, d embedded devices, and k distinct service types). The NOTIFY message uses a duration (the *CACHE-CONTROL* which is at least 30 minutes) for which the advertisement is valid. Due to the unreliable nature of the User Datagram Protocol (UDP), the Digital Living Network Alliance Interoperability Guidelines, based on the UPnP DA 1.0, recommends that devices should send each of the above discovery messages more than once but not more than three times. Also, advertisements must be periodically re-sent prior to the CACHE-CONTROL value (Figure 1). The NOTIFY messages with ssdp:alive that UPnP devices send periodically are presented by the *B* set. The *C* set presents the advertisements duplicated due to the unreliable nature of UDP multicast. Advertisements and duplicate sets are presented by the *D* group. The norm recommends the implementations to apply a repetition of advertisements using a randomly distributed interval that must be less than one-half of the CACHE-CONTROL value. Moreover, spreading the duplicate sets is suggested to reduce the traffic storm.

Figure 2 presents the SSDP (Simple Service Discovery Protocol) advertisement groups with and without spreading. As for media servers, when a control point (CP) is added to the network, it searches for devices using multicast M-SEARCH messages sent more than once and periodically to guarantee that devices receive it. Each device answers with $3+2d+k$ messages for its root device, embedded devices and service types. In addition to the discovery advertisement and discovery search, the CP retrieves descriptions of the existing devices/services. A control point invokes actions on media servers using the SOAP protocol. Device and service descriptions are written using the UPnP Template Language (UPnP Forum, 2008a). These descriptions have usually an important size.

Figure 1. SSDP advertisements

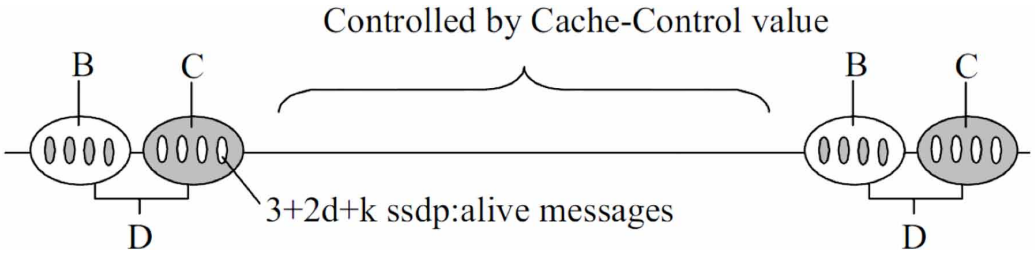
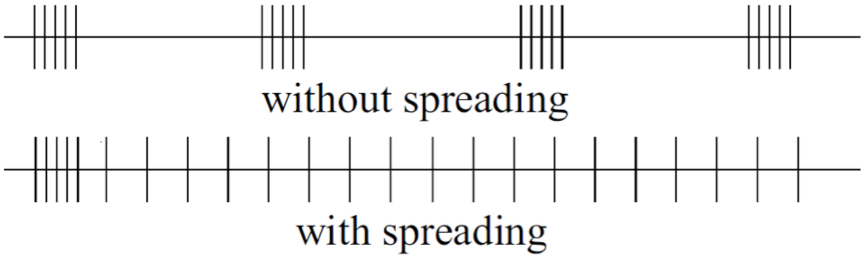


Figure 2. Advertisements and spreading



In actual digital homes, the number, the nature (UDP and multicast) and the periodicity of UPnP advertisements are inconvenient. Also, to be able to play one media item, several messages and steps must be achieved (DLNA, 2007; DLNA, 2014). Consequently, a mobile device, that joins the digital home, should support: the multicast function, the UPnP Template Language parsing, the SOAP protocol and the unreliable nature of the User Datagram Protocol (UDP) especially over a wireless access. Moreover, there is no guarantee that the original format of a requested media item is compatible with the renderer. This situation is not adapted for heterogeneous environments where rendering capabilities, access technology, bandwidth, congestion probability and power consumption are not the same for all the existing devices that can be connected through Ethernet, WLAN, Bluetooth, etc.

The UPnP norm, used in digital homes, provides the presentation function that uses a simple Web page presenting a media server. This function can be used in order to provide renderers with some control of the shared media items (UPnP, 2008a). Unfortunately, the level of the provided control depends on the design and implementation of each presentation page. The control of media items is completely specified by the media server's vendor and not standardized. Consequently, the presentation function cannot guarantee a universal access to heterogeneous devices.

MEASUREMENT OF NETWORK TRAFFIC

In this section, we will investigate how existing digital homes systems and media servers affect negatively the network resources and hence the user experience based on real-world evaluations. The unnecessarily use of the network resources and components affects negatively the user experience directly and indirectly. Precisely, it affects the availability and the performance of the home network, the devices used by the network (energy and processing) and the user's applications especially for the user's social applications that may require an important traffic.

We consider the background traffic (needed in current digital homes to discover existing media servers) and the traffic implied by the user's actions while browsing shared items. It is important to notice that heterogeneous devices connected by the wireless network cannot use the shared services because they do not support natively the used protocols (such as the *multicast*, i.e., sending one message for different destinations). If the user of such devices wants to play shared items, he has to set up specific applications and do required configurations to be able to discover media servers, discover and render items (Jovanovic et al., 2012; Ilkic, 2013). Also, only compatible items (e.g. media items with supported codecs) will be rendered. These requirements are not adapted for novice users using heterogeneous devices at home.

Testing Architecture

The testing architecture was implemented in a way that represents a typical digital home architecture. Indeed, the platform includes Media Servers (software and hardware-embedded), Media Players with heterogeneous devices and a basic connecting network (wired and wireless).

The testing platform (Figure 3) is composed of a digital home network connecting two servers, an Internet home box (Orange Pro Livebox), a game box (Play Station 3), a DLNA enabled TV (BRAVIA KDL-46Z5500) and a mobile phone (a 3G iPhone) that represent the heterogeneous devices connected through a WiFi access point. The Ethernet LAN has a monitored switch port connected to a computer that uses the Wireshark packet analyzer. The two servers have different implementations of media servers; the home box uses the native media server of the provider.

Background Traffic

In this section the measurements consider the number of messages and bandwidth consumption of the digital home background traffic (Figure 4 and 5). The considered traffic concerns only the advertisements of the existing digital media servers (software media servers in DMS and the embedded media server of the Home-Box, see Figure 3). The traffic is captured using the monitored port of the switch connecting all the devices of the testing architecture. We do not show the plots for all tested media servers, but we rather select the most commonly used software servers (e.g. TVMOBiLi, PMS, TWonkyMedia and Skifta) in addition to the media server embedded in the Home-Box. Even thought that the traffic is sent to many destinations (using multicast to the IP address: 239.255.255.250:1900), we consider the single traffic as received by only one device connected to the Ethernet LAN. We can easily deduce that if we have n connected device, the whole traffic can be computed by multiplying the single traffic by n.

Figure 3. Testing architecture

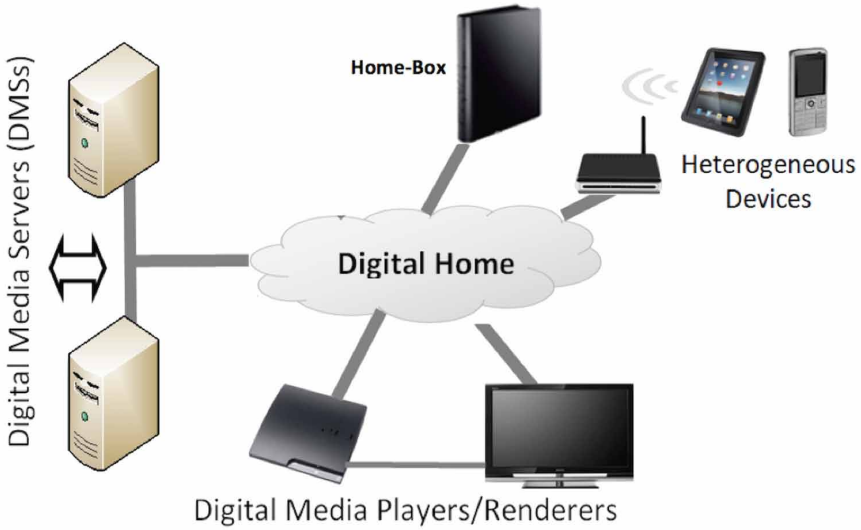
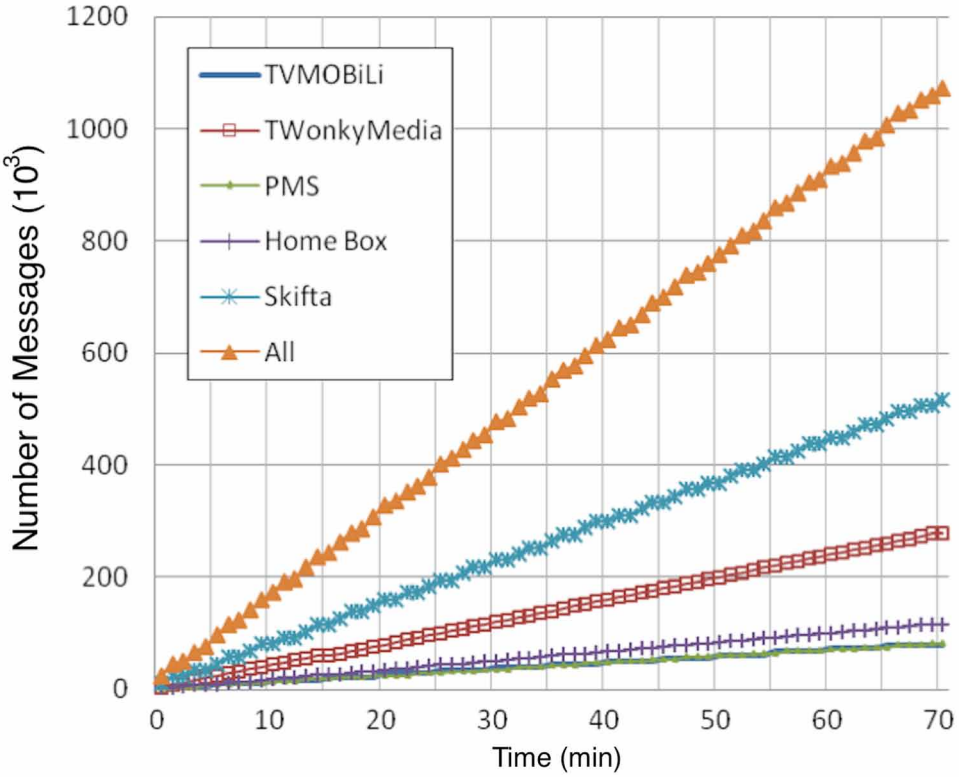


Figure 4. Cumulative number of messages in the background traffic received by one device within 70 min



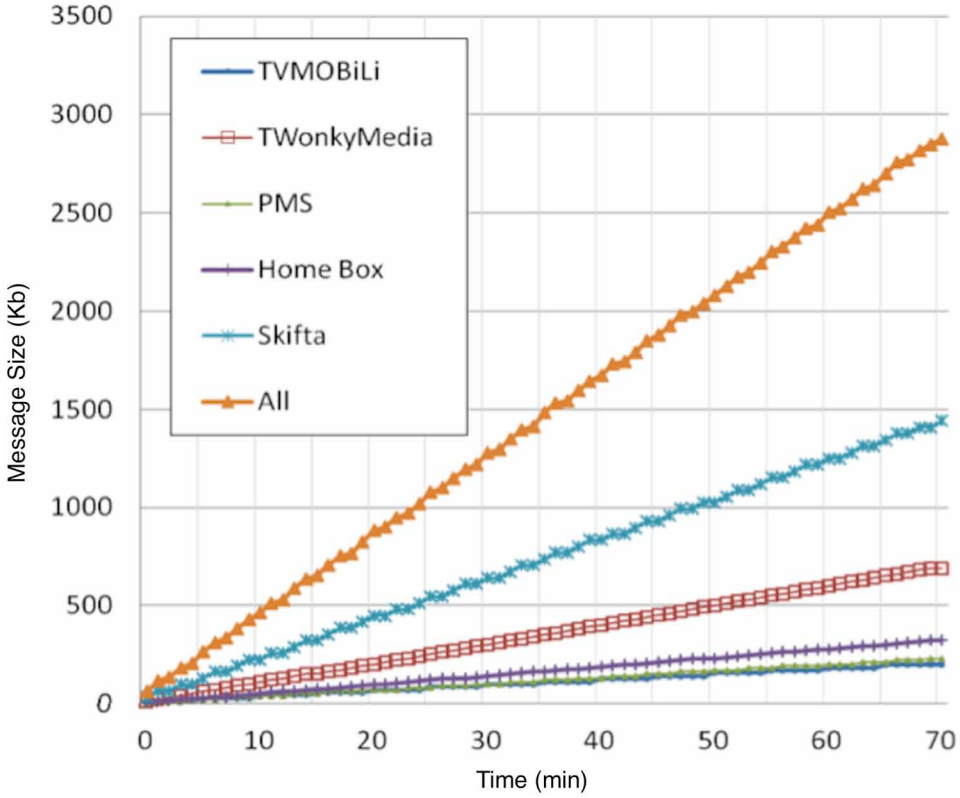
Based on our experimentations, we observe that the behavior of all the tested media servers is DLNA-compliant (DLNA, 2014) which means that the servers implementations follow the DLNA standard specification. The only noticed difference is due to the different implementations of the advertisements intervals.

Measurements show that within one hour, the user's network is affected by approximately 3000 unnecessary Kbytes and more than 104 unnecessary messages per one digital device. Indeed, even if the user does not perform any actions in a standard digital home network (e.g. searching or rendering a media item) the home network components still awake (consuming energy) and the resources are negatively affected by existing media servers. This situation is true when the home include some DLNA devices (i.e. 75% of existing CEs (In-Sat, 2010) such as connected TV) or when the user is unaware about the existence of digital technologies at home, which is mostly the case.

Browsing Shared Media Items

In a digital home, the most frequent action of the user concerns mainly browsing/searching media items and playing them using existing renderers. For novice users, rendering the shared content, through their heterogeneous terminals, is not intuitive and remains, in many cases, impossible (codecs issues, terminals configurations, etc.). Indeed, to be able to find and play one shared media item, a device (such as a handheld devices connected via WiFi) must (1) support the multicast mode in transmitting and receiving

Figure 5. Cumulative size of messages in the background traffic received by one device within 70 min



data, (2) the network interface of the device must be configured for this mode, (3) the device software must be able to parse long descriptions written in the XML-based UPnP Template language, (4) the SOAP protocol must be implemented in the embedded system, (5) the access network method (which is mostly wireless) must handle the unreliable nature of UDP transport, and (6) the device must be able to decode the original format of shared media items since no content adaptations are available by default. Unfortunately, these last identified requirements are not satisfied natively even by recent handheld devices such as smart phones and tablets. If the user's device is compatible to take benefits from his/her digital home environment, the device searches for existing media servers, browses available items and play them.

Figures 6 and 7 show the number and size of messages used to find and browse items shared in the digital home network represented by our testing architecture (Figure 3). In our tested scenario, we consider only one standard media server (the DMS embedded in the home box). The used device is the game box that is connected to a TV set in order to display the rendered media item. From $t = 0$ to 15 seconds, the user searches existing media servers. At $t = 45$ seconds, the user selects the discovered media server and explore its root folder. The root folder stores 24 sub directories and one video item.

From t = 0 to 15 seconds, the renderer sends (as specified by the norm) searching messages in a multicast mode. The media server notifies its existence and then the device retrieves the server's description. Messages from $t = 45$ seconds are related to the root folder's description, metadata and content.

Our measurements show that the total number of exchanged messages (only on the network segment between the media server and the device) is 68. The size of exchanged messages is of 38,98 Kbytes.

Figure 6. Number of messages (over time) used in browsing media items of one MS

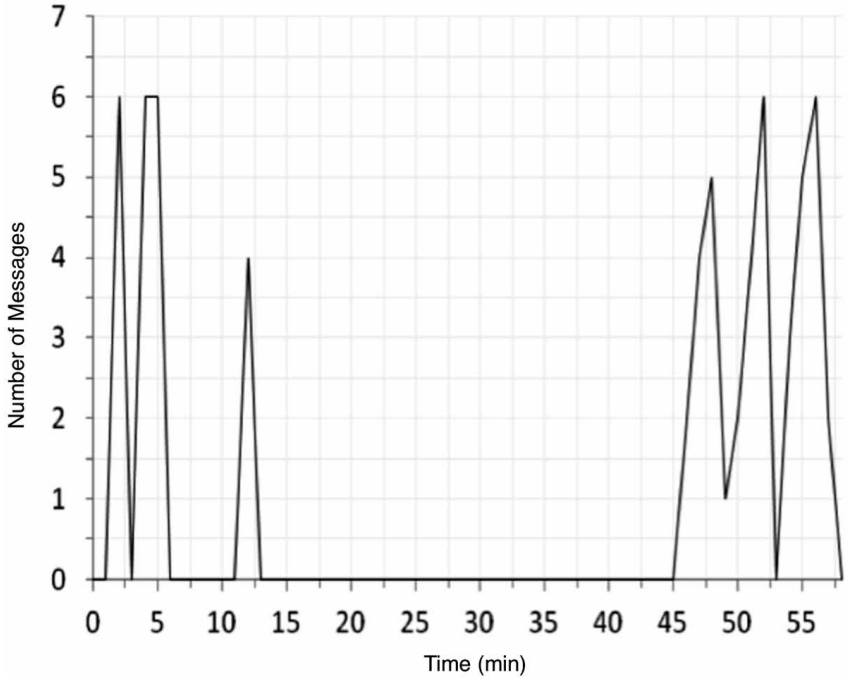
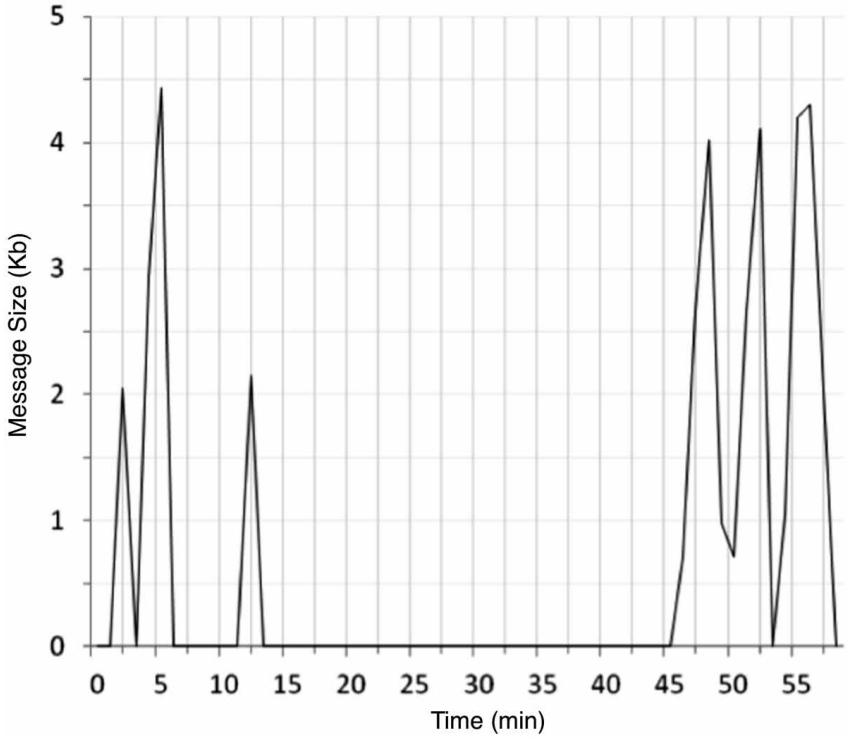


Figure 7. Size of messages (over time) used in browsing media items of one MS



Note that messages do not include any media content and concerns only the listing of the root folder (the first level of the media server). Device searching messages are sent in a multicast mode so they will be transmitted to the other digital devices on all the network segments. Also, if other media servers exist in the home network, the set of messages (from $t = 0$ to 15) will be increased with all of the received notifications (any media server must reply to a searching message as specified by the norm).

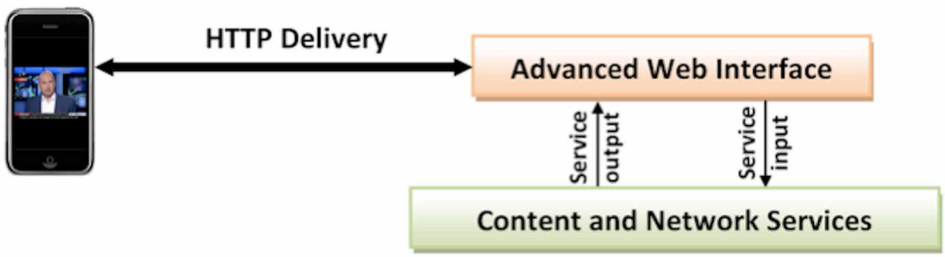
OPTIMIZING MEDIA DISCOVERY AND RENDERING

In this section, we identify a set of guidelines in order to optimize the media access in digital homes usages by novice users and heterogeneous devices. Even if some of these guidelines appear trivial, they are not all followed by the current digital home systems. The identified requirements allow avoiding the unnecessary background traffic of media servers and the traffic used in browsing shared media items hence significantly improving the user's experience. The guidelines are based on our experimentations in the context of digital home environments and from the lessons that we have learned from previous measurements. We identify five guidelines:

1. No network traffic should be generated if the user does not ask the digital home system for some items to browse/render. Also, unnecessary traffic should be avoided if it is not useful for the user's actions.
2. Existing media servers should be *easily* found by the novice user using any terminal whatever its capabilities.
3. Content adaptation and negotiation techniques should be easily integrated to better fit heterogeneous rendering limitations.
4. Proposed optimizations and approaches should be compatible with existing digital home architectures and media servers.
5. Media servers should be easily used by heterogeneous terminals without strong technical requirements on the device side or its access method

The first identified guideline can be easily satisfied by adopting the client/server model where the server answers only to the received requests with the needed content. To be compatible with heterogeneous devices having different software capabilities, the HTTP protocol represents the best candidate for the user's device that interacts with the digital home network through an adaptable Web interface (guideline 2). The network entity that hosts the Web server can behave as a middleware (Figure 8) that

Figure 8. Client/Server mode for home networks



discovers media servers (by applying a set of network operations and use available services), list items in standard Web pages and caches most used results (guidelines 4 and 5).

The client/server model can provide content adaptation and negotiation (guideline 3) based on the HTTP Transparent Content Negotiation (TCN) rules (Holtman & Mutz, 1998) and, if needed, based on external profiles that can describe the capabilities of devices (Figure 9).

USING A WEB CLIENT-SERVER APPROACH

In order to test the impact of our guidelines in existing digital home systems we have integrated a Web client-server system in our testing architecture. We have implemented and integrated the functions of UNIVERSALLY (Lemlouma, 2013). UNIVERSALLY was proposed in (Lemlouma, 2013) to enable the access and control of existing media resources at home using Web interfaces and the HTTP protocol.

Figure 9. Client/Server model for digital homes

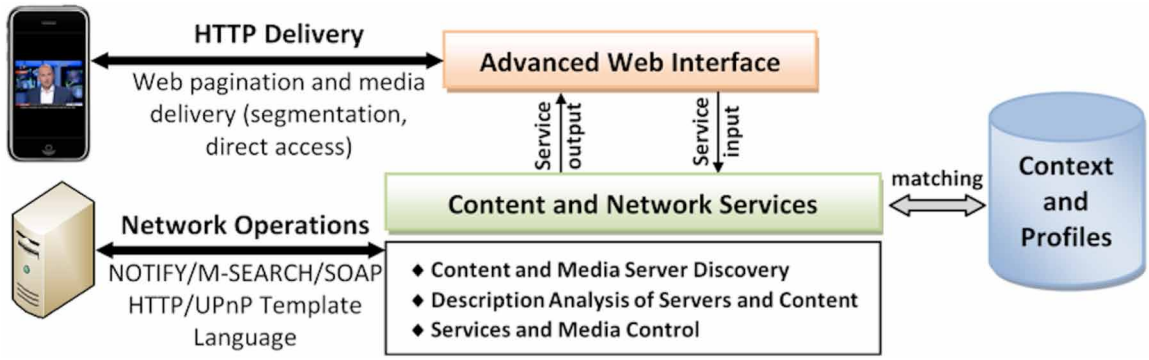
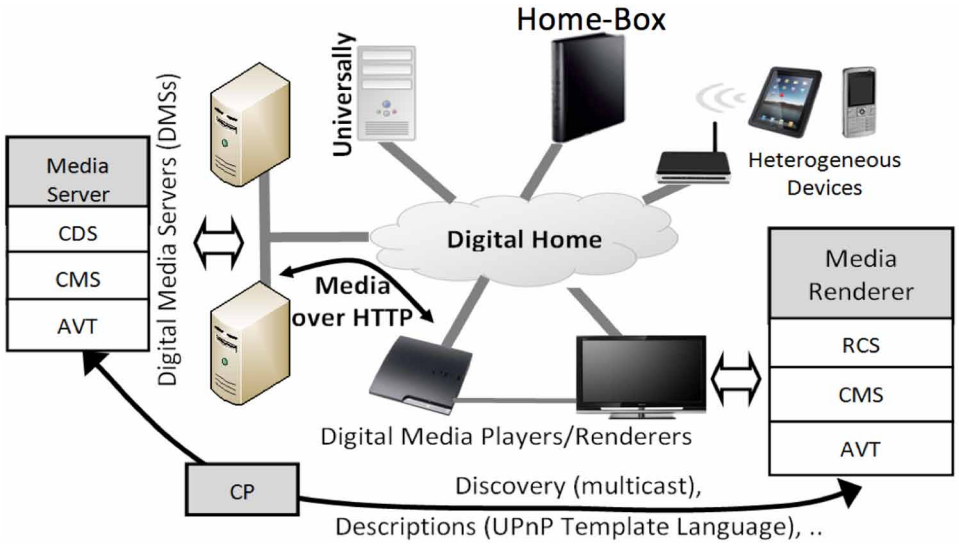


Figure 10. Testing architecture using a Web-based architecture



The key idea is to provide an easy media access only when it is needed by a user and requested by its device. Based on Web interface (Called AWI-*Advanced Web Interface* (Lemlouma, 2013)), devices can browse available DMSs and resources using the HTTP protocol. Once a media resource is found, the user can use it directly by hitting the displayed HTML hyperlink. In order to improve the media transfer, the media transport is extended to any transport protocol by including appropriate and compatible transport in the source of hyperlinks. For instance, hyperlink sources can include *rtp://* or *rtsp://* sources if the target device supports them. To perform DLNA media controls and actions (e.g. a stream seek) over HTTP, a web server is implemented with a full support of the HTTP range header (Figure 10). For instance, when the user seeks a certain position of a given media stream, the starting HTTP range is computed according to the corresponding offset of the media file stored in the media server.

UPnP main functions (discovery, control, etc.) were delegated to a specific implemented module that ensures the access for limited devices such as those which do not support the multicast or are not compatible with DLNA. Since devices with advances capabilities can also use the Web interface, UPnP advertisements of media services are filtered and only responses to the M-SEARCH requests originated by the user are authorized. Unnecessary traffic is so avoided. A *context* module is used to describe the hardware and software capabilities of devices that aims to play a media resource. This module is based on the W3C RDF *Multimedia Universal Profiling* (MUP) (Lemlouma, 2013). MUP specifies the displaying and rendering capabilities of a device. Near to 14.000 different HTTP user agents are considered. If the original format of a media is not supported, it can be adapted then transferred to the device. Based on the device's rendering capabilities, the Web interface is also dynamically adapted by performing a pagination of discovery results when the device explores media resources of available DMSs. The pagination allows to dynamically generate small HTML pages with *next* and *previous* links and so only small parts of the content is sent to the user. The pagination is based on the number of discovered resources (*child* of a device or a directory) which is extracted from the SOAP answer (*childCount* attribute of the XML element *DIDL-Lite/container*) of a *Browse/BrowseMetadata* action (UPnP, 2008a; UPnP 2008b).

BANDWIDTH CONSUMPTION AND ACCESS TIME FOR MEDIA ITEMS AND FOLDERS LISTING

In order to demonstrate the importance of the proposed guidelines for current digital homes we focus on the bandwidth consumption and access time when the user lists several media folders and items. Folders and items are hosted within the commonly used media servers at home (for instance a DMS, see Figure 10). We compare these evaluations using the DLNA system and our implementation of the client-server approach compliant to our identified guidelines.

In our experimentation, within the testing architecture (Figure 10), the Web interface of UNIVERSALLY is accessible from the *192.168.1.11* IP address. In a general case, UNIVERSALLY should be run on an IP address known by the digital home system. This can be easily guaranteed using a local DNS server that associates a familiar name to the UNIVERSALLY IP address. A similar technique is usually used by ISPs to access the home box without memorizing the box IP address. The client-server approach provides the access to all the available media servers of our testing architecture and transports media content in a paginated Web interface. Searching MSs is done only once when the user accesses the AWI interface hence background and periodic traffic (such as UPnP announcements) is avoided. Re-

quired messages (such as UPnP requests) are sent only when the user browses the available media items in the home network. The AWI's home page is a implemented using a simple Web page with an HTML *refresh* duration, after which the user is redirected to a new page where the result of services discovery is displayed. At any moment, the user can manually trigger a new services discovery. The client-server approach has allowed to: avoid unnecessary traffic (NOTIFY and M-SEARCH), unify the eventual available presentations of MSs and devices, make the browsing of resources possible and optimal and avoid SOAP and XML UPnP handling and parsing for limited heterogeneous devices.

Media Items and Folders Listing

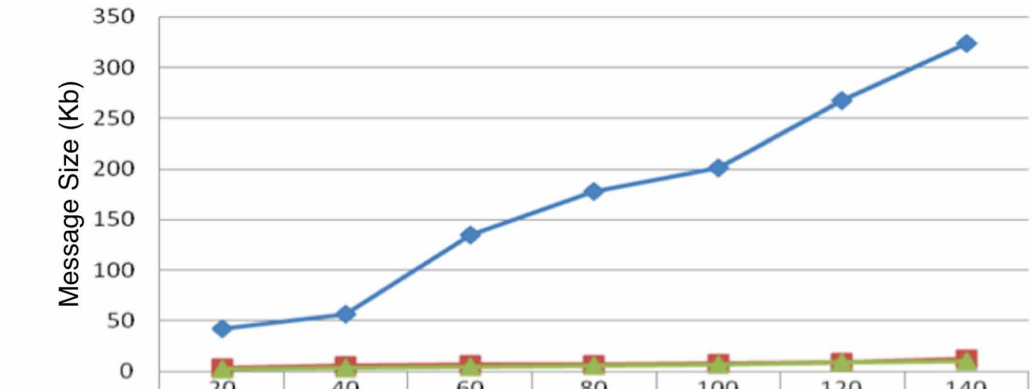
In a digital home, the main frequent action of a user is searching stored media items such as video and music files. Our real-world experimentations reveal that the user quality of experience is usually affected negatively in the current models of digital home networks. In Figure 11 and 12 we measure the bandwidth consumption and the access time when the user lists several media items and folders. The user's actions (listing folders and items) are performed, in our testing architecture, either using the media server embedded in the home box of an ISP (box MS) or using the client-server approach.

To experiment the cost of media items browsing we consider the following user's actions: browsing media folders/subfolders and browsing media items inside the folders. We focus on the access time and size of messages necessary to perform such actions.

For our purpose, we create 1120 video items (12,9 GBytes) and distribute them into different folders. The content is stored in 14 folders: 7 folders store (each of them) from 20 to 140 subfolders of videos; the 7 other folders store (each of them) from 20 to 140 media items with a step of 20 items.

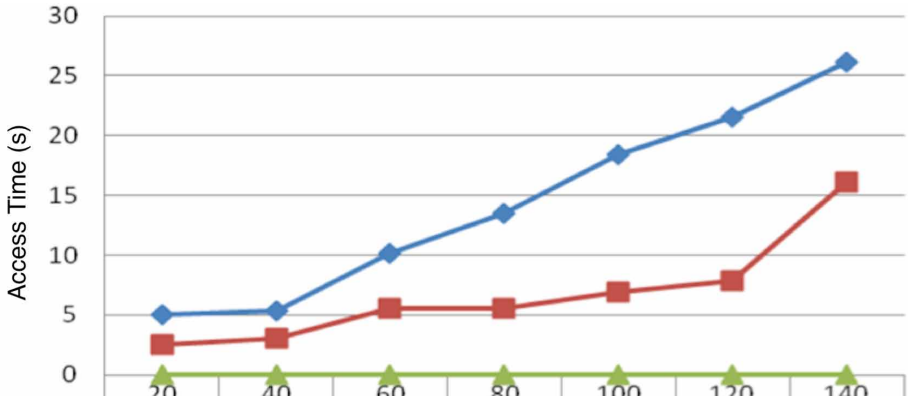
Figure 11 shows that the network bandwidth is negatively affected when the box MS is used for browsing folders containing several media items (20 to 140 media items with a step of 20). For instance, the client-server model requires 7,51KB to browse 100 media items while the box MS requires 200,62KB.

Figure 11. Browsing items and folders and the bandwidth consumption



	20	40	60	80	100	120	140
Items	42,58	56,11	134,59	177,82	200,62	266,90	323,19
Folders	3,73	6,22	7,03	7,07	7,51	8,78	12,33
UNIV.	2,51	3,72	4,93	6,14	7,35	8,57	9,78

Figure 12. Browsing items and folders and the bandwidth consumption



	20	40	60	80	100	120	140
Items	5,08	5,33	10,18	13,49	18,43	21,56	26,17
Folders	2,52	3,00	5,53	5,56	6,91	7,90	16,11
UNIV.	0,0040	0,0081	0,0121	0,0161	0,0201	0,0242	0,0282

The bandwidth consumption required in browsing folders containing subfolders remains acceptable and comparable to the client-server approach that uses the HTTP protocol. For instance, UNIVERSALLY requires 9,78KB to browse 140 folders while the box MS requires 12,33KB.

In Figure 12, the access time is measured between the user's request timestamp and the timestamp of the last packet received by the media renderer. Hence the measured access time includes the processing time of the box MS and the UNIVERSALLY Web server. Figure 12 shows that with a DLNA-compliant media server, the user's quality of experience is negatively affected for both listing subfolders and media items. For instance, 16,11 seconds (resp. 26,17) are required to browse 140 folders (resp. items). However, browsing subfolders and items with the UNIVERSALLY HTTP-based approach improves the required access time. For instance, browsing 140 items (or folders) requires only 0,0282 seconds.

The negative user's quality of experience regarding the access time and bandwidth consumption is mainly explained by the important size of digital home metadata related to items and folders (e.g. *upnp:albumArtURI*, *upnp:genre*, *childCount*, *icons*). These metadata are processed and sent within the media server packets to the media renderer. This approach is not adapted for a home media access within heterogeneous and limited devices using a wireless access (bandwidth consumption). Indeed, devices, such as smartphones and tablets, are not able to natively process the received metadata and the used complex XML schema (DLNA, UPnP and Dublin Core Metadata). Furthermore, in the case where the media item codec is not supported the bandwidth consumption becomes unnecessary. The HTTP-based approach represents the best alternative thanks to the client/server model, the mime-types compact descriptions and caching capabilities.

CONCLUSION

This paper focused on the use of the digital home systems to share and access different media and data coming from different sources using a wide range of different devices. We have shown how the user's

experience is negatively affected in current digital home systems where users are usually novice and search/render media items using heterogeneous handheld devices through a wireless access. For instance, within only one hour and without any user's action, the user's network is still *awake* and affected by approximately 3000 unnecessary Kbytes and more than 104 unnecessary messages per digital device.

We have identified the key requirements to improve the user's quality of experience in such environments in terms of access time and bandwidth consumption. Based on real-world evaluations, we have measured the negative impact of the current digital home network model based on a typical platform. We compared this impact -using the same testing architecture- with the Web client-server implementation that follows our identified guidelines and shows the significant improvements. Besides the fact that the Web-based architecture solves the user's difficulties in using the digital home system and improves the interoperability using heterogeneous devices, the interactivity of the system was also improved. For instance, using existing media servers 16,11 seconds (resp. 26,17) are required to browse 140 folders (resp. items). However, using a client-server model, the user action requires only 0,0282 seconds.

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Chapter 72
21st Century New Literacies and Digital Tools as Empowering Pedagogies for Urban Youth of Color

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ABSTRACT

Increasingly, more youth of color are gaining access to multiple forms of digital and popular media, yet 21st Century Literacies are virtually absent from the curriculum in most schools that serve them. By contrast, their increased knowledge of digital tools is usually met with restrictive access. For example, in many urban public high schools, cell phones are seen as contraband and students are required to "check" them at the door. Additionally, access to the Internet and social media platforms are blocked on most computers to which students have access while in school. More research is needed on how race, gender, ethnicity, and language intersect with access to digital tools in schools. This chapter presents a dialogue about the positive impact of using 21st Century New Literacies and digital tools with Black male middle and high school students. The authors highlight ways that teachers can effectively use digital tools in their classrooms.

INTRODUCTION

In American schools across the country, Black and Latino youth, and more specifically males, find themselves in a precarious position: they are consistently talked about and treated in ways that threaten their social and academic success (Haddix, 2009; Howard, 2013; Hucks, 2011; Noguera, 2003; Sealey-Ruiz & Greene, 2011b; Toldson & Lewis, 2012). Often, they are positioned as those students most in need of disciplinary action (Skiba, Nardo, Peterson, 2002) and academic remediation, and the ones who

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are least qualified for gifted and talented, and honors programs. These same youth often attend schools where there is limited access to high quality afterschool and tutoring programs, as well as enrichment programs in the arts and technology. As a society, if we continue to underfund the public schools mostly relied on by Black and Latino children, we will maintain the existing access gap between them and their White peers (who often attend well-resourced schools), and ensure Black and Latino underperformance on academic achievement measures (Ladson-Billings, 2006) for years to come.

The authors believe that educators should be concerned with the prevalence of a new kind of 'digital gap' between urban youth from working class and/or low-income communities and their peers who attend school in more economically affluent, White middle class environments. When newer technologies are available, students of color often do not have immediate access to these innovations because they are not readily available in their schools (Hobbs, 2012). Yet, it has been proven that when given access to these technologies, children who have had limited access quickly adapt and gain command in using them (Kaiser, 2010). We are not suggesting that the "digital divide" has disappeared; there is still reason to be greatly concerned about this, even as urban youth of color purchase and use mobile devices, and engage in online social networks in record numbers (Kaiser, 2010). Rather, we call for an examination of the ways in which youth of color are using these newer technologies, and how their increased access to digital tools and digital media is being positioned in schools and in research.

In our research we advocate for a shift in the discourse -- away from binaries created by access and performance -- toward notions of equity that qualify and contextualize digital disparities within local and societal histories, values, languages, and perceptions of success and disproportion. In other words, we argue that merely providing students with technology and online education, (even in varying degrees), and offering them training to meet curriculum and technology standards will not ensure access to social, cultural, and economic capital. Instead, real dialogue and action are needed to address and counter widening academic and digital gaps that persist within and beyond our current education system. In this chapter, we invite readers to engage in dialogue with us about the digital gap facing urban youth, and offer some implications for digital literacy education for youth of color in today's classroom.

As middle and high school literacy teachers, and as scholars in the fields of English and urban education we have observed how some youth are being encouraged to be the builders, creators, and producers of these digital tools and spaces in official school environments while others are not. Addressing and countering any kind of achievement gap requires having open and honest dialogue about its underpinnings and enacting curricula, pedagogy, and educational policies for transformation and change.

Indeed, the "digital divide" is no longer merely a question of access, but as Yang (2007) argues, one of power and control. He writes,

Bridging the digital divide reveals a deeper divide, in which poor, urban, immigrant youth are not full citizens of society. …marginalized youth often appropriate their newfound digital literacies to curse the state of inequality. Specifically, youth create subaltern public spheres, so-called subcultures, through such media as MySpace and text messaging. So framed, the "digital divide" is therefore an ideological divide and should refer to the antagonistic ideologies surrounding the purposes of new media. On one hand, charitable educators and government agencies seek to increase access to the information highway in order to produce compliant citizens for a global economy. On the other hand, youth subvert these resources to become counter-citizens, indulging in pleasure, resisting the "civilizing" project of education, and in some cases, organizing for the disruption of that very global economy (p. 12).

Yang's point suggests support for Banks' (2005) notion of a Black digital ethos. Banks argues that "a set of attitudes, knowledges, expectations and commitments…" (p. 48) must be developed and used by Blacks as they engage with digital technologies. Blacks have a history of civil rights activism in the U.S., and as members of a racialized group (Omi & Winat, 1986), they continue to face threats to their civil rights through institutionalized racist policies like "stop and frisk", the rampant killing of youth by police and others (as in the recent killing of Trayvon Martin), and in the massive closings of public schools in their communities. Black youth have taken up digital tools to announce these injustices in their communities and organize protests. In this way, they connect to the historical legacy of U.S. civil rights activism, and mobilize support for their causes through digital media.

Urban Youth Technology Consumption

Research from the Kaiser Foundation (2010) notes that while children of color are among some of the most active users of video games, television, online and offline music channels, social networks, and cellular phones, they are not usually the populations who are engaged in digital and media literacy opportunities in their schools. Solomon, Allen, and Resta (2002) note, "Although instructional technology has been part of the American educational landscape for decades, the integration of technology into the classroom lags beyond expectations for its use (Cuban, 2001), especially in traditionally underserved populations" (as quoted in Hobbs, 2012, p.2). Research by Hobbs (2012) confirms this digital gap. She writes,

...although there has been a significant funding initiative by charitable foundations over the past 5 years to support the field of digital media and learning, these resources have by and large gone to support a few very small and highly intensive initiatives (including the development of games for learning) and not yet have had much impact on a large number of children in low-income and urban communities." (p. 2).

Despite this evidence, urban students of color creatively find ways to engage with digital media at their local community centers or neighborhood libraries if they don't have immediate access in their homes. They understand the importance of being technologically and digitally literate, and they look beyond their school environments for access.

Viewing Urban Youth Technology Consumption Through a Deficit Lens

The aforementioned Kaiser (2010) study also found that children and teenagers whose parents do not have a college degree spent 90 minutes more per day exposed to media than children from higher socioeconomic families. In 1999, the difference was just 16 minutes. The study found that children of parents who do not have a college degree spend 11.5 hours each day exposed to media from a variety of sources, including television, computer and other gadgets, a reported increase of 4 hours and 40 minutes per day since 1999. In families where a parent has a college education or an advanced degree, Kaiser found that children use 10 hours of multimedia a day, a 3.5-hour jump since 1999. Children of more educated parents, those thought to have a higher socioeconomic status, also use their devices for entertainment. But, a main argument of the report, the point with which we are most concerned and take contention, is its statement that there exists a growing gap between the use of digital tools for education or "meaningful content creation". The writers of the report position those who use technology and other digital tools

for pure entertainment at high rates, as contributing to a 'time-wasting gap'. As researchers, we find it interesting that now, in recent times, when the "digital divide" between youth of color and Whites is narrowing, researchers are *still* finding ways to position urban youth from poorer and/or working class communities in negative ways. According to the Kaiser report, these youth are not 'falling behind' as much as they are 'wasting time'. Now that these youth and their families are engaging with technology in ways, and at comparable rates to their more affluent peers, their digital use is described in deficit ways.

In the past decade, digital technologies have significantly changed the way we live. In schools, from K-12 through the graduate level, computers, smartphones, social networking sites, and APPS are used in many classrooms to issue and complete assignments, share comments, and push student and instructor thinking in new directions. Specifically, as literacy educators we have witnessed the indisputable benefits that technology provides in our writing classrooms. Students in our classrooms are able to capture their thoughts in real time with audio and video recorders; effectively and efficiently edit their work, and include various multimodal elements (images, music, and audio) to enhance their written work, which can take on various forms (i.e. essay, blog, vlog, iMovie, Powerpoint, etc.). Given all of the advantages that digital tools offer students, we are dismayed at the ways in which these tools are restricted in schools where Black and Latino students are the majority, and are suddenly being viewed as negative when poor and low-income youth of color increase their engagement with them (Kaiser, 2010).

NEW LITERACIES IN URBAN ENGLISH LANGUAGE ARTS CLASSROOMS

In their Policy Research Brief on a Framework for 21st Century Learning, and 21st Century Literacies, the National Council for Teachers of English (NCTE) (2009, 2013) makes a compelling argument for the need to engage students in 21st Century literacy instruction, and to design classroom spaces where students and teachers have access to current technologies. NCTE advocates for students to develop technological proficiency, understanding how to "access, evaluate, synthesize, and contribute to information" (NCTE, 2009, p. 5). These policy briefs also discuss the importance of engaging students in the practices and kinds of thinking that are valued in the 21st Century: written and oral communication skills, collaboration, work ethic, critical thinking, and leadership. This framework, however, is taken up in particular ways given the school context and the student demographic. Conceptions of 21st century literacies vary by social context and are an effect of the distribution of economic, cultural, and social power (Gee, 1996). More specifically, how urban youth of color are constructed as 21st century literacy users, is bound by assumptions, and oft times deficit framings, of their race, language, gender, and socioeconomic status.

Research by Hobbs (2012) affirms the significance of using digital media literacy in urban schools. A study she conducted on a teacher and her elementary students in Philadelphia found that the use of digital tools can engage students in complex and difficult topics (like homelessness) for deeper understanding. The research also makes a case for the necessity for teachers to be creative and strategic in their use of digital tools in urban classrooms, and for their willingness to find use for digital tools at unexpected moments. When incorporating digital tools and literacies in classroom curriculum, teachers must first critically examine both the challenges and the benefits for using such tools (Hucks and Ragan, 2012). For example, when teaching writing and composing, using digital tools does not exclude or happen in place of teaching the writing process, facilitating writing workshops, focusing on writing conventions and grammar, or preparing students for writing on demand. This, of course, becomes challenging as

most urban public schools do not have sufficient access to digital technology, and often their teachers are burdened with scripted curriculum that is aligned with very narrow state standards.

Over the past decade we have learned a great deal about how to engage students in academic learning from different cultural, racial, and linguistics backgrounds (Gay, 2010; Heath, 1996; Ladson-Billings, 1997; Moll & Gonzalez, 1994). What is missing from this dialogue is how to develop an empowering pedagogy that builds on new literacy practices for 21st Century learners. Race and culture matter in schools (Banks, 2004; Howard, 2008). Instructional inequities such as tracking and high concentration of students of color in low-performing schools only serve to reify a cycle of failure that contributes to a dominant narrative which pathologizes students of color (Dixson & DeCuir, 2004; Ladson-Billings & Tate, 1995). Through critical literacy pedagogical approaches, efforts have been made within literacy education to incorporate and examine themes related to equity, achievement, and culture (Morrell, 2012); however, there still remains a need for a robust dialogue about how these factors intersect with 21st Century literacy education.

New literacy studies are situated within an intersection of sociolinguistics and anthropology (Morrell, 2004; Schreibman, Siemens & Unsworth, 2008) and represent a re-conceptualization concerning the nature of literacy. New literacy scholars examine local literacy practices and interactions (Street, 2005; Gee, 1996) that focus on how people engage in events to understand how they use literacy to do work, or to get things done. Preparing and supporting teachers to enact pedagogy informed by constructs of New Literacy Studies would begin to foster a conversation about providing more empowering contexts for literacy learning, and help highlight the importance of ensuring that all students are equipped to succeed in the 21st Century beyond school.

The Need for Digital Literacies in Urban Schools

In the next section of this chapter, we share our personal digital access stories that help to position our passion for the digital literacies work we do with youth of color. Within this storytelling dialogue, we continue a conversation previously started in a recent journal article. We had the opportunity to engage in dialogue about the use and restrictions of digital tools in the schools were we've taught. Our conversation was published in the November 2012 issue of the Journal of Adolescent and Adult Literacy. The article we co-authored, *Cultivating Digital and Popular Literacies as Empowering and Emancipatory Acts Among Urban Youth* (Haddix & Sealey-Ruiz, 2012), was the result of multiple conversations over several months. We discussed the work we do in our writing classrooms with young males of color. In the article, we encouraged educators to rethink (and actively use) digital literacies in urban classrooms, and shared the implications for not doing so.

In our conversation, we talked about our respective work with urban youth, particularly Black and Latino males in out of school or alternative spaces, and their persistent and intentional use of digital tools to author and to make meaning of their lives. And, we put forth an argument for the validation and affirmation of their digital composing processes and use of digital tools and other marginalized literacy practices in school and official educational contexts. In that dialogic piece, we wrote about how we find it curious that our use of digital tools and popular culture with urban Black and Latino males happens in "alternative" settings or outside official school contexts and we also make the point that these same literacy practices are not marginalized within other school contexts or with other youth from more privileged backgrounds. We call out the criminalization and policing of digital and popular literacies among Black

and Latino males in urban school settings, and we reflect on the ways that we have witnessed emancipation and empowerment when students were not only allowed, but "free" to engage in such practices.

The idea for this chapter grew out of that journal article and our desire to continue a public discussion around the use of critical, digital, and visual, literacies that seek to achieve positive academic goals for students of color, and more specifically, those students who are marginalized, "pushed aside," and at risk of failing academically. In our research, we explore learning environments that build on and support the curricular and pedagogical practices for teaching composing to urban adolescent youth and ones that establish complimentary digital literacy practices. The lessons we design and the assignments we issue to our students validate their current literacy and language practices, in and out of school, and the ways in which they access technology to communicate their lived experiences via digital composing processes.

In our many years of teaching youth of color, we have observed that these digitally composed processes are often non-school sanctioned, and in contrast, the use of technology "in school" is relegated to remedial instruction which positions urban adolescent youth as "receivers" of information and technology users. We challenge this framing and call for a use of technology in urban school settings that aims to build learning technology environments which position urban adolescent youth as knowledge producers, creators, and designers, and not merely passive and uncritical consumers.

For the past several years, we have worked with males of color -- from middle school to high school age -- in out-of-school and alterative school settings. We have witnessed the ways in which their writing is enhanced (more fluid writing, increase in self-correction of errors and inconsistences in their writing) with the use of digital tools. We have also witnessed, first hand, how these same tools are made to seem suspicious when Black and Latino students, and particularly our male students ask and are allowed to use them.

As colleagues in the field of English education, it is common for us to share ideas about our teaching. During our more recent conversations we began to pay particular attention to what was happening with our students' use of digital technologies in our classrooms, and the attitude toward their use of these tools by some other teachers and administrators in our schools. We also looked further outward, and continued to examine how the literature and popular press framed the use of digital tools by youth of color. We found very little research that focuses on how race, class, ethnicity, and gender intersect with the use of digital literacies in school settings (Vasudevan, L., Schultz, K., & Bateman, J. (2010). Although our article was published in 2012, we continue to conduct research in this area and explore the use of digital tools with our students, and whether or not the use of digital technologies have increased in urban schools.

We continue the conversation in this chapter by asking ourselves additional questions about what we see in the schools where we serve; observing both student access to and engagement with digital literacies. We first share our own stories about growing up during a different time of the "digital divide," when much of the discourse was about inequitable access to computers. Having grown up during the 1970s and 1980s, before the onset of the digital age, we are not considered digital natives. We begin with our own narratives to underscore the importance of teachers and educators situating their own social locations and histories relative to the digital histories of the youth in today's classrooms. We then discuss our observations and share testimony about how student learning is ignited when they are given the opportunity to fully engage with the digital tools and media present in their everyday experiences. In particular, our male students of color who had been "pushed aside" and positioned marginally within the official school context, positively responded to using digital tools and engaging with digital literacies as part of their learning experience. Through our narratives, experiences working with youth, and our

research, we also learned that these opportunities to engage with digital literacies are often restricted in schools attended by youth of color. Here we continue to discuss our observations on the use of digital literacy in urban schools.

DIGITAL LITERACIES: AUTHORS' DIGITAL ACCESS STORIES

Yolanda: When I think about the role of digital literacies in my life, I immediately think about the level of access I had to it. I never realized that my family was poor until I learned how those outside of my South Bronx neighborhood (through movies and newspaper articles) discussed people like us who lived in places like the South Bronx. In the early 1980s I had access to some of the newer technologies that others teens in my hood and I were most interested in: video games! Since my friends and I had access to most of these games through our local candy store, we didn't imagine that we were on the lower end of the digital divide, in fact, we didn't know that one existed!

I would say that my digital literacy skills were developed at Mel's, the most popular candy store on my block. Lessons began when I filled the huge Atari video machine with quarters to play Q-bert, Pac-Man, and Asteroids. Other lessons were learned when I visited my friend Michelle's house (her mom and dad worked so they were considered well-off) where she had these same games on a table top Atari. Her family also owned a computer. Outside of the videogames I played at Mel's and computer time at Michelle's house, I didn't know much about computers or their capabilities. In high school I majored in Computer Science because my junior high school teacher, Mr. Hoffman told me that "computers are going to be the future", and he felt I should be on the right side of that future. I remember trips to the "control room" at school – a large, frigid room with monstrous-sized machines that were said to "run" the computers in the lab. I vaguely remember working on keypunch cards, but not really understanding the Cobal and Fortran coding I was supposed to master by my final year of high school. Even still, my high school experience and trips to Mel's candy store and Michelle's house made an impression on me.

The summer following my second year of college (I had declared myself a Computer Science major there, too), I was able to buy my first (used) Apple computer – an off-white, oddly-shaped "box" with a small, green, monochrome screen. I had worked and saved for an entire year to buy my first Apple. Once I purchased my own computer, I had decided I would focus my college studies on becoming a computer programmer even though I didn't really enjoy what I was learning in school. A new era and way of thinking was happening right before me, and, as Mr. Hoffman cautioned, I wanted to ride the wave of innovation that was taking shape in my lifetime.

Fast forward: it was a decade later when I worked in my first corporate job and I was able to afford a brand new IBM Thinkpad. Years before, I had found the courage to switch my college major from Computer Science to English, but I still understood the need to be in touch with technology and how it was impacting my life. Now access was a little easier – I worked on desktop computer at work and had a laptop at home. I no longer played video games, but I recognized the games I played at Mel's and Michelle's house to be my first steps in acquiring digital literacy skills.

When I started teaching in the early 1990s, I knew the value of technology for my students because I knew the world it had opened up for me. I worked in an alternative high school with limited resources. There were two computers in the library, and one in the teachers lounge. In terms of their access to computers and technology, many of my students were a reflection of me just a decade earlier, but perhaps they were in a more vulnerable position. I had attended Murray Bergtraum High School for Business

Careers and majored in Computer Science, and therefore had regular access to, and some education in computers and technology. At the high school where I taught, there was limited access to computers, and to my knowledge, no courses were taught on computer science or digital technology.

Marcelle: I remember watching an episode of Tony Brown's Journal on PBS back in the late 1980s where he brought on panelists to talk about the digital divide. The digital divide was an issue of access—social and economic mobility was linked closely to whether or not you had a computer in your home. As a teen who spent much of my free time in the public libraries and whose computer access was often limited to use in those spaces (we had a typewriter at home), I remember wondering if I was going to be left behind or somehow disadvantaged if I didn't have immediate access to the latest technology. My dad was obsessed with knowing about advances in technology. He was a factory worker and my mother stayed at home and eventually worked as an administrative assistant, so we didn't have the means to access this technology. However, I was quite aware of the fact that the world was changing and that there was new knowledge and skills to be had.

When I was twelve years old, I participated in a computer literacy summer camp for students of color from working class backgrounds at one of the state universities. At camp, we learned how to write code and how to create graphic images. We learned about computer infrastructure. This was back when computer screens were monochrome. I attended this camp three summers in a row, and as I think about it, the mission of this program was to empower young people of color to be engineers, creators, designers, and producers. The goal of the program was to provide us with digital literacy during a time when computers in schools were limited in use.

Eventually, at home, we acquired a desktop computer. It had a cassette tape drive. At most, I used the computer to play video games and to word process academic assignments. Though, throughout my high school years, I still relied heavily on my typewriter and liquid white out. I then attended a university where they promoted the "Mac in the Room" program—every dorm room was equipped with a Mac computer. I would say that my regular computer use began during my college years; however, much of this use involved word processing. Different from my experiences in computer camp, I was not encouraged to use digital tools for production or creation. Though, I loved that aspect of computer programming. I guess I feel like I might as well have been using a typewriter. Computers just made it easier—I could back space and erase versus reach for the white out.

Professionally, I've worked numerous positions in higher education administration, and with each new position, my use of the computer increased. In one position, I was actually the department Webmaster—I knew how to write HTML code as well as navigate the newer web design programs. Because I had a computer at work, however, I never felt it was a necessity to have a computer for home use. At one point, my partner and I purchased a cheap Toshiba laptop and followed that with the purchase of a Dell laptop. But, my use of digital technology was relegated to my career. I did not use email at home; I did not surf the Internet or shop online at home. Even in the early 2000s, I still wrote out and mailed all of my bills. I preferred to have phone conversations and resisted texting or chatting online. In some ways, I wanted to preserve the sanctity of my home and personal life—no technology allowed.

In the last five years, I moved from being a serial iPhone user to not having a smartphone at all. I do not text, and this often surprises and upsets some people. I do use Facebook and communicate regularly with family and friends via email, but I've been reluctant to participate in other forms of social media unless I'm using it for a course assignment. Honestly, I was becoming a passive consumer of new digital technology, and I feel that many people are. Having the latest smartphone or iPad 6 is more about social capital (or being popular) these days and not about ingenuity and productivity necessarily. But, quite

different from my own childhood, each person in my home has his or her own personal computer. We have more laptops in my home than we do televisions. We do not have cable television, but we probably would not be able to function without WI-FI. My son is a digital native—he uses technology with much ease, including creating and writing on his blog to watching and commenting on Youtube videos. While I understand the importance of being digitally literate in the 21st Century, I want to embrace and promote critical digital literacy. We can be passive consumers and users of digital tools, or we can be active doers, creators, and producers in these new digital and online environments.

Yolanda: Speaking of being creators and producers, I know you have noticed as I have, that students are prohibited from using digital tools in school. Why do you think this is happening to young people in urban schools?

Marcelle: In the English methods course I teach each spring, I showed preservice English teachers a YouTube video of a young artist, Suli Breaks, performing a spoken word poem where he critiques the standardization of the schooling system. We watched this clip on the same day that we discussed Yang's (2007) article about youth organizing through the use of digital tools and online spaces. I asked the students to deconstruct the video, thinking specifically about the digital knowledge and resources necessary and inherent in the composing of the video. I asked them to imagine what was involved in the students' organizing and digital composing processes. I said, "consider what the students did to make this video possible, assumingly without teacher or adult intervention." My students struggled to list what might be involved. Instead, the students focused on all of the limitations or factors that might contribute to students not being able to create such videos and why this kind of project would not be readily possible in a school environment. This is precisely why I engage my preservice teachers in such learning activities—we have to disrupt and shift any thinking that limits the possibilities for our students.

I do not feel that it is an issue of access for urban schools—the resources are there. Our schools have computers, smartboards, and other digital tools. It is a question of how these tools are used, who gets to use them, and for what purposes. The central administration determines which online tools and sites are permissible to students and to teachers. There is strict protocol involved in gaining permission to use certain sites and some teachers feel, why bother? Instead, we construct narratives about students' abilities and capacity to engage with these tools. We tell ourselves that, "Students need to focus on basic reading, writing, and math skills anyway." Or, "We don't have time to teach critical digital literacy, we have to prepare these students for the test."

I recently completed a mini-documentary film project with a group of middle school students at one of the local schools. This school is marked as a persistently low-achieving school in our district, and in fact, it is being restructured for the next school year. Most recently, it was featured in the local news as the school with the highest number of suspensions. In talking with the eighth graders in the film project, they clearly articulate messages like, "these teachers don't care about us" and "we not learning anything so why come to school?" The last few months have been focused on test-taking and completing school work to be promoted to ninth grade. The film project was a departure from their day-to-day. With consent from the principal, I was able to work with the students 2-3 times per work during the school day. We began by previewing several documentary shorts; the students participated in writing workshops to develop their own stories; then I gave each of the students a digital camera and they gathered necessary footage and images. Over several days, the students worked with iMovie to edit their films and construct narratives. They created multilayered stories using text, sound, and images. I did not reveal to the students that I had never created a film or worked with iMovie; this was a first for me too. So, in essence, I was learning to use the tools at the same time they developed these skills. I witnessed firsthand what is

possible when students are equipped with the tools, time, and space to create and produce. We will soon have a screening of their films. The students are proud of their work, as they should be, and they want to share their accomplishments with their teachers and peers. It is essential that the very teachers that doubt their abilities witness and experience the results of their talents and ambition. Yet, I am prepared for the many reasons and factors that teachers will raise to discredit or essentialize why students were able to produce these films. So, as Yang (2007) stated, this is very much about an "ideological divide" and not merely a digital one.

Yolanda: You were willing to be vulnerable and learn along with your students. Some teachers are not comfortable with this. In fact, in some ways it can seem as though a move like this de-centers teacher authority, and yields power to the students. Why would teachers shift or de-center authority to allow students, that are oftentimes feared, a position of power?

Marcelle: When young people have tools that enable them to author their lives and to speak out, power in the classroom is redistributed. We know that certain pedagogical and curricular practices can and will result in a positive return for marginalized, academically underachieving students. This can include leveraging students' interests and choices in the topics, the genres, and the mediums and tools they use when composing in school.

When we refuse to use and encourage such practices, I believe that this is intentional—we do not really want to close this so-called achievement gap. I am constantly witnessing how the same digital tools and practices are demonized in certain spaces and celebrated in others. For example, I've worked in urban school contexts in which students are mandated to "put away or give away" their digital tools before entering the school. In other words, showing school readiness becomes interpreted as "no technology allowed," instead of acknowledging the potential for certain tools to transform literacy learning.

Yolanda: I also ask you that [question] because there is a huge police presence in the surrounding neighborhoods of my alternative school in New York City. The aggressive stop-and-frisk policy in New York allows the police to cruise the area around the school at least twice a week. When some people in the community are arrested on drug-related charges, this image carries over into the school.

I do believe that this stereotype creates a subtext that assumes that if Black and Latino males are texting, they must be engaged in a drug trade. In this way, the everyday act of texting becomes criminalized in a context in which texting, in fact, has the potential for significant teaching and learning possibilities. To me, this kind of racial profiling has a direct negative impact on curricular and pedagogical decisions.

Within educational research, policy, and practice, significant attention is paid to the ways that certain school contexts are designed to control and socialize urban youth of color, especially Black and Latino males, for the school-to-prison pipeline in lieu of identifying and spotlighting the kinds of pedagogical practices that empower them to achieve academic greatness.

Marcelle: So, how are we asking teachers to see digital literacies as emancipatory acts? How are we asking them to rethink the use of digital literacies and popular culture in ways that offer more freedom in the classroom?

Yolanda: I think we are asking them to, one, request more technology access where there isn't much, and two, if there is access to computers and other digital tools, to allow students to use them for their in-school learning experiences. This will involve trusting students to use the Internet to access critical YouTube videos, like the one by Suli Breaks that you mentioned. This means that teachers would need to encourage students to think about how video can enhance student opinions about what needs to be changed in society, starting with the educational system. And then, I think, we are asking educators not to be so alarmed when students want to use their smartphone to compose or download images, and use

Google and other sites as resources. We have to begin to trust them, and particularly with our boys of color, stop jumping to the conclusion *that* they are always visiting inappropriate websites when they go online, or texting with friends (or worse) if they pull out their smartphones. Sure, some of these things may happen, but then that gives educators the opportunity to collaborate with their students on guidelines for their classroom community when working with technology, and engage them in conversation about the importance of trust in the classroom. It will take the teacher to lead this. I know we can do it if we move past some of our discomfort and doubt about our urban students' use of digital tools and media.

IMPLICATIONS FOR 21ST CENTURY EDUCATORS

We want educators (preservice and inservice) to consider this chapter as an entry point to their own digital story. We want them to reflect on personal experiences with digital media making. We would like for educators to closely observe the access their students have to digital tools in their schools and ask then some difficult questions about who has robust access and who does not. We want educators to think about the work they need to do in their classrooms with their own students toward developing their digital literacy skills. We remain concerned with unearthing the reasons why emancipatory pedagogies—which have great potential to undo deficit constructions of Black and Latino males and their literacy practices, including the use of digital tools and popular culture—are not more readily available in traditional urban school settings.

When incorporating digital composing into their classroom curriculum, teachers should first critically examine both the challenges and the benefits of using digital tools in writing instruction and other subjects. Digital tools can serve as a powerful way for teachers to draw on students' out-of-school practices and talents when composing in school and when completing other academic tasks. English educators, in particular, should continue to think about ways to transform their instruction through the use of online digital composing sites such as storybird.com, storify.com, bitstrips.com, xtranormal.com, and other free blogging tools (e.g., blogger.com, wordpress.com). Many sites have tools specifically tailored for teachers to use in the classroom.

CONCLUSION

We are members of the digital age. Digital tools, social media, and multiple ways of digitally expressing ourselves continue to enhance our lives. Youth in our classrooms remind us how significant digital ways of knowing can be, and how media is rapidly changing in ways that can benefit us. We now APP it, Google it, tweet and storiyfy it, Skype in, and turn to tumbler, instagram, or Facebook to stay connected on personal levels, but also to organize mass protests.

Technology continues to rapidly advance. The advent of cellular and smart phones, iPads, etc., has narrowed the divide between students who would have access to technology, and those who would not. Notably, even with access to these tools, many students of color in urban schools are not allowed to engage with them in ways that other students are allowed to. We have witnessed the ease with which our students are able to compose poems, essay drafts, lyrics, and script lines with the use of smart phones in our writing classes. The use of these tools makes learning fun for them. They are engaged, feel in control, and are able to share their work with their social media network instantaneously.

Supporting urban students' 21st Century new literacy learning in race and culturally conscious ways can shrink the 'digital gap' between them and their White peers in well-resourced schools. This support has the potential to create accessible and equitable educational opportunities for urban youth. A critical multicultural framework for preparing teachers to work with diverse student populations must account for both sound content knowledge and advocate for a sustained commitment against oppressive structures that impede the academic success of marginalized students. Beginning teachers, especially, need multiple and complex opportunities to consider how new literacies can and must be enacted in their teaching, and these opportunities must address the demands of an increasingly technologically and digitally sophisticated society.

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KEY TERMS AND DEFINITIONS

21st Century New Literacies: A wide range of abilities and competencies which require fluency with technology and building intentional cross-cultural connections and relationships with others as well as attending to the ethical responsibilities required by these complex environments.

Critical Literacy: Critical literacy encourages readers to adopt a critical and questioning approach, and to actively analyze texts. A critical literacy approach offers strategies for uncovering underlying messages present in texts.

Digital Composing Process: This process can take on several forms such as participating in an online discussion through a listserv or bulletin board. It can refer to creating compositions in presentation software, participating in chat rooms, or creating webpages. It can also mean creating a digital portfolio with audio and video files or scanned print writings, as well as composing on a class weblog or wiki.

Digital Divide and Digital Gap: A digital divide is an economic inequality between groups, broadly construed, in terms of access to, use of, or knowledge of information and communication technologies. A digital gap refers to the disparities in how some youth are invited to be creators and innovators of digital media, while other youth are positioned as consumers. The digital gap also refers to the (slower) speed at which newer technologies are introduced to most youth in urban school contexts compared to youth in well-resourced schools.

Digital Literacy: This is the ability to effectively and critically navigate, evaluate and create information using a range of digital technologies. It requires one to recognize and use that power, to manipulate and transform digital media, to distribute pervasively, and to easily adapt them to new forms.

Digital Tools: Digital tools range from devices like desktop computers, ebooks, thumbdrives, smartphones, and laptops, to social media like facebook, tumblr, twitter, to Internet Browsers (Safari, Firefox, Internet Explorer) and email. Essentially, digital tools help us communicate in a variety of ways.

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Chapter 73
Vancouver's Digital Strategy: Disruption, New Direction, or Business as Usual?

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ABSTRACT

A growing number of cities have started to realize the need to be 'smart', to use digital technology to drive prosperity and capitalize on the rapidly growing digital economy. Some local governments have developed 'urban digital strategies' to speed up the pace of change, and to move their digital planning from ad-hoc to an integrated and strategic approach. This paper examines Vancouver's Digital Strategy (VDS) and questions the role defined for this new piece of strategy. The findings represent competing views – offered by local government versus digital business community - for the role of digital in two areas of governance, and strategic planning. The paper concludes by suggesting that urban digital strategies need be incorporated into strategic urban and regional planning with a focus on the biggest issues, specific to each city.

INTRODUCTION

There is not a clear consensus in the literature on how to define strategic urban and regional planning. It is however understood that urban and regional planning is far broader that the classic definition of development control which refers to the planning process behind regulating and managing changes to land use and development. The broad definition of strategic urban and regional planning is clarified with reference to local contexts around the ongoing major issues facing cities and regions, whether climate change, social transformation, economic crisis, or technological advancement (Albrechts, 2006). An established body of the literature (Sartorioa, 2005; Searle and Bunker, 2010; Williams, 1999) discusses the never ending shift in the focus of strategic urban and regional planning as a result of the shift in what matters the most in different parts of the world at any points of the time.

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Infrastructure has been one of the founding pillars of strategic urban and regional planning (Burnham and Bennett, 1909; Saalman, 1971). Planners recognize that infrastructure, as a powerful driver of economic growth and social prosperity, exerts a profound and pervasive influence on cities and regions (Graham and Marvin, 2001; Neuman and Smith, 2010). The definition and scope of infrastructure, and as a result, the major planning concerns and policy issues associated with have evolved over time. More recently, the fast growing digital economy has highlighted the role of telecommunication infrastructure in strategic planning for economic growth and social development (Alizadeh et al., 2015; Neuman and Smith, 2010; World Bank, 2015).

There is a new line of research about how cities and regions can/should capitalize on the potentials of telecommunication. It builds upon the growing international research on smart cities and digital economy; and explores telecommunication-based opportunities in a range of planning topics including but not limited to participatory planning, public safety, disaster management, local and regional economic development, employment growth, sustainable development and control, transport management, governance, development assessment, and infrastructure (Heo et al., 2014; Rodríguez-Bolívar, 2015; Yau et al., 2014). The aim is to apply telecommunication to enhance cities' liveability, workability and sustainability (Berst et al., 2014 p.6).

Debates on the implications of telecommunication are not limited to academia. Different levels of governments around the world have started to develop policies and initiatives with the aim of capitalizing on digital economy (OECD, 2015; World Bank, 2015). National digital strategies now exist in a growing number of both developed and developing countries including: Singapore, India, Taiwan, China, South Korea, Malaysia, Ireland, Israel, Australia and Finland.

Interestingly, the first generation of digital strategies focused on businesses (Bornheim, 2001; Kulatilaka and Venkatraman, 2001; Mithas and Lucas, 2010). The idea was that digital technology had reached the mainstream, so e-business or e-commerce was everyone's business in the new economy (Fingar and Aronica, 2001). The digital business strategies were enforced by the concept of digital disruption (Christensen, 1997) which attracted an extraordinary level of attention from both academia and practice. It was argued that even though disruptive technologies (in this case digital technologies) initially underperform established ones in serving the mainstream market, they eventually displace the established technologies. Discussions on digital disruption put a great emphasis on the timing of adoption of new technologies and suggested that in the process of advancing disruptive technologies, entrant firms that supported the new technologies will ultimately displace the incumbent firms that supported the 'old' technology. The notion of disruptive technology in the business world has been re-examined and re-invented several times (Danneels, 2004; Downes, 2009; McQuivey, 2013). McQuivey (2013), for example, took the disruptive technology notion to the next level and called for businesses to find disruptive new things to do, rather than just doing the old things in new ways.

There is a growing body of literature making a similar argument for cities (Bulu et al., 2014; Heo et al., 2014; Hollands, 2008); that smart technologies have now matured to the point that cities of all sizes can afford and benefit from them; and that cities should use digital technologies in their planning and management (Berst et al., 2014). Some cities have taken up this recommendation with the development of 'digital strategies' to speed up the pace of change, and to move digital planning from ad-hoc to integrated and strategic (Bloomberg et al., 2010; Bloomberg et al., 2013; City of Chicago, 2013; City of Vancouver, 2013). Digital urban strategies cover issues ranging from business creation and productivity growth, to public administration, education, health, environment, citizen engagement, and development

(Alizadeh, 2015; Alizadeh and Sipe, 2015). Such digital strategies are relatively new prepared by ambitious cities such as New York, Vancouver and Chicago.

This paper investigates Vancouver's Digital Strategy (VDS) in order to understand the role defined for the digital economy in urban management. The paper takes the already established concept of digital disruption (Benner, 2003; Dunleavy et al., 2006; Heo et al., 2014) beyond the business world, and applies it to urban governance. It questions the level of disruption, if any, caused by this new piece of technology-based strategy. By doing so, the paper raises a bigger question of interest to urban planners, managers and decision-makers – to what extent should planning for digital technology and the digital economy be integrated with and incorporated into strategic urban planning?

The paper starts with a literature review of urban governance and digital technologies which sets the theoretical foundation. It then provides an investigation of Vancouver's Digital Strategy based on a combination of policy analysis and empirical data gathered through interviewing a sample of stakeholders involved in the strategy development process, and implementation. Lessons learned are mostly focused on a single case study and cannot be easily generalized. However, the core massage could inspire all cities around the world to embrace digital technologies with the aim of enhanced liveability, workability and sustainability; and to address their core issues and challenges.

URBAN GOVERNANCE AND DIGITAL TECHNOLOGIES

While the notion of digital technologies and disruption caused by them has been widely discussed in the business world for the last two decades, its implications for governance and more specifically urban local governance is only beginning to be realised.

One of the first areas impacted by the notion of digital technologies is economic development (Benner, 2003). It is now understood that digital technologies are both critical for and highly disruptive to existing employment opportunities (Brynjolfsson and McAfee, 2012). Many government (national, regional, and local) policies have an explicit goal of both growth and equity in the promotion of digital economy.

A second area of disruption caused by the digital technologies is the introduction of e-government (Dunleavy et al., 2006). E-government involves the use of telecommunication technologies by public organizations to manage, redefine and disseminate information, communication and transaction relations with citizens, businesses and the general community (Edmiston, 2003; Maeng and Nedovic-Budic, 2004). The literature produced in the last ten years suggested that e-government can create improved decision-making, increased government access, better public service delivery, internal efficiency; and support political accountability and participatory democracy (Irani et al., 2005; Jesuale, 2006; Moody, 2007). More importantly, it has been argued that e-government makes many existing organisational structures and processes obsolete (Bovaird, 2003; Georgescu, 2007).

However, research coming out of the US and Europe warns that while the beneficial prospects at all levels of government are high, e-government has been penetrating at higher levels of government much more rapidly than at the local level (Evans-Cowley and Conroy, 2009; Evans-Cowley and Hollander, 2010). One obstacle seems to be the complex nature of digital-readiness necessary to incorporate e-governance with local governments' traditional planning role (Moody, 2007; Weerakkody et al., 2007). Attempts to use telecommunication-based solutions to manage and administer urban development as a core part of local government activities are underdeveloped (Dawes, 2009; Norris and Reddick, 2013).

More recently, Kumar (2015) noted that e-governance literature has been dominated by computer scientists and IT specialists, mostly in the absence of specialists in urban development, urban planning, climate change and energy governance.

In response to the criticism towards limitations of e-governance, an emerging body of literature suggests that the development of digital technology over the last few decades, has set the stage for 'smart cities' (Bulu et al., 2014; Heo et al., 2014; Hollands, 2008). The concept of a smart city involves city innovation in management and policy as well as technology (Nam and Pardo, 2011), and calls for a comprehensive range of specialities including both technologist and urban experts. To provide a vision of how digital technology will transform the cities of tomorrow, the Smart Cities Council has recently released *Smart Cities Readiness Guide: The Planning Manual for Building Tomorrow's Cities Today*. Their definition of a smart city is comprehensive: "A smart city uses information and communications technology (ICT) to enhance its liveability, workability and sustainability" (Berst et al., 2014 p.6).

Such a broad definition for 'smart cities' is part of an argument aiming to overcome the simplistic implications of digital technologies for cities (Allwinkle and Cruickshank, 2011; Caragliu et al., 2011; Chourabi et al., 2012). The smart city concept has been described as a multi-dimensional initiative. Based on a review of current literature, Gil-Garcia et. al (2016) identified multiple dimensions of smart city and proposes an integrative view that highlights how each dimension contributes to the understanding and development of smart governments. The dimensions of smart cities explored in this study are diverse and multifaceted including but not limited to evidence-based decision making (with respect to availability of big data), citizen centricity, sustainability, innovation and entrepreneurialism, equality, citizen engagement and resiliency. From this perspective, the smart city initiative is a potential model for cities of the digital era, providing them with a chance to integrate new technologies, the digital economy, social systems and ecological concerns with the long-term goal of sustainable urban development (Deakin, 2013; Luque et al., 2014).

Encouraged by the promises of smart city advocates as well as the literature over the past ten years describing the socio-economic benefits of new technology (Galloway, 2007; Katz et al., 2010; Willson et al., 2009), many cities have realised the need to be 'smart', to use digital technology to drive prosperity and capitalise on the rapidly growing digital economy. One way cities have begun to be 'smart' is through the development of 'digital strategies' to speed up the pace of change, to ensure that digital economy is a high priority and more importantly to move their digital planning from ad-hoc to integrated and strategic.

RESEARCH METHODOLOGY

In mid-2013 the City of Vancouver released the 'Vancouver's Digital Strategy (VDS) to capitalize on the digital economy and to enhance digital connections amongst its citizens, businesses and the city as a digital organization (City of Vancouver, 2013). The VDS was the result of extensive consultation with stakeholders including external and internal advisory groups and subject matter experts.

This paper investigates the VDS in order to understand the development phase of the strategy and to assess the role defined for the digital in urban management. The paper questions the level of disruption, if any, caused by this new piece of technology-based urban strategy. The investigation starts with a brief policy analysis of the VDS, which is built on earlier studies (Alizadeh, 2015) in which detailed

analysis of the strategy document offered in three areas of context, development process, and content analysis. This brief policy analysis is then followed by an analysis of ten semi-structured interviews of VDS stakeholders. The interviewees included three City of Vancouver officials involved with preparing and implementing the strategy, plus three small and medium enterprises (SMEs), two corporate digital businesses and two academics who participated in the external advisory committee during the VDS development phase. The semi-structured interviews took between 60 to 90 minutes, during which questions were asked mostly in three main areas. Firstly, questions were asked about the involvement of each interviewee with the strategy document either in the development or the implementation phase. Secondly, interviewees were asked about the strengths and limitations of the strategy document, and their perception of the role defined for the VDS in Vancouver. Finally, in the last part of the interviews questions were asked about interviewees' views on how the VDS sits within the broader strategic planning for Vancouver (e.g. in relation to other existing strategic documents prepared for the city such as the Greenest City 2020 Action Plan (City of Vancouver, 2009) and Vancouver's Economic Action Strategy (Vancouver Economic Commission, 2011).The semi-structured nature of interviewees allowed to explore different levels of details based on the interviewees' expertise. For example, digital business experts - interviewed because of their involvement with the external advisory group behind the VDS - were far more interested and able to share their insights on section two of the interview structure.

The digital recordings of all the interviews were transcribed into Microsoft Word documents using a transcription kit. The next step was to code the data for analysis. After several rounds of careful reviews of the transcripts, two major themes were identified under which the interviewees had discussed the role of the VDS in the urban management of Vancouver: 1) governance and 2) strategic planning. Following the identification of the two main themes, two thematic documents were prepared in which all the interview quotations relevant to each main theme were stored. Both thematic documents have been reviewed a number of times to identify sub-themes and their connections with one another, also a number of the quotations were chosen to be used in subsequent writing. The identified sub-themes for the governance theme were about the scale of change: whether digital technologies should/could disrupt the conventional ways in which Vancouver's local government operates; whether the strategy should/could be showing a new direction for governance; or whether the strategy merely facilitates the business as usual. The identified sub-themes for the strategic planning theme focused on the importance of linking with the major strategic issues identified in Vancouver (e.g. environment and economy).

It is, however, important to acknowledge the limitation of this research as a single case study research. Previous literature notes that it is not unusual for case study research to be limited to one case only, especially when the number of available choices is too limited (Stake, 1995). Considering that urban digital strategies are relatively new at the local government level, it was important for this study to select a case of a mid-sized city (Vancouver in this case), and not necessary a champion global city such as New York. A line in the methodological research argues that the value of case study research, and single case study research in particular, might have been underestimated (Flyvbjerg, 2006; Gomm et al., 2000). While there is a question around the generalization of findings based on one or limited number of case studies, there is a growing argument about the power of case study research to explore new concepts, contribute to theory building, and inspire others to learn from the case study under investigation (Gerring, 2007). In the case of this study, lessons learned in Vancouver can inspire any city, looking to play a proactive role in taking advantage of digital opportunities.

A POLICY ANALYSIS OF VANCOUVER'S DIGITAL STRATEGY

This section of the article is built on earlier detailed policy analysis of the VDS (Alizadeh, 2015). The analysis is conducted in three areas of: 1) the context in which the strategy document was prepared; 2) the development process; and 3) a brief content analysis.

- **Context:** The VDS was prepared by Vancouver City Council (2013) located in British Columbia, Canada. Vancouver is Canada's eighth largest city and the third largest metropolitan area. It is the most densely populated in Canada (with population density of about 5,249 people per square kilometre), and the fourth most densely populated city over 250,000 residents in North America, behind New York City, San Francisco, and Mexico City (Statistics Canada, 2011).
- **Development Process:** The VDS was developed over seven months with the Chief Librarian of Vancouver and the CEO of the Vancouver Economic Commission assigned as senior managers overseeing the strategy development process. In October 2012, the Digital Strategy Team with the help of PricewaterhouseCoopers (PWC) assessed the city's current state of digital readiness on two scales: capability (online, mobile, social, infrastructure and assets, organization) and digital maturity (absent, exploring, enabled, connected). The City of Vancouver was positioned between "exploring" and "enabled", and rated as having a moderate level of digital maturity. From November 2012 to January 2013, the Digital Strategy Team consulted with industry insiders, digital thought leaders, start-up founders, students, business executives, citizens and staff. In January and February 2013, the Digital Strategy Team examined more than 120 ideas that emerged from consultation. The team refined the list by identifying 50 concepts from which they drew 9 initiatives. Finally in April 2013, the team presented the strategy to the Standing Committee on City Finance and Services and it was officially approved by Council. In September 2013 a Chief Digital Officer (a new role within the organization) was appointed to lead the implementation of the city's digital strategy.

An in depth investigation of the consultation process has highlighted a few issues. For example, the strategy document refers to an online crowd-sourcing exercise in which participants were asked to add, comment and help prioritize ideas by voting for their favourites. Unfortunately, the online exercise had only 823 users who submitted 43 ideas, 64 comments, and 830 votes. The low rate of participation raises concerns about the quality and extent of public engagement, and whether this strategy was useful. However, it is important to note that this was only one of the consultation methods adopted.

- **Content Analysis:** The VDS is a four-year plan with a vision to enhance multidirectional digital connections amongst citizens, employees, business and government. This vision is supported by four aims and objectives – three primarily on the citizens and businesses, and the fourth focused on the city as a digital organization. The aims cover engagement + access, infrastructure, economy and organizational digital maturity.

While the digital economy is one of the areas of interest in the strategy document, it is noted that in addition to coaching and supporting the business sector, the regulatory environment also needs to be

adjusted accordingly. Further, the VDS addresses the issue of governance and new e-governance opportunities. The digital strategy extends to different areas of the city's responsibility, in order to define a versatile role for the digital technology.

The document identifies nine initiatives with the highest priority to accelerate the vision. Similar to the strategy's aims and objectives, the nine priority initiatives cover a diverse range including e-governance, e-businesses and digital infrastructure. Interestingly, in order to create a favourable and supportive regulatory environment, the strategy make the link to land-use planning and notes that a review of zoning by-laws in needed to remove or minimize impediments to digital clusters.

This paper acknowledges the broad definition of digital strategy offered in the VDS and welcomes the explicit link between land-use planning and digital economy. Finally, (and importantly) the VDS opens an important line of conversation between different stakeholders in the city around the potential role of digital economy in Vancouver' future development.

INTERVIEW FINDINGS

What we learned in the interviews about the role and purpose of the VDS can be described under the two broad themes of: 1) governance and 2) strategic planning.

Governance

The literature over the past ten years emphasises the role of digital technologies in transforming modern governance. Dunleavy et al. (2006) argued that most recent policy changes and public management reforms focused on shifts in digital infrastructure. Based on their research in the UK, Australia, New Zealand, Japan, Netherlands, US and Canada, Dunleavy et al. (2006) concluded that the future of public management and governance depends on digital maturity. Here, digital maturity for governance was described as reintegration of services, holistic and joined-up approaches to policy-making and the extensive digitalization of administrative operations. In other words, previous studies argued that e-governance is the new governance, as it creates a channel bringing government closer to citizens by increasing the speed and efficiency of their interactions (Georgescu, 2007; Kumar, 2015).

The call for the reintegration of services and holistic and joined-up approaches to policy-making in the digital age (Dunleavy et al., 2006; Kumar, 2015) was welcomed in the VDS. During our interviews, government officials noted that the new strategy is playing a binding role to '*pull together a range of conventional efforts at the city governance level*' and that *the strategy basically was the result of a realization on behalf of city staff that we needed a strategic thread through all of the activities related to digital.*

The interviewed city officials further explained that such need to build a link through a digital strategy became clear in 2010 as part of their attempts to redesign the council's website:

One of the things that became very clear as we were redesigning the City website was that, there were many pockets of digital initiatives including web development happening across various service areas in the City. These digital efforts were not consistent in terms of approach, philosophy and implementation… As a result, it became clear that we needed a comprehensive strategy around digital at the City. So, that we weren't all working in isolation.

The binding function of the VDS was described - by several city officials - as a *'horizontal link between otherwise vertically parallel departments in the City*' to provide '*a coherent framework for anything digital going on at the City*'. Moreover, the city official interviewees believed that such a horizontal link would help the city to be more citizen-centric, as it '*will facilitate and streamline communication between the local government and citizens'*.

A focus on the '*internal role'* of the VDS to '*create internal horizontal relationships that did not exist before'* was acknowledged across all interviews. However, there was an opposing view, raised by some members of the external advisory committee suggesting that the VDS was only offering a platform to '*rationalise already approved decisions'*. Some of the external advisory committee members, interviewed by us, questioned the VDS's claim to set out a roadmap from the ad-hoc digital approach to an integrated and strategic one that prioritizes key actions (City of Vancouver, 2013). As they believed that the VDS '*just brought together about 30 million dollars' worth of previously approved council investment that had been already approved*'. One of the interviewees – an external advisory committee member - showed their frustration as follows:

For me this is an exercise of rationalization of existing decisions and less about a re-conceiving or rethinking or disrupting old ways, and more about here's this big desperate bunch of IT and ICT investments and service decisions and a bunch of other stuff that has come up through individual departments; let's put them together, and nothing more.

Some of the external advisory committee members, interviewed for this research, criticized the VDS for being '*a process of rationalization of previously made decisions to make them look coherent*'. One member described the VDS as '*kind of a reverse engineering to turn the planning process upside down*'. This harsh critique of the VDS was explained by:

It wasn't like let's go out and find out what's needed or what's required or what we could do or what should be. It was like what do we have and how to we then organize that in a way that aligns to perhaps some bigger thing… As a result, the final output is a bunch of previous decisions made around information communication technology that were then thematically organized and given a reason as to why those previous decisions should exist: textbook rationalization of power being rationalized.

The opposing views - expressed in the interviews - by which some admired the VDS for defining a horizontal link in the otherwise vertical structure of the local government, and others criticised the VDS for rationalizing already made decisions by putting them together, is perhaps understandable based the levels of expectations set for the digital strategy. On one side of the debate, is a local government recognising that the '*public demands more government services to be online*', as expressed by one government official interviewee. This is a demand beyond the traditional scope of local governments, and an extension of what was traditionally described as responsive governance. As a result, local governments in most cases do not have the in-house capacity to address such a demand. In the case of Vancouver, a consultant (PWC) was hired to lead the development of the digital strategy; and then an external person, with no background in local government and yet highly experienced in digital banking and digital business sector, was hired as the Chief Digital Officer to lead the implementation. In other words, the local

government in Vancouver, while acknowledging the need to adapt to the disruptive new technology, is still in the learning mode. As a result, the interviewed government officials were very modest about the mission of the VDS:

We knew we weren't going to boil the ocean on the strategy – that was not our goal.

The strategy was introduced as a modest one on several occasions by the interviewed government officials using expressions such as '*it is not a change-the-world strategy'*, and *'it's a let's-get-caught-up-to-where-we-need-to-be strategy*'. They also mentioned that:

When you look at where the city of Vancouver was starting in terms of its digital strategy, we just needed to get its house in order first.

From the local government point of view, the VDS was described as a '*pragmatic strategy*' and '*just a beginning of a roadmap'*.

On the other side of this debate, however, is a broader expectation from the digital strategy. This expectation was mostly raised by the digital business sector – interviewed members of the external advisory board - that felt disappointed by what they described as '*the lack of strategic thinking'* in the VDS:

I was hoping that in a city like Vancouver which is quite progressive in many ways we could try to invoke or tap into some sort of bottom-up innovative approach in this digital strategy

When asked to elaborate more on their preferred approach, different members of the external advisory board discussed their expectations of the VDS which was beyond what the local government was ready to go -- at least for the time being. Interviewed members of the external advisory boards who could mostly be described as digital experts, were expecting the VDS to stimulate a clear push for structural reform through e-governance as a way to transform administration across local government in Vancouver. While some admitted that Vancouver was behind in the digital domain and needed to catch up, the interviewed digital experts believed that the city needed to aim to be '*in the leading pack'*.

Different members of the external advisory board offered suggestions to '*disrupt how the government works*' including an emphasis on '*paperless government'*:

If you really want to kind of shift things you'd say we're going to get rid of paper. Not because I think getting rid of paper is the most, Holy Grail, but it really makes you rethink a lot of processes, and disrupt the old ways.

It was mentioned several times that:

The level of ambition embedded in the document is not, from a tech community background, what is expected to be.

The interviewed digital experts who were members of the external advisory board criticised the VDS for '*not being ambitious enough in transforming local government's structure'* and this was explained by:

The technical expertise of the local government staff tends to be for any reasons quite behind the time comparing to the tech problem. In fact, they don't have expertise in house and in most cases, they don't even know what the options available are.

Strategic Planning

The interviewees, who were part of the external advisory to the VDS, described one of the main issues that they had with the VDS in its current format as follows:

This digital strategy could be the digital strategy for an insurance company. There is nothing that makes it specific to Vancouver or even, quite frankly, specific to any urban context.

Vancouver, similar to many other local governments, did not have the in-house capability to produce a digital strategy, and yet recognized the need to do so. This led the city to use an external digital strategy consultant for the production of the VDS. The consultant, similar to most digital strategy companies, had expertise in digital business but had limited experience with local government sector, and did not necessarily understood the complexity and diversity of responsibilities involved. As a result, the urban digital strategy prepared for the Vancouver, looks similar to one that has been produced for an insurance company, banking system or in case any businesses as in this age most businesses need digital strategies.

Members of the external advisory board, interviewed by us, also pointed out a few shortcomings that could be described as specific to Vancouver:

If you are really going to get into the economic development or the economic benefit of digital, look at the zoning of buildings where tech companies want to be. Stuff which is not very digital at all, stuff which is just civic government, urban planning in a sense.

Hearing such ideas from interviewees with digital expertise but no urban planning background or experience was insightful. It was interesting to see how these people, because of their vast experiences in the innovation sector, articulate their spatial expectation of a digital strategy with the aim of boosting economic development.

Moreover, the discussions with different members of the external advisory board with vast expertise in the digital sector clarified the need for the VDS to link to strategic planning. Below quotation is an example:

I always think that digital strategies need to plug into whatever that the city is already good at and think about what can be done better because of the digital…

This emphasis on linking the digital strategy with the '*bigger ideas of what's challenging the city*' was repeated more than 20 times in the interviews; and aligns well with the recent literature on smart cities (Bulu et al., 2014; Heo et al., 2014; Hollands, 2008). Below quotations are a few examples of what was discussed in the interviews – mostly by the external advisory board members. There is a clear expectation for the digital strategy to link to the strategic issues/challenges of the city – in this case Vancouver:

Let's start with the problem as opposed to any solution. Let's start with the big problems that we have in our city rather than imposing a solution just because everyone else is doing it.

The best way to sell a digital strategy and to show that it is needed is to demonstrate how it can contribute to the biggest problems of the city and if it cannot, what's the point of it?

Views like those above led to a new line of discussion in the interviews: how can digital technologies play a role in tacking the big issues in Vancouver?

In the case of Vancouver, it is not difficult to identify the main planning issues and priorities. The City of Vancouver has developed quite a few major strategic documents in the recent years including Greenest City 2020 Action Plan (City of Vancouver, 2009) and Vancouver's Economic Action Strategy (Vancouver Economic Commission, 2011). As part of the interview structure (described earlier in the research methods section of the paper) we asked questions about the strategic links between these three strategies (digital, environmental and economic). The following quote from a government official in charge of the VDS development offers a summary:

We were all very aware of the other strategies but, we didn't see any need to interact with the staffs who were implementing the Greenest City Action strategy. Vancouver Economic Commission (as part of managerial team behind the digital strategy) brought their knowledge of the Economic Action Strategy to the table though.

This lack of interest to link to the other strategies was clearly noticed by the VDS external advisory members who had noticed that '*there were no urban planners involved in the discussions'* and *'they were not even trying to link to any other existing planning strategies'*.

Having said this, the fact that Vancouver Economic Commission was leading two of the recent major strategies - Economic Action Strategy and the VDS - has resulted in a clear economic focus in the digital strategy. This focus aligns with a growing number of digital strategy documents that introduce themselves as digital economy enablers. For example, a study of Brisbane's Digital Strategy showed that a digital economy with an emphasis on enabling SMEs in the digital age was the core of the strategy (Alizadeh and Sipe, 2015). More specifically, in the case of Vancouver, when local government officials were asked to nominate their first priority for the VDS, 'digital economy' was the resounding answer:

Our first priority is creating digital economic opportunities; enabling the sector as identifying what can the city do to nurture their growth.

However, there is still a big question about the lack of alliance between the VDS and the most significant and trademark strategy of Vancouver, the Greenest City 2020 Action Plan. Greenest City Action Plan is the city's top priority. While many cities around the world aim for green targets, Vancouver wants to be the greenest -- #1 -- which makes it very different from any other green strategy prepared around the world.

However, even with such a high priority, there was little connection with the digital strategy. Government officials justified this by declaring their interest in building '*operational alliance'* during the implementation phase. They admitted that during the implementation phase there are some crucial

operational links between the two strategies as both strategies had a number of similar initiatives. For example, the Greenest Strategy has a clean tech demonstration linked with a number of initiatives included in the VDS. So, in the absence of any official links between the two strategies in the development phase, some unofficial attempts have emerged during implementation.

LESSONS LEARNED

The local government in Vancouver should be praised for being the pioneer in taking up digital opportunities through development of an urban digital strategy. As discussed earlier in the paper, the literature (Danneels, 2004; Downes, 2009; McQuivey, 2013) puts a great emphasis on the timing of adoption of new technologies and suggests that pioneers have a strong competitive edge to disrupt the old ways. Having said this, our analysis of the VDS unravels two competing/opposing views on the role defined for the new strategy in the future urban management of Vancouver. The views offered by the local government side could be described as more conservative, while the digital business experts push for a more radical and perhaps disruptive role.

The role of digital in the urban management of Vancouver was discussed under the two broad themes of governance, and strategic planning. A summary of the lessons learned follows:

What we learned from the interviews conducted suggests that there is an agreement across different stakeholders involved with the preparation and implementation of the VDS that digital technologies offer a chance to transform the structure of local governance in Vancouver. There however seemed to be a difference about the scale of this transformation. The interviewed local government officials focused on the power of digital technologies to establishing or strengthening horizontal links within the internal governance structure. The interviewed digital experts - who were members of the external advisory board - however pushed for an extensive transformation, perhaps a disruptive one; and believed that digital technologies provide a chance to strongly question the old ways in which local government was structured. This subgroup of interviewees believed that the VDS fell short of fulfilling such a broader role in transforming local government based on the digital opportunities available.

On the question of digital technology and strategic planning in Vancouver, the lack of explicit link in the document is obvious. All interviewees admitted that there was no real attempt to link the VDS to other competing strategic documents – on environment and economic development - being prepared around the same time. Having said this, the fact that Vancouver Economic Commission was leading both Economic Action Strategy and the VDS has resulted in a clear economic focus in the digital strategy. There is, however, a big question about the lack of alliance between the VDS and the most significant and trademark strategy of Vancouver, the Greenest City 2020 Action Plan.

We identified two opposing views in response to this big question. The local government officials interviewed by us, believed that an operational link at the implementation phase will connect the two technological and environmental strategies. This view was questioned by the digital experts who believed that the VDS looks like any other digital strategy and does not necessarily link to the big issues in Vancouver. This is a concern that resonates with the literature on smart cities. Nam and Pardo (2011), for example, point out that the unique context of each city shapes the technological, organizational and policy aspects of that city, and as a result a smart city should be considered as a contextualized interplay among technological innovation, managerial and organizational innovation, and policy innovation. More specifically, when it comes to the relation between green city and smart city concepts (as it is the big

question in Vancouver), the literature argues that the realization of digital is a necessary component for achieving green city targets. El-Diraby (2009) outlines a vision to harness and analyse sustainability data in urban areas. In this vision, relevant environmental and energy-use data need be extracted from diverse sources so that local decision makers can synchronize the data and create an integrated virtual organization. In this view, making ultimate sustainable decisions and achieving green city targets depends on digital technologies.

Our analysis of the VDS suggests that an operational alliance is not a sufficient substitute for the lack of strategic thinking in the development phase of the VDS. The VDS has failed to align with the flagship green strategy, which raises questions around the core priorities of the VDS versus the core priorities of Vancouver. While Vancouver puts the highest priority on the environment, the VDS fails to explicitly include this in it set of priorities. A strategic link between the two digital and environmental strategies could result in digitally enabled initiatives to support the Greenest Strategy. For instance, one priority area for the VDS is to create digital work/mobile workforce, yet no attempt has been made to link this to the greenest action plan based on the environmental benefits of telework which is widely discussed in the literature (Bose and Luo, 2012; Rietveld, 2011). Surprisingly, telework does not seem to be on the agenda for a city that wants to be the greenest. The city does not even offer telework as part of flexible work options to its own employees. This puts Vancouver behind many other cities that already have that option available.

To sum up, the VDS could be considered as a step in the right direction to capitalize on the digitally enabled opportunities. However, in its current format seems to fail to make strategic connections with the priority green agenda set for the city. This shortcoming highly restricts its ability to play a proactive role in the management of the city, let alone transform or disrupt the old ways.

CONCLUSION

This paper uses a combination of policy analysis and key stakeholder interviews to examine the role of the VDS in planning and governance in Vancouver.

Based on the policy analysis, this paper acknowledges the broad definition of digital strategy offered in the VDS and welcomes the explicit link between land-use planning and the digital economy. The VDS opens an important line of communications between stakeholders on the role of the digital economy in Vancouver's future development.

Our interviews revealed some shortcomings in the VDS in two broad areas of governance and strategic planning. The VDS has been reported to be successful in establishing (previously missing) horizontal links in the internal structure of the local government. However, there was a call made by some of our interviewees – mostly from the digital business community - to take this opportunity to fully transform the internal governance structure with initiatives such as paperless governance. The VDS was criticised for not disrupting the old ways and merely rationalizing (and providing a better framework) for some of the already approved digital decisions.

A second line of discussion in the interviews focused on how the VDS links to the competing environmental and economic strategic documents prepared around the same time in Vancouver. This discussion is in line with the question raised at the beginning of the paper about the extent to which planning for the digital technology should be incorporated into strategic urban and regional planning. Our findings suggest that a digital strategy works best if it is incorporated into strategic planning. In the case of

Vancouver, the lack of a strategic link between the VDS and the city's flagship strategy - the Greenest City Action Plan - was questioned. However, some operational links between the two strategies at the implementation phase was acknowledged.

While there are some areas of improvement, Vancouver should be commended for being a forerunner in producing Canada's first urban digital strategy. Lessons learned from the VDS could inform any city looking forward to play a proactive role in the digital economy, to capitalize on the digitally-enabled solutions in order to address the core issues facing their future.

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Chapter 74
Our Future:
With the Good, the Bad, or the Ugly eServices? Case Finland

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ABSTRACT

We live in an ever-changing world. Despite that many new and excellent reforms are achieved, this period of time is also very confusing when many things that were regarded as concrete are becoming virtual. In spite of all this incompleteness, our common goal should be a good information society and the purpose of this chapter is to find out some factors that reveal the steps toward it. The question we ask is how to find a balance between a good life and eServices from the human point of view. The key findings pointed to issues in the needs of structural changes in the society. Another challenge that can be observed and which will be in the most essential role in the future, is the ownership and control over My Data. Agreements are a common practice in the business and when the subject is eServices in the future, we cannot avoid discussion of the end-user agreements, too.

INTRODUCTION

The world is in a great structural change and it seems that the economic growth will be based more and more on services in the future. (European Commission, 2015; Jungner, 2015; Koch, 2015) ICT has played a significant role for decades and this trend still seems to continue, however, in a changing world, the role of ICT has also had to change from a technical role to a more user-oriented role (Digitalization, 2016; Jungner, 2015; Koch, 2015). At the same time as we are encountering so many economic challenges, our common objective should still be the steps towards a good life and good information society (Liideri, 2015). But what does good life mean to us? Very different things, of course, depending on your perspective. The Finnish government has a vision that by the year 2030 Finland is a good place to live a meaningful and dignified life for everyone. The starting point is an individual's dignity and right to live a good and dignified life. Firstly the aim is to take each of us as an individual personality and secondly

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to emphasize self-determination, while, on the other hand, carrying responsibility for ourselves as well. (Korhonen, 2016; Valtioneuvosto, 2016)

Today, knowledge is the raw material and one of the factors of production. Thinking about business life, it can be said that companies are implementing good life by doing profitable business with knowledge. In practice this means that good eServices are established for the people, other companies and the society. Furthermore, when considering good life from the perspective of the society, the main purpose of eServices is to help and motivate people to take care of themselves as well as possible (Korhonen, 2016). To some, it means health and wellbeing services, some others are motivated by hobbies, entertainment or gaming, while for many contacts with the family, neighbours and friends are the most important. In addition the world is undergoing a dramatic demographic transformation: the trend is toward an older population.

As people are living longer, according to many studies these elderly people are suffering from loneliness to a greater extent. Here eServices, and especially platform technology, can offer an opportunity to solve the problem by helping the elderly people to increase interaction with other people (Marcelino et al., 2005). More often than not the elderly also want to live at their homes as long as possible and digital services can help them to live independently and to feel themselves dignified. The working life is also undergoing great changes. In Finland work has traditionally played a very important role in an individual's life, to the extence that sometimes individual´s value is measured by one´s work or position. Digital services allow new forms of work, as well as different combinations of work and life. Because of that role, eServices are important also in the working life and digital services can be said to be a contribution toward a good life in that sense, too.

The eServices and related matters are reviewed and considered in this chapter. First some background issues are presented while, the next section provides a brief description of digitalization in general and eServices are introduced via three Finnish application examples widely adopted by users: Firstbeat, OniBus.com, and 112 Suomi. However generally stated and unfortunately, all eServices are not good ones. It can be said that there are way too many bad eServices, even ugly ones and that is why we will study and analyse the features of eServices. Users should demand more and better applications and one key to promote this is try to create awareness of possibilities of applications and enhance the understanding and knowledge of the users. When we discuss eServices one important topic is the end-user agreements and this is, of course, a subject of consideration of that cannot be avoided in this chapter. Personal data and My Data are closely linked to eServices. Therefore, the possibilities of these topics are also discussed. Who owns and controls personal data in the future? The service providers or the person her/himself? What will be the roles of the service provider and the user?

Summarily, the purpose of this chapter is to find out some factors that reveal the steps toward the good information society. It seems that, after all, digital services are the most important building blocks of a good life in the future. However, there are also several significant challenges.

BACKGROUND

In order to understand what eServices really are or mean, we have to study the nature of digitalization in general first. Swedish professor Gulliksen (2016) unfurled the concept of "digitality" in his conference speeches by the words "digitization" and "digitalization". As a product of digitization a file stored in a digital form is created. There are many different formats and the one to be used is determined by the

requirements of the application. For example, files meant to be electronically distributed are normally stored in a packed format. Hence, an average person sees digitization just as a simple process in which a digital picture of any readable material is created by using a smart-phone, computer or scanner. However, in practice, the process is much more complicated, since the quality of the copy, the storage file format, the intended use and the questions related to archiving of the file have to be determined. Gulliksen (2016) described the term digitalization as meaning the renovation of the ways of acting by utilising modern information technology. In a broader sense, it can be said that in addition to the renovation of the ways of acting, digitality also means the digitalization of internal processes and electrifying of services i.e. providing eServices.

In the previous paragraph digitalization was defined as a process of moving to a digital business model, and not just some investigation of software or device. What is more, Gartner (2016) links digitalization with different ages of IT. The first phase was the age of IT manufacturing when the focus was on the technology. The age of IT industrialization can be seen as the second phase when the production was heavily developed. Digitalization is the third age in the development of IT and currently the focus is on the business models where the customer is in the central point, in other words, companies want to establish good eServices to the customers.

Thinking ahead, we all want to have a good life, but who can define what good life really means? Should this question be dealt with the possibility of obtaining information, as well as a function of time? Probably. What comes to the Nordic countries, it can be said that in the not so distant past, it were the authorities and specialists who told and, to a major extent, also decided what was best for the people. This was enforced by the fact that it was difficult to gather information and that the expertise and knowledge truly were in the hands of a small academic or otherwise educated elite. It can be rightfully said that during those days information meant power and it was carefully protected in the fear of loss of that power. Companies and organizations were hierarchical and management was practiced one-way only, top-down (source). On the other hand, power also meant concrete responsibility that could not be delegated or avoided. It is obvious that, at the time, life was not fair to everyone, but it should also be noted that according to the hierarchy of needs, from the perspective of an individual, their focus was mainly on the lower levels of that hierarchy as nowadays. That is why for the most the elements of good life meant satisfying the needs for nutrition and a place to live. Opposite to this, the situation today is quite different. The technical development is playing a big role, since Internet and digital services have changed it all: nowadays Internet gives almost every person on the planet equal means to acquire the same information. Information has become real-time and global: News published in Finland is available and accessible simultaneously also in America and Asia. Furthermore, a future trend is an ever increasing emphasis on individuality. People want individual, tailor-made, high quality services that can be accessed independent of time or place as the building blocks for a good life and the digital services are a good solution for that need.

According to several surveys (Digibarometri, 2016; Digibarometri, 2015; SME barometer, 2015) Finland has excellent technical prerequisities for digitalization, but contradictory to that, they had not been widely been applied in the business life. Even though we have some fresh examples of success, such as in the gaming technology, our predominant ways of acting date back to the industrial age, a fact that also applies to the management practices. It can be seen that we have not yet taken benefit of the possibilities offered by these technical preconditions (Korhonen 2015). In addition to this, the rigid structure of the Finnish society that lacks flexibility has been criticized by many. Gartner's (2016) definition for digitalization is following: "*Digitalization is the use of digital technologies to change a*

business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business". This definition supports the opinion that the Finns have not yet stepped into the era of digitalization.

October 2016 Finnish MIT professor Bengt Holmström was awarded with the Nobel Prize in economics together with professor Oliver Hart for their insights into modern contract theory. Among many others, Holmström (HS, 2015) pointed out that the structures of our working life are too rigid. He manifests that Finland should pay more attention to the changes in the global economy and courageously renew the working life, because the technological development has profoundly changed the nature of work and respectively this calls for large structural reforms respectively. What is more, according to recent studies the new rules in the working life can have a very favourable effect on the economic growth (HS, 2015). Contrary to this, the Finnish labour market institutions have highlighted the problems in the business management. According to the Finnish research (TIVIA, 2016) digitalization, so far, means to Finnish companies more or less electrification of the current processes whereas the possibilities of creating new digital business for international markets have not been utilized yet, and the pioneers of digitalization are low in numbers. Additionally, only 30 per cent of the IT and business managers report that digitalization has evoked interest in the top-level management towards global business opportunities. Stated in this way, the number perhaps does not sound so alarming, but when you look at it from the percpective that 70 per cent of the top-level management is not interested in the utilisation of digitalization, the future outlook raises doubts and worry. According to Kolesnik (2016) the actual roadblock is the lack of leadership. In Finnish organizations, digitalization is, in a way, everybody's and nobody's matter. Even though, digitalization is becoming part of every process and function, the real pioneers of digital business and new business models are missing. Helenius (2016) adds that in Finnish companies, for the time being, the real ownership of the development of digital business is missing and siloed. As a summary, could it be said that according to the made study the managers of digitalization are missing in the Finnish companies and because the digitalization is siloed and nobody's matter, the need for structural reforms becomes inevitable also in the light of this study?

What is more, both the number of ICT equipment and the very essence of ICT has increased continuously in our lives during the last two decades. Among the first digital services that touched the entire Finnish society were the digital banking services introduced by the Finnish banks in the early 90's. It can be said, that closing down of the branch offices and steering the customers into the net to use the new digital services equally involved individuals, companies and authorities. This transition has also been one of the most remarkable structural changes in the society. Furthermore, with the advancements in technology we have started to utilize eservices in our other everyday routines, too. Therefore, it can be said that eservices have creeped in to our lives little by little and this development is one of the reasons why we have not paid enough attention to their quality, but rather have embraced all sorts without much of objection. The development of the majority of eservices has started with the technology, the organizational or financial benefits first in mind whereas the customer or user-friendliness have often been neglected totally. Fortunately, we are slowly heading into a better direction and the successful companies are developing their digital businesses from the basis of customer satisfaction. According to Li & Suomi (2009) the 8 key-elements of the quality of eServices are presented in Table 1: website design, reliability, responsiveness, security, fulfillment, personalization, information and empathy.

Agreements are a common practice in the business life and when the subject turns to eServices, we cannot avoid discussion of agreements, too. According to the Business dictionary (2016) the concept of agreement means negotiated and usually legally enforceable understanding between two or more

Table 1. The eight dimensions of eService quality

Dimension of eService Quality	Description
Website design	• Appealing and well organized website • Consistent and standardized navigation • Well-organized appearance of user interface • Quickly downloading • Ease use of the online transaction
Reliability	• Accurate delivery service • Complete order service • Company being truthful about it offering • The online service always correct • Keeping service promise • Accurate online booking records • Website always available
Responsiveness	• Adequate contact information and performance • Prompt responses to customers • Timely responses to customers • Adequate response time • Quickly solve problems
Security	• Protect the financial data of customers • Protect the personal data of customers • Terms on payment and delivery • Good reputation
Fulfillment	• Information on products or services available when purchasing • Systems runs smoothly in the transaction process. • Accurate promises about delivery service in purchasing process • Available to modify and/or defer the purchasing process at any time without commitment
Personalization	• Personalized • Products and services • Payment terms • Delivery terms • Design
Information	• Updated information • Information current and timely • Information accurate and relevant • Information easy to understand
Empathy	• Good personal attention • Adequate contacts • Address complaints friendly • Consistently courteous

Source: Li & Suomi, 2009.

legally competent parties. In this context we are interested in the end-users and it can be said that those are persons or organizations who actually use a product, opposite to the persons or organizations who authorize, order, procure, or pay for it. So, today nearly everyone is an end-user. What about the status of our end-user agreements then? We made a quick and restricted empirical research related to the end-user agreements with a target group selected from consumers who use eServices. The results of the survey were shocking. We will return to these results later in paragraph the "Agreements and contracts" paragraph.

We mentioned earlier that personalization (Li & Suomi, 2009) is an important dimension of the quality of eService, because it could improve customer´s satisfaction. On the other hand interactivity between customers and enterprises offers opportunities for enterprises to obtain valuable information on

the customer, her/his needs, residence, her/his purchasing habits etc. Collecting customer data has grown exponentially in a relatively short period of time. Nowadays all of our actions on the internet will leave a digital footprint and all data are typically collected by different kinds of companies and organizations. Earlier they were usually big multinational companies, but today "all parties", not just commercial ones, collect relevant, but unfortunately, also irrelevant data about us for their own purposes. We ourselves do not control that data, and generally even know nothing of the nature or contents these collected and recorded contents of data. It is fair to say that the situation is somewhat complicated. In order to offer good eServices companies have to know their customers. However, the data collected needs to be limited to the purposes and use of the eService provided. Warma (2016) presented a good example of this issue in a public lecture held at the Internet Forum organized by Aalto University. In a research test carried out in Germany a candid camera was hidden in a confectionery and when receiving payments from the customers, the shop assistant also asked for their personal information, such as phone number, home address etc. The same customers, who, when using eServices, happily give all the information requested without questioning, were surprised, displeased, angry or even refused to provide the information. In this situation a person wanted to know why the irrelevant information is collected and how that information relates to the purchase of bread. Exactly same questions should be asked when using the eServices, too. This naturally raises the question: Why don´t we?

ESERVICES: THE BUILDING BLOCKS OF A GOOD LIFE

Eservices in General

The world is really changing now: we had transferred via industrial revolution to the information revolution and are now rushing fast toward the digital world where information is the raw material. (Korhonen, 2015; Liideri, 2015; Porter, 2001) It can be said that in the 19th century gold and other metals were mined, whereas in the 20th century enormous amounts of products were produced in factories to the "market" and now in the 21st century it will be the data mining that brings revenue to most companies and the economic growth will be increasingly based on eServices. Hofacker et al. (2007) defined the concept of eService as "an act or performance that creates value and provides benefits for customers through a process that is stored as an algorithm and typically implemented by networked software." Already entirely new opportunities exist already for the use of the existing information and archives for the creation of innovative digital services by enriching, reformulating and combining digitally stored information. Therefore it seems that eServices will have a lot to give to us as the building blocks of a good life.

In the Finnish government´s vision our country is described as a good place to live a meaningful and dignified life for everyone. Thus, the starting point for this vision is the individual's dignity and right to live a good and dignified life. On the other hand the aim is to take each one of us as a unique personality and also to emphasize one´s self-determination. The community is written into this vision too - everyone can be her/himself and is accepted by the society. The above mentioned description also directly applies to the characterization of a good digital service. The basis is the customer need, where customer experience data is gathered and analyzed and finally the user-friendly service is personalized based on that data. A service is also available as needed, independent of time and place, in the form and in a channel desired by the user. The aim and purpose of an eService is to make users' life easier and better. Communication with the near-ones and interaction with the known and unknown persons is

made possible. Furthermore, the eServices are also entertaining and promote the sense of community. In summary, all of these are essential elements of a good quality of life. (Korhonen, 2016) The next three applications are a couple of examples of how ones´s everyday life can be made easier. These examples demonstrate well the needs for structural change in the society, too.

The first example describes a person´s own activities to improve her/his own health. A company called Firstbeat Technologies Ltd has developed heart rate analysis technology and their mission is to bring the actual measurement data as the basis for the analysis and decisions to be made related to the personal wellbeing and physical performance. The application transforms heartbeat data into personalized insights on stress-level, exercise and sleep. It can be said that invisible things become visible and, because of that, you really become aware of your own situation and can choose the optimal level of nutrition, exercise and rest to improve your health and wellbeing. Subsequently in the future we will be increasingly measuring and monitoring our own health ourselves by the means of new applications and eServices. Consequently, this development calls for reform of the society, especially of those public organizations that provide health and social services. (Firstbeat Technologies, 2016)

The second example is related to travel and mobility. OnniBus.com is an innovative inter-city express bus service that is based on a new customer-oriented business model. Tickets are priced dynamically starting from one Euros, so that the earlier you purchase your ticket, the cheaper it becomes, which underlies OnniBus.com´s philosophy: "An empty seat is the most expensive seat". The company operates modern, fuel efficient coaches which are equipped with air conditioning, toilets, free Wi-Fi and limited mobility access. With the excellent service, new routes and flexible pricing it has proved to be a new alternative to air, train and car travel in Finland. The company was established in 2014 and just after one year of operation, significant changes throughout to entire travel business segment could be observed. The state railways monopoly, as well as other bus companies, had to react on the altered behavior and demands of the customers. This resulted in a more customer-oriented operation, more friendly service, lower prices and better routes throughout the country. (OnniBus.com, 2016)

The third example, 112 Suomi, is a public, free-of-charge smartphone application which makes it easier and more secure to get aid and help in the case of emergency. Surprising many, the citizens immediately adopted the service after it was made available free for download. The application enables automatic delivery of the caller's location information to the emergency service dispatcher (in Finland). The service is especially valuable in places where the determination of the exact location is difficult, such as on streets with the same names in cities or on a traffic accident scene on a highway. The application uses phone´s data network connection to transmit the GPS location information. In addition to this, the application also shows the GPS location information on the phone screen and by reading location coordinates aloud the user can forward her/his location to the emergency service dispatcher even without phone´s data network connection. 112 Suomi application is a positive example of the trend that we are heading for a good information society. (112 Suomi, 2016)

Good, Bad or Ugly?

In the previous paragraph an eService was defined from the user and customer perspective. Today, the customer must be placed in the center of action. A successful service is personalized, easy to use and affordable (Lakaniemi, 2014). Unfortunately, in addition to good digital services, there are a lot of not-so-good-services too and when the goal is a good information society and further a good life, it is important to recognize a good eService, which is not always an easy task. Our research is based

on user-orientation and we have considered how to help and encourage users to identify differences in eServices. In general, there is a lot of discussion on digitalization, its benefits and threats, but it seems that the debate often takes place on a too abstract level, and we have also found out that many users are tired of the continuous grinding on the subject, which does not get a grip. One useful way has proven to be to illustrate the difference between a bad and an ugly eService. As an example, words good, bad and ugly are described below simply using a dictionary (Table 2.). It is amazing how well the meaning of words also correlates with the features of an eService, including the importance of visibility and ownership of your personal data. Again, the world has changed: in the industrial era literacy was an essential skill and the transition to a knowledge society gave birth to a need for media literacy, do we need digital information literacy today, i.e. special skills to be able to read digital information, since it is no longer possible to get by with the means of traditional literacy?

Eservices and End-User Agreements: Do We Accept the End-User Agreements Just Because We Feel That We Have No Choice?

Contracts and agreements are an integral part of any business. According to the Business dictionary (2016) end-users can be described as persons or organizations that actually use a product, contrary to persons or organizations that authorize, order, procure, or pay for it. Naturally, when discussing eServices, end-user agreements are of main interest to us.

As we noted earlier today, one way or another, most of us are users of digital services and at the same time we can be called end-users, too. Although all kinds of agreements and contracts, as well as

Table 2. Explanations of words good, bad and ugly, and their correlation with features of eService

Term/Word	Good	Bad	Ugly
Explanation and correlation with features of eService	• Morally excellent; virtuous; righteous; pious: • Satisfactory in quality, quantity, or degree • Of high quality; excellent • Right, proper, fit, well-behaved • Kind, beneficent, or friendly: to do a good deed • Honorable or worthy; in good standing • Profit or advantage; worth; benefit: What good will that do? • Excellence or merit; kindness: to do good • Moral righteousness; virtue: to be a power for good • Having admirable, pleasing, superior, or positive qualities; not negative, bad or mediocre • Suitable or efficient for a purpose • Pleasant, enjoyable, interesting • Healthy • Successful • Positive, suitable, satisfaction	• Not good in any manner or degree • Having a wicked or evil character; morally reprehensible • Of poor or inferior quality; defective; deficient • Inadequate or below standard; not satisfactory for use • Inaccurate, incorrect, or faulty • Invalid, unsound, or false: a bad insurance claim; bad judgment • Causing or liable to cause sickness or ill health; injurious or harmful • A bad condition, character or quality • Not good; of poor quality; inadequate; inferior: bad workmanship, bad soil, bad light for reading • (Often foll by at) lacking skill or talent; incompetent: a bad painter, bad at sports • (Often foll by for) harmful: bad air, smoking is bad for you	• Very unattractive or unpleasant to look at; offensive to the sense of beauty; displeasing in appearance. • Disagreeable; unpleasant; objectionable: ugly tricks; ugly discords. • Morally revolting: ugly crime. • Threatening trouble or danger: ugly symptoms • Mean; hostile; quarrelsome: • An ugly mood; an ugly frame of mind. • (Especially of natural phenomena) unpleasant or dangerous • Ill-favored • Hard-featured • Unsightly • Unlovely • Heinous, vile, monstrous • Corrupt • Disadvantageous • Ominous • Spiteful, stormy, tempestuous

Source: Cambridge dictionary, 2016.

their problems are presented daily by press, governments, European Union, companies etc. no extensive general or public discussion, or debate on the end-user agreements related to eServices has taken place. Why not? Are we just happy and satisfied with the current situation? The question awoke our interest, whether there really is nothing to complain or to disagree. So, before a broader planning and conduct of research, we made a quick empirical pilot survey related to the end-user agreements. The objective of a survey was to find out the level of knowledge of users by means of three questions:

- Do you know, what is an end-user agreement?
- Do you read the end-user agreement before accepting it?
- Do you understand terms and conditions of the end-user agreement?

The target group selected were consumers who had used different kinds of eServices at least two years (Table 3). First, we defined a small 10 person (5 women and 5 men) target group consisting of a student, managing director (administration, academic degree), older person, younger person, middle-aged person, ICT consultant (multinational company), entrepreneur (SME, tourism), public servant, trade worker and teacher (lecturer, health care). In this pilot survey we did not select any experts in law to the target group.

Our expectation was that the responses of participants would disperse: some would know and understand the end-user agreements while others would not know anything about the whole issue. However, the results we got were quite shocking. None of participants understood the end-user agreement (terms and conditions) related to the eServices she/he is using. Only 1 out of 10 read the end-user agreement before accepting it (but still did not understand its content). One of the participants sometimes eyed the text of the end-user agreement trying to find out if some collection of data is involved. 8 out of 10 just accepted the end-user agreement straight away in order gain access to the desired application. The general comment was that they have no option but accept the terms.

Summarily, the result of our empirical pilot survey was:

The participants accepted the end-user agreements when using eServices, even though

- They do not understand the "end-user agreement language".
- They do not understand the contents or terms.
- They do not recognize that an end-user agreement is a legal agreement.

Table 3. Participants of pilot survey in which the familiarity with end-user agreements and their terms and conditions was examined. Consumers had used eServices at least two years.

Participants of Pilot Survey (Consumers, 5 Women and 5 Men)
• Student • Managing director (administration, academic degree) • Older person • Younger person • Middle-aged person • ICT consultant (multinational company) • Entrepreneur (SME, tourism) • Public servant • Trade worker • Teacher (lecturer, health care)

The extent of the pilot survey was limited and that is why broader conclusions should not be drawn. However, the results were so uniform and confusing that we dare to say that this cannot be our future with eServices.

Because the results of study were so surprising, we decided to explore further the contents of the end-user agreements of some applications. Here the focus was specifically on the content, terms, wordings etc. and not on the characteristics or a quality of the application. First of all, if you just read an end-user agreement, you can quickly note that end-user agreements are legal texts and when somebody uses the application, at the same time, she/he will enter into a legal agreement, as well as agrees to all of the listed terms which usually means many pages of obscure legal text. Quite often the next thing the user finds is the adoption of privacy policy which covers how the provider may collect, use, share, and store your personal information. Some agreements are strictly declared that the provider has the ownership of all the data, but there are also cases in which users owns all of the content, feedback, and personal information she/he provides, but even in those cases the users have to grant the provider a non-exclusive license to her/his data. As a rule, the provider announces that they have the right to change or discontinue part or all of the eServices and due to that they do not promise to store user´s content or data, but that it is the user´s sole responsibility. In those agreements in which the text is clearer there are sometimes lists of matters the user can and cannot do. For example, in the user-agreement of LinkedIn (2016) there are lists of "You agree that you will" and, on contrary, "You agree you will not". However, how a user should react when "you will" –list consist of 4 bullets and "you will not"-list has 44 bullets?

When one thinks about the current end-user agreements described above, it inevitably raises the question whether the situation could be reversed: would any eService provider accept an agreement in which the terms and conditions were not understandable and they were unilaterally dictated by user and, in addition to this, the terms could change during the contract period? Not very likely. Then, why do we accept this as users?

For a very long time it has been said that competition is hard in the business world. However, considering the current situation of end-user agreements of eServices, it is not easy to believe the claim. At the moment, the eService provider can offer an agreement with terms and conditions that only the provider her/him/itself understands and is aware of all the contents. Perhaps this current digital revolution leads to a completely new situation in which companies and organizations really have to compete for customers and the agreement with its terms will be a real means of improving customer satisfaction and further an essential key to a success in business. Most likely, increased transparency in the contractual matters would also increase consumer awareness of the contracts and their contents in each sector. Subsequently, this would make the comparison of the alternatives possible, which in turn would lead to a real competition for the customers. Additionally, that kind of situation would create a real opportunity for the companies to also acquire a competitive advantage and succeed in the global market.

CHALLENGES

Personal Data and My Data

The term My Data can be described as a human-centric approach to the management and processing of personal data, in which people are given permission and access to the data gathered on them while they have been using digital service channels. Therefore My Data includes one´s shopping history, phone

logs, traffic data, health records and other data accumulated into the records of different internet service providers. Subsequently, it can be concluded that, what becomes essential over time, is the ability and possibility for the users of these services to migrate this data either to her/himself or into some other authorized service in a, for them, more reusable form. (Poikola et al., 2014)

However, with the ever expanding and wider use of the personal data, more and more uncertainty and doubt is arising among people regarding the possible loss of privacy (Asp, 2014). It is a common perception among private persons that companies and governments already know too much of them, which in turn makes them feel uncomfortable. On the other hand, people do not understand the various advanced ways and methods in which their personal data is used in promoting goods and services in the social media, and in general, directed and personalized marketing in the web. Furthermore, they have no idea of what kind of personal data and how much of it each individual service provider possesses of them. Related to this, we can again talk about the bad and ugly eServices, because it is important for the users of the services to be able to distinguish and understand whether their personal data is used for executing business, crime or other illegal activity or if the method of data collection is just a clumsy one but the collected data will eventually turn into benefit of the user or, in some cases, for the common good in the form of statistical data or via general research.

Related to this, Poikola et al. (2014) point out that the traditional perspective to the protection of privacy is such that, the less personal data is collected, the better. This point of view, however, neglects the value of accumulated data to the person her/himself and is in contradiction with the megatrend of the increasing collection of and usage of personal data. The goal should be enabling the collection and usage of personal data in such a way that the benefits are maximized and the threat of the exposure of the personal data is minimized. The key to reaching this is to enforce individual's role, rights and practical means in the management of the data related to them.

Big data and open data are concepts often discussed in conjunction with the digitalization and they are naturally and closely related to eServices. When interviewing companies and public authorities, it was revealed that, as the most important factors in the usage of big data were regarded the usability of the data, abundance and real-time nature of the collection points, enhanced forecasting potential created by the accumulated amount of data and, finally, the utilization of the combination of dissimilar datatypes and the user experience. On the other hand, as the obstacles for the utilization of this data were seen, for example, the vast quantity of data, questions related to the cost i.e. free vs. chargeable access to the data, issues with the ownership of and access to the data, risks involving possible abuse and loss of the data and, last but not least, the vague status of the rights of the parties handing over their data. (Valtioneuvosto, 2016)

When considering open data and My Data, common characteristics can be observed. Both call for an agreement on common principles, wise regulation and machine-readable interfaces, standards and services for a managed transfer of data, storage, processing and analysis. According to the definition of open data, anyone is technically and juridically free to use, reuse and share it. Correspondingly, My Data could be defined as data owner of which is technically and juridically free to use, reuse and share it. (Poikola et al., 2014)

Furthermore, almost any mass data can contain aspects of My Data i.e. "my-own-data" and, therefore, it plays a critical role in the development of the mass data ecosystem. As an example, a growing group of services are related to the personal health combining data from several separate sources together. In order to solve the issues related to My Data, it is obvious that we need new practices in which the emphasis shifts from the jurisdiction to the tools for managing the data. It is estimated that one of the most

promising means for the creation of tools for managing My Data are the so called blockchain technologies which are well suited to distributed data backup, processing and security and, further, to sharing of a value or resources. (Valtioneuvosto, 2016)

The Structural Changes of Society

Already twenty years ago, in 1995, Tapscott (2016) painted a picture where people are beginning to ask, "Will the smaller world our children inherit be a better one?" The question is very essential at the moment: changes have touched all of us and transformations can be seen in governments, organizations and companies, as well as, in the relationships between people. Digitalization has changed and is changing our everyday lives. Tapscott also pointed out signs by which a new economy has not led to a better life, but on the contrary, our privacy is vanishing, for example.

The existing laws and norms, structures and practices do not work in the new situation. Our information society is built on the foundation of administration and, therefore, the change takes place very slowly. Although we are well aware of that major reforms in the structures are needed, all parties want to hold on to the benefits achieved, and therefore any changes in the laws, norms and practices are difficult to execute. In addition, this rapidly changing world does not accept preparation times that last years or months. Governments are not adequately equipped to meet the new public expectations, as was also judged by the Governance Committee (2013). According to the survey, many governments are following a logic of simply and directly converting existing processes into their online versions. Some improvements can be observed, but mostly the governments spend their time and resources in digitalizing existing models and practices instead of rethinking the whole system by the requirements of the digital age (Tapscott, 2016). In short, one can say that it has been more digitization than real digitilization (Gulliksen, 2016; HS 2016).

What is more, Finnish society is currently undergoing a large structural reform. The existing methods and practices are being questioned with the aim of making them more effective and flexible. Several studies show that the digital skills of Finns are on a high level and, therefore, the prerequisites for the utilization of digitalization are excellent, when, paradoxically, at the same time we are unable to turn this knowledge into practice. (Digile, 2015; Digile 2016; Korhonen, 2015) However, important background work has been done in several projects: National Service Architecture Programme 2014-2017, eServices and eDemocracy Acceleration Programme 2009-2015 and The Finnish Open Data Programme 2013-2015 (Valtioneuvosto, 2016).

According to Pöysti (2016) the ongoing National Provincial Reform is the most extensive reform of the administration and practices in the history of Finland. It has an impact on every citizens' public services, as well as, on hundreds of thousands of jobs and workplaces. The provinces will be responsible for arranging and managing the social and health-care services, general administration and other essential public services in their domain. In this reform, digitalization plays a vital role and it is also a centric tool when implementing it. Heinonen (2016) says that in Finland we are creating something entirely new, since provinces have never before existed in Finland as independent administrative areas as meant by the Finnish constitution. Along with the National Provincial Reform, duties and tasks of over 400 different organizations will be handed over to the 18 provinces as to be arranged by them in the future. This responsibility of the arrangement of the mentioned services will be effective as of 1.1.2019. As of writing the text, the new provinces' own opinion of the task a ahead is best described as a Mission

Impossible (Mäkinen & Korhonen, 2016) and it is clear that successful execution of this reform requires the involvement of every Finnish individual and organization and that this is also our common goal as a nation i.e. we need to transform it in to a Mission Accomplished by 2019.

FUTURE RESEARCH DIRECTIONS

We are going through an interesting time of a digital revolution and it can be seen that this period is very different from the previous decades, since changes are taking place so quickly, globally, simultaneously at different levels and in different sizes, whereas before, the changes took place as in a row of a process, locally, and most often as a function of time. Thinking about eServices, a future direction of research could be divided into two entities: human-company-society (Figure 1) and human intelligence-technology (i.e. machine/automation/robots)-artificial intelligence (Figure 2).

Human-Company-Society

When we think about service business, a direction in the future will be toward more and more customer-oriented and user-centric digital services. From a human point of view, one interesting topic of further research will be the personal data. As mentioned earlier, any mass data can contain aspects of My Data and, therefore, it will play a critical role in the development of the mass data ecosystems (Poikola et al., 2014). Personal health data is a good example: already today there are services that combine data from several sources together. In the future new tools will be needed for managing that combined data rather

Figure 1. The first future direction of research concerning eServices: human-company-society

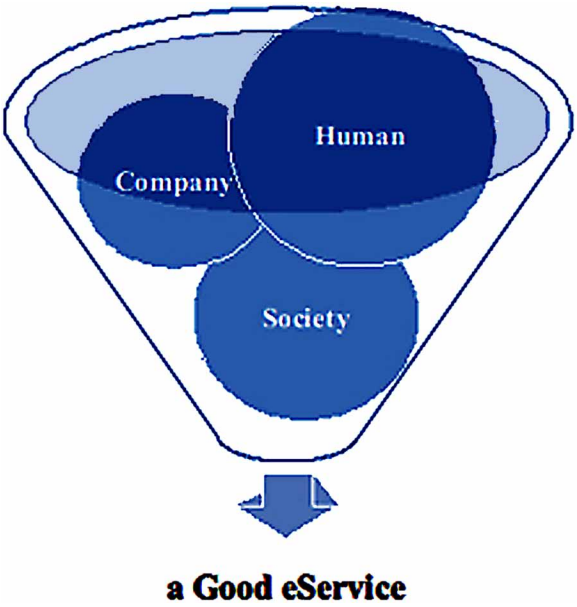
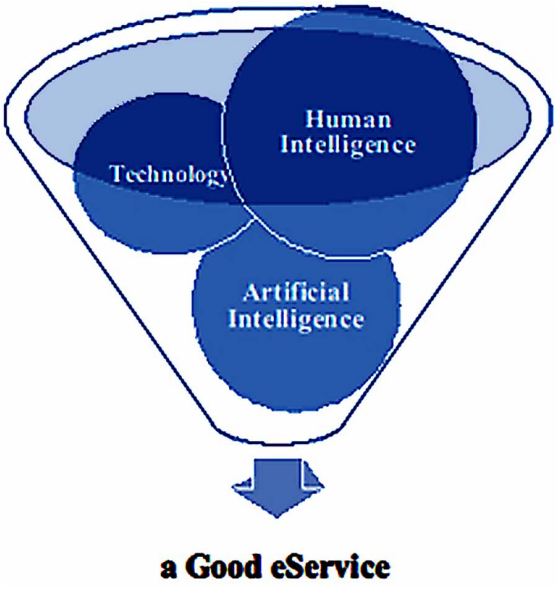


Figure 2. The second direction of research concerning eServices: human intelligence-technology-artificial intelligence



than a law to control the situation. Along with My Data, we can move from the organization centric ways of organazing personal data into more human centric methods by placing the individual in the center of the data management (Open Knowledge Finland, 2016). This means that the service provider offers back the information it has collected on the individual, in its plain or in an enriched form, which the individual can then utilize him/herself or share, trade or sell further to other services. Whether My Data will be the future solution and, unlike today, will we have complete ownership of our personal data in the future?

Further, what comes to services, mobile payment or mobile wallet are important from a company´s point of view. Nowadays, instead of paying with cash or a credit card, a consumer can use a mobile phone to pay for services or goods. These payment services are operated under financial regulation, but what about the future? The banking world is also undergoing a rapid evolution, maybe even a revolution. It can be asked if there are any banks at all in the future. Do we have virtual money, bitcoin or a similar form of currency or payment? Will the blockchain technology be the future solution and, unlike today, we have complete ownership of our money in the future?

According to the futurists, health technology is expected to proliferate. There are already several applications which allow for anybody the possibility to figure out the status of her/his daily health. From the society´s point of view, this self-measurement will be very interesting and also a significant development that will cause structural changes in the society (Social Affairs and Health), and its implications should be further examined, both on the administrative and operative levels.

Human Intelligence -Technology (Machine/ Automation/Robot) - Artificial Intelligence

In this chapter we have considered how to find a balance between eServices and a good life. It can be said that a basis for the digital services is a technology and "a source of ideas", as well "a designer" is the human intelligence. As mentioned earlier, a technology-centric eService could usually be named as a bad or ugly eService and according to several international studies, a user-centric, as well as, consumer-oriented eService is considered a good eService by the customers.

Nowadays, researchers generally agree that there are several types of intelligence, including analytic, emotional and linguistic intelligence. Generally speaking, it can be said that human intelligence is the ability to achieve goals in different environments, or as Legg & Hutter (2007) say, intelligence measures the human's ability to achieve goals in different contexts. Contrary to this, artificial intelligence (A.I.) is exhibited by machines. The difference between the human intelligence and A.I. is in the level of capacities: memory, processing power, learning ability and adaptability. (Russell & Norvik, 2013) When simplifying the elements of a eService design, it can be separated in to three issues:

- Goal,
- Challenges that must be crossed to reach the goal,
- Designer, who aims to overcome the challenges has the needed capabilities.

When thinking about the mentioned elements and eServices as the building blocks of a good life in the future i.e. our needs of good eServices, could it be so that artificial intelligence can also be used as a designer of an eService, and not only as an effective calculator or in decision support such as today?

CONCLUSION

We live in an ever changing world. Although many new and excellent reforms have been achieved, this period of time is also very confusing, when many things which were regarded as concrete and permanent, are becoming virtual. In spite of all this incompleteness, our common goal should be the good information society. As for the economic growth, it seems that eServices are a response to the growth objectives in the near future. The question we ask in this chapter is, how to find a balance between a good life and eServices.

As a conclusion, it seems that digital services will be the most important building blocks of good life in the future. The main purpose of eServices is to help and motivate people to take care of themselves as well as possible. To some, it means health and wellbeing services, some others are motivated by hobbies, entertainment or gaming, while for many contacts with the family, neighbors and friends are the most important. Digital services also allow new forms of work, as well as different combinations of work and living.

On the other hand, also challenges have been identified. The major issue seems to be the need for a structural reform in the society. In Finland the National Provincial Reform (Pöysti, 2016), is going on which means that significant changes in the structure of the society can be expected. These reforms are full of possibilities and, as of writing this text, we believe them to be steps towards a good life, as well as, towards a good information society. However, in order to succeed in this reform, a lot of work, changes in the old attitudes and, especially, cooperation between individuals, companies and organizations is needed.

Digital services can be regarded as information-driven service processes because of the absence of a physical element. Relevant digital information is vital for the customers in their decision making when many things are taking place in the virtual environment and a customer cannot physically examine "what they want or which one to choose". From the human point of view, we need special skills to be able to read and comprehend the digital information, since it is no longer possible to get by with the means of traditional literacy: it certainly can be said that, at the moment, we cannot see the forest from the trees.

There is a lot of discussion of the digitalization and eServices in general, its benefits and threats, but it seems that the debate often takes place on a too abstract level, and we have found that many users are tired of the continuous grinding on the subject. A useful way has proven to be to practically illustrate the differences between a good, a bad and an ugly eService. Another challenge that can be observed and which will be in the most essential role in the future, is the ownership and control over My Data. (Poikola et al., 2014). Furthermore, the end-user agreements are one of the main issues that need to be transformed in to a more user-friendly form. Everyone should understand that they are legally binding agreements that should be taken seriously. It sounds quite absurd that we are willing to accept the terms and conditions that we do not comprehend. This cannot be the right way, and the current practice cannot continue in the future.

In summary we must have courage and determination to demand better and improved eServices, as well as fair agreement terms. Successful companies take the customer experience into account and continuously develop their businesses based on this information and feedback. Tapscott (2016) says that, when you look last twenty years back i.e. the period between 1995 and 2015, it can be detected that the technology alone does not create prosperity, good democracy or justice, but the involvement of the humans is required, too. So, when we set our sight twenty years ahead, it is only the very choices of each one of us that can make a good life possible.

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Chapter 75
Digital Retail and How Customer-Centric Technology is Reshaping the Industry:
IT-Enabled Digital Disruption

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ABSTRACT

This chapter explains the digital disruption that has occurred and is still happening in the retail industry. It explains the relative positions of the world's leading retailers Wal-Mart, Amazon and Alibaba and the business models of the two top online competitors. It focuses on the impact of SMAC (Social, Mobile, Analytics and Cloud) technologies and new retail trends enabled or boosted by technology such as omni-channel, customer experience, internet of things (IoT) and analytics, fulfillment and delivery. It deepens into IT and business model customer-centric design, the role of the customer and the store in the new digital retail and finishes with an assessment of ROI in retail digitization. The chapter concludes the fundamental IT-enabled changes of digital disruption are critical for all players, traditional brick-and-mortar retailers, pure online players and those with both an online and an offline presence.

INTRODUCTION

Digital Disruption

Digital disruption is a mindset that ultimately leads to a way of behaving; a mindset that bypasses traditional analog barriers, eliminating the gaps and boundaries that prevent people and companies from giving customers what they want in the moment that they want it. (McQuivey, 2013)

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In order to analyze how technology is reshaping the retail business, we must first understand digital disruption. Digital business is a reality, whether companies are ready or not to compete in a new, fast-pacing, and more competitive environment.

Let's provide a few examples of digital disruption. Goodwin (2015) states:

Uber, the world's largest taxi company, owns no vehicles. Facebook, the world's most popular media owner, creates no content. Alibaba, the most valuable retailer, has no inventory, and Airbnb, the world's largest accommodation provider, owns no real estate.

We could add additional examples such as:

- **Amazon:** The world's largest book retailer, has no bookshops or, more accurately, didn't have any till November 2015. The company has more than 3 million books available and sold around $7.5 billion in books in 2015[1].
- **Apple:** The largest music retailer in the world from 2010, sold 35 billion songs online till 2014 through its online iTunes service. With a minor role of its physical Apple stores, its online iTunes store made Apple become the new leader in the music industry.
- **Google:** A search engine or arguably the already biggest media company in the world generated $67.4 billion in online advertising revenues in 2015. No other company in the world generates that much only from advertising activities.
- **YouTube:** Acquired by Google, is the most populated video service in the world with more than a billion viewers and 6 billion hours of video watched every month, relying mostly in user-generated content.

These examples should lead all companies to reflect on how digital business is reshaping their industries. New digital disruptors menace the status quo relegating former industry leaders to lower rank positions, even leading those unable to adapt into bankruptcy (i.e. Blockbuster). And there is no room for self-complacency. Digital disruptors are subject to be attacked by a new breed of competitors whose business models could make them obsolete or even redundant. For instance, Apple now faces new competition from free streaming and cheap monthly subscription services like Spotify.

The survival of the fittest is neither new nor exclusive to business. A Darwinian view of business evolution explains different periods such as the industrial revolution powered by the steam engine. But this time there is a fundamental and more profound impact: its speed and global reach. According to Bradley, Loucks, Macaulay, Noronha and Wade, (2015), "digital disruption has the potential to overturn incumbents and reshape markets faster than perhaps any force in history." Let's include the impact of globalization. Most digital disruptors were born as global players in an enlarged economic world. Now companies are able to reach not only western traditional markets but also those coming from communist regimes and other traditionally off-limits countries. In this context, the impact of digitization will be remarkable. The digital world is only starting and some disruptors already enjoy more than a billion users a few years after their creation.

The impact of digital disruption undermines the way business are conducted around the world and the very essence of different activities is being challenged. Industries will not change due to digitization.

They probably already did and further changes are in process. Digital technologies have transformed and keep transforming several industries such as music, film, media, passenger transportation, accommodation, and retail!

Digital Retail

According to international rankings, such as Deloitte's Global 250 Powers of Retailing 2016, which includes information for fiscal years up to June 2015, Wal-Mart, a traditional US brick-and-mortar hypermarkets retailer is, by far, the biggest retailer in the world, roughly multiplying by 4.3 its more direct follower. It is the Moby-Dick of retail, the gigantic white whale created by Herman Melville in his renowned 1851 fiction book.

Amazon, which ranked 12th with $70.1 billion in revenues coming from www.amazon.com, is considered the biggest online retailer. If growth rates continue - it climbed to $79.3 billion in 2015 - it may reach a position in the global podium in a few years.

However, considering Wal-Mart for a gold medal may be arguable. The biggest player may not even be ranked, as most rankings only consider revenues from retail activities. Disruption is here, don't underestimate its impact. New business models come with new revenue generating activities and the very idea of traditional sectors/ industries may have limited value (don't forget that Google is, after all, a media company).

Many voices claim the Chinese e-commerce giant Alibaba, owner of www.alibaba.com (B2B), www.taobao.com (C2C) and www.tmall.com (B2C) websites, is bigger than Amazon. The boldest even claim it has overturn Wal-Mart as the biggest retailer in the world.

There are good reasons to support Alibaba's place in the world podium. The first and most obvious: Alibaba manages roughly the same gross merchandise value as Wal-Mart. According to both companies:

- Wal-Mart total revenue was $482.1 billion in fiscal 2016, $13.7 billion from e-commerce (Wal-Mart, 2016a).
- Alibaba sold Gross Merchandise Value of 3.09 trillion Yuan in the 12 months to March 31, 2016 (Alibaba, 2016). This translates to 479.5 or 486.5 billion USD[2] depending on whether we take the exchange rate at the end of the period or an average during it. Roughly Alibaba sells the same as Wal-Mart!

Wal-Mart is by far the biggest retailer in the world in terms of revenues, but switching the focus to the GMV (gross merchandise value) managed by retailers, an online and relatively unknown player in most western markets, has already topped the world rank and will, most likely, consolidate the first position soon, regardless of the current relative decline due to exchange rate fluctuations. This is due to substantial differences in growth rates. While Alibaba has sustained a 2-digits growth rate during the last years, Wal-Mart's has been modest. If we take a look at the last available quarter, in the three months to June 2016, Alibaba (2016b) grew 24% compared to the same period in 2015, while Wal-Mart (2016b) grew only 0.5% from May till July 2016.

Alibaba also managed transactions on a single day worth $14.3 billion, more than Wal-Mart's yearly online sales ($13.7 billion), and way more than Amazon's $1.1 billion sales on a single day[3] . It exceeded $1 billion in the first 8 minutes. So considering Alibaba bigger than Amazon sounds plausible.

Can Alibaba be compared to Wal-Mart? In terms of revenue recognition, Alibaba is not even a retailer. According to The Economist (2013), Alibaba is "a platform for retail, rather than a retailer itself." It sells marketing services to companies and people selling through its websites, rather than charging a commission on merchandise sold. So, technically, the major part of its business does not generate a penny from retail activities. This explains why it is not even ranked by Deloitte and others: it does not sell by itself. It is a new kind of intermediary that facilitates trade and a strategic substitute for retailers. As it enables direct sales between the owner of the merchandise and the end customer, it menaces wholesalers and other intermediaries as well. It covers a number of functions in the retail value chain, regardless of the fact that it does not own the merchandise. From a customers' perspective, Alibaba is a competitor. They simply care about the offer, price, and delivery options, not about how companies organize internally to deliver the merchandise.

What about Amazon? Amazon does not disclose GMV but there are some estimations. It has both first party (1p) and third party (3p) sales, which understate their sales. 1p sales book the full price as revenue, while 3p sales generate a commission which is the only recognized revenue. Amazon's global GMV was estimated to be around $180 billion in 2014 (Chalaban, 2015). Bearing in mind its 1P and 3P sales in 2015, we could estimate this figure to have increased to around $240 billion[4].

GMV allows for a better comparison than revenues. Understanding retail size as the value of merchandise sold and profit as a percentage on that we can compare the three top retailers. Alibaba's amazing 42% profit on revenues is generated thanks to facilitating the sale of almost half a trillion dollars of GMV. Its profitability is above any curve or standard in the low-margin retail industry. But, in fact, comparing it to GMV puts its feet in the ground, as it would show a rather standard 1.4% profit, half than Wal-Mart's 3%. Both Alibaba and Amazon have relatively low profitability, something we can expect from fast-growing companies, who sacrifice relative margins to build a bigger volume of sales. We conclude there are two pure online players in the podium of a traditionally brick-and-mortar dominated sector and a traditional incumbent (see Table 1).

Relative profitability should not be a great concern as long as growth continues. Gordon Orr suggests (Alibaba) could become one of the world's most valuable companies five years from now, with potentially more than $1 trillion of sales passing through its platforms each year (as cited in The Economist, 2013). GMV may not be the only criteria to measure retailers' size. But regardless of Wal-Mart still being the biggest player or not, online sharks and crocodiles are successfully challenging the gigantic Moby-Dick and differences between them show great potential for new disruptors.

Table 1. Top three retailers by GMV in million USD (Note: Fiscal years ending January 31, 2016 (Wal-Mart), March 31, 2016, (Alibaba) and December 31, 2015 (Amazon). Exchange rate for Alibaba at March 31, 2016. Depending on the exchange rate used for comparison, Alibaba would be ahead or behind Wal-Mart in terms of GMV)

	GMV	Revenues	Profit	In % of GMV
Wal-Mart	482,130	482,130	14,694	3.0%
Alibaba	479,454	15,677	6,637	1.4%
Amazon	240,520	79,268	596	0.2%

A GAME OF SHARKS AND CROCODILES

eBay may be a shark in the ocean, but I am a crocodile in the Yangtze River. If we fight in the ocean, we lose—but if we fight in the river, we win. (Jack Ma – Alibaba)

Disruption may adopt different shapes. The well-known and commonly quoted sentence from Jack Ma, comparing eBay with a shark, which perfectly applies to Amazon, and Alibaba with a Crocodile, is a brilliant example. Amazon is strong in western countries, while Alibaba dominates in China. Moving to new markets has proven difficult for both as the online world is not as standard as we could think.

The way they sell merchandise online is almost antagonistic, but both are customer-centric in their own way. Amazon has a western style approach with strong focus on showing the product. Look for instance for a wedding dress and the product will be the center of the site. Alibaba has an apparently childish, even naive, look and feel for western standards. It focuses on trust and relationship. Look for a wedding dress and the main image may be a smiling woman who shows illusion on her face because she is getting married. The dress may not even be completely seen on the initial page.

This approach responds to different buying attitudes in China. Building trust and relationships helps Alibaba in a country where businesses are not always trustworthy. According to Erisman (2015) some people even meet and marry thanks to Alibaba. Would you imagine customers from America, Europe, and most other countries in the world telling they met their lifetime partners through Amazon.com? Probably not.

Another key difference is that Alibaba only facilitates commerce, without actually owning, warehousing or delivering the merchandise, being more similar to a software company than to a retailer. In contrast, Amazon's model strongly relies on 1p sales, selling directly to customers and excelling in logistics.

But success of both Amazon and Alibaba, among other new retailers, has strong underlying grounds that go relatively unnoticed: its customer-centric IT design. Technology enabled business models are reshaping the industry. While technology is a means to an end, not an end by itself, it is a fundamental factor which explains both the rise and success of new digital disruptors, and the digital transformation of traditional brick-and-mortar retailers.

While traditional competitors are soon credited with cutting-edge innovations when they make improvements on their existing business models, many pure online players are born digital with a user-centric focus that is taken for granted. Most of them were born with features that may not necessarily be noticeable. For instance, customers don't need to understand the analytics engine that enables personalized recommendations at Amazon.com. We simply see the result, usually with delight.

The new breed of retailers led by Amazon and Alibaba are changing the game because they are born digital. They use technological developments to unleash customer value. They are born SMAC!

SMAC RETAIL

In the new technological retail landscape, SMAC technologies are winning momentum. SMAC, an acronym which stands for Social, Mobility, Analytics and Cloud, is a term that helps explaining how customer-centric technologies are reshaping the industry, the emergence of digital competitors and business models, and the fundamental shift towards the customer. These technologies play a key role in retail digital transformation. According to Parikh (2014), retailers use:

- Social Media to engage with customers and convert.
- Mobile Platforms to stay connected 'on the go'.
- Analytics to personalize and derive insights.
- Cloud Business Models to quickly design customized solutions over the Internet.

Are retailers becoming SMAC? Let's briefly analyze its four components.

Social

We may intuitively believe online purchases are based solely on price. While price is still an important element in any digital offering, this is no longer true, if it ever was. As retailers enable new social shopping features, purchasing any product online may resemble the in-store shopping experience to a great extent. Thanks to technology we can involve our friends in the purchasing process, asking for opinions and recommendations. This means technology allows replicating online the social interactions that occur offline. The social customer has changed, rather than spending a day walking around a mall, many people now spend hours on visually pleasing product sites that make wish-listing easy and rewarding (Kamenec, 2014). So e-commerce sites also adapt, and are developed ad hoc to cater the taste of an increasingly demanding shopper.

Customer interactions on social networks, forums, etc. strongly determine purchasing decisions. Our friends' opinions are key in order to decide between two similar products. We even trust on unknown customers who write their reviews and tell about their experiences. Why? Because customers are saturated of traditional marketing messages and look for real users' opinions. If there are enough reviews of a product, the social feedback will probably be fair and accurate. Companies react with more targeted, and usually intrusive, marketing messages as they leverage social friends to endorse their products. Overall, 67% of shoppers say that either reading (45%) or writing (22%) social media reviews and comments influences their online shopping behavior (PWC, 2016).

Social commerce is on the rise. According to Smith (2015a) social media increased its share of e-commerce referrals nearly 200% between the first quarters of 2014 and 2015. The growing importance of social aspects encourages top tier competitors, such as Alibaba and Amazon, to add social features:

- Alibaba mixes social-networking functions into its platforms, trying to engage customers and to increase the time they spend on their websites.
- Amazon's 'Wish List' tries to encourage shopping by enabling the creation and sharing of lists of products people want as gifts.

Other pure players are born social, like Polyvore. Launched in 2007 and acquired by Yahoo in 2015 for around $200 million, it has become a visual search engine for clothing and outfits. Polyvore changes the purchasing experience as customers can create 'sets' (several products combined to create an outfit), share them in social networks, like and share the product, and see details of specific products in the set. It heavily relies on customer generated content - around 3 million sets/ month -, it enjoys 20 million users, mostly female, its conversion rate and average order value are among the highest in the industry, and its share of the social shopping market is second, only after Facebook and ahead of Twitter and Pinterest.

Social media is key to capture bigger shares in the retail market. The growth in social-driven retail sales and referral traffic is undeniable and social media has converted into the *great influencer* to make product decisions (PWC, 2016).

Mobility

As a tool for communication, socialization, leisure, and work, smartphones are becoming an extension of our own bodies. They are widespread devices, not only in rich countries, but also in some of the poorest, where smartphones allow rendering services to previously unreachable rural populations. More than 2 billion people already use them.

From a retailers' perspective, cell phones are used to compare prices (36% of customers), research products (36%), access coupons/ promotional codes (31%), and check reviews about the product/ retailer (25%), among others. Overall, 76% of customers are using it in the purchasing cycle (PWC, 2016).

These devices enable new mobility services ranging from providing information to managing transactions. Most retailers (88%) state their purpose with mobile strategies is to drive shoppers to the store (Rosenblum & Rowen, 2015). Customers can receive personalized marketing messages on their phones when they stand in front of a specific shelf, search for product information and customer reviews while navigating the store, etc.

However, one of the best-known success stories is based on getting the opposite: moving the stores closer to customers. If the mountain will not come to Mohammed, then Mohammed must go to the mountain. Homeplus virtual stores, which belong to Tesco, one of the world's biggest retailers, let the stores come to the people in South Korean subway stations. Customers are able to shop on their smartphones by scanning QR codes. As a result, online sales increased by 130% in 3 months and Homeplus soon became the first online retailer in the country and a close second offline[5].

Homeplus is only an example, but the shift towards mobile is global. Mobile commerce already represents 30% of total US online commerce (Brohan, 2015), but in this case, the US is lagging behind other countries. Many people in other nations increasingly rely on mobile devices to make their purchases, i.e. 69% of all transactions on Chinese Singles' day were made on mobile devices (PWC, 2016). The growing importance of mobility is a world-scale phenomenon.

Mobile devices' role has changed from a relatively simple communication device to an open gate to the digital world. As they enable socializing and purchasing functions, they became purchasing tools, which generates new challenges.

Analytics

What gets measured gets managed. (Peter Drucker)

20th century leaders could be successful relying on their intuition to make decisions. Not anymore. The current competitive landscape force business leaders to base their decisions on an increasing amount of previously captured, digitally stored, properly cured, and (hopefully) analyzed data. This is more obvious in the marketing function where traditional creative professionals ('mad men') are being substituted by more analytical profiles ('math men')[6].

The amount of collected data grows exponentially. Eric Schmidt told there were 5 exabytes of information created between the dawn of civilization through 2003, but that much information is now created

every 2 days (as cited in Siegles, 2010). And figures kept growing since then. Internet traffic alone may reach 1.3 Zettabytes in 2016, with an increase from 2015 to 2016 almost equal to all IP traffic generated in 2011 (Cisco, 2012).

But, how is this data managed? Can retailers really derive insights or do they only collect information? Maybe the most famous example of the use of data analytics is Forbes article *How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did* (Hill, 2012). The teenage girl with an upset father is only the tip of the iceberg. Back in 2012, through the analysis of customer purchases, Target could accurately predict the probability of pregnancy for their customers and due dates within very narrow windows. Having retailers managing sensitive information is controversial, as many customers may feel upset if they discover Target (or any other retailer) know about their pregnancies. So Target changed their ad hoc coupons to make them look random, including products a pregnant woman is not likely to buy such as a lawn mower close to those specifically intended for her: diapers, rattles, strollers… Hill makes an important reflection. If they are able to reach and measure your womb, what else they might be able to do?

The shocking part is that, as customers, we don't need to provide much information. Use your loyalty card or a credit card when you pay and the rest will be done in the backstage. Your profile will be enriched with a history of previous purchases and, in cases like Target, the information may be put into the right context to develop useful knowledge about your habits.

Data-driven decision making is a reality only for some companies. While many international retailers invest heavily on big data and analytics, most are still developing their capabilities. Most major players already have a loyalty program, but do not necessarily have the ability to use the information they store. They may even have a number of not interconnected databases lacking an integrated CRM with a 360 degrees view of their customers.

Regardless of their current situation, in order to be competitive retailers must develop their analytical skills. It is critical that they measure the right metrics, analyze their performance on these metrics and adapt accordingly to ensure they survive and thrive (Deloitte, 2015). If not, they risk collecting interesting data without deriving insights. Imagine a married couple buys Coca-Cola on a regular basis, and, occasionally, some Pepsi. It may be interesting to discover a Pepsi lover is visiting them from time to time, but it does not seem useful. Useful data is actionable; it can be leveraged to lead customers into additional purchases, such as predicting pregnancies. If the same customers stop buying meat and suddenly increase the purchase of vegan associated products, then retailers may be able to use this information to target them with a customized vegan offering to increase sales.

Integrating context aware data and information from social networks is another key challenge to improve marketing efficiency. Data generated during the purchasing cycle and the information customers freely share should enrich their profiles. Armed with this information, retailers can reach their customers in new business moments in order to boost their sales.

And customers are only one side of the coin. On the other side of marketing analytics, retailers must optimize their publicity. There are many intermediaries between the marketer or the retailer and the publisher. A typical chain includes an agency, a trading desk, a demand-side platform (DSP), third party data, a supply-side platform (SSP), and an ad server before finally reaching the publisher. The complexity of managing data give rise to data management platforms (DMPs), and allows disintermediating some of these actors (O'Hara, 2016). DMPs allow working with several DSPs simultaneously, integrating both 1p, 2p, and 3p data to get a better understanding of audiences, to do better segmentation and targeting, and increasing the efficiency of publicity budgets.

Cloud

It is difficult to find any computer or smartphone user who does not rely on some cloud computing services, even being unaware of this fact. As individuals, we are likely to use WhatsApp, whose services are rendered on IBM's Softlayer – an IaaS solution –, or e-mail. Gmail, Hotmail, Yahoo, and others deliver e-mail hosted services over the Internet.

Companies in general, and retailers are no exception, are moving to the cloud. Think about the main software categories such as ERPs or CRMs. Most, if not all, major software vendors are offering cloud-based solutions that are substituting on-site implementations. Corporate clients are embracing the cloud in search of greater efficiencies because it is cheaper and easier to implement, it reduces maintenance cost, it improves internal efficiency, and it is easily scalable. The cloud business value includes faster deployment of new technologies and services, create innovative business models that help customization and are based on services, and connect and interact with stakeholders (Parikh, 2014). This trend also reflects the evolution of corporate software. Standard solutions would probably not suffice 15 years ago. Nowadays, their higher quality, continuous upgrades, and sectorial adaptations make standard solutions fit retailers' business and improve value for money.

In order to understand the cloud effect, let's think about music. With Apple's iTunes on the Cloud - included in the iCloud service - customers can store their music, among other files, access, stream, or download it from different devices. It works as a backup not tied to any hardware that can be stolen, lost, or broken. The physical store is a customer touchpoint rather than a music store. From 2016, Spotify offers its streaming services on Google's cloud, without any physical store. Both business models completely differ from that of traditional brick-and mortar music retailers.

As the role of the store is expected to evolve into a showroom providing experiences, insights, and information, but not storing physical products (Gaudin, 2016), cloud computing may have an even greater role to play. Kilcourse (as cited in Gaudin, 2016) states that "by using cloud computing services, retailers won't need to buy new technology, learn how to use it, set it up and manage it." Its simplicity removes barriers and will speed-up adoption.

RETAIL TRENDS ENABLED OR BOOSTED BY TECHNOLOGY

SMAC and other technologies are enabling or boosting fundamental changes that are transforming the way retailers deal and relate with their customers.

Omni-Channel

Omni-channel is about offering continuous purchasing experiences. Customers start a purchase on any channel (i.e. web), continue on another (i.e. store) and place the order on a third one (i.e. smartphone app). Omni-channel implies integration, with all channels serving the customer indistinctly. It differs from multi-channel, in which several channels are in place but not closely intertwined. Though we usually see omni-channel and multi-channel used interchangeably, as omni-channel is the final objective of multi-channel retailers in different stages of maturity.

Retailers are transforming. Omni-channel competitors already dominate the e-commerce sphere, with 39 out of 50 top e-retailers being omni-channel brick and mortar retailers, and 11 out of 50 being pure

online players (Deloitte, 2016). This does not necessarily mean that the experience in all their channels is identical, but at least they are working on improving it. Those unable to adapt to omni-channel may struggle to survive as customers' expectations and competing offerings keep raising the bar of customer service.

Customers are not loyal to a specific channel, "they expect online integration between social networks, mobile and physical stores" (Capgemini, 2012). This explains why retailers are accelerating their omni-channel approach, creating a more innovative retail environment where online and in-store shopping are a seamless experience for customers, and why they are including physical stores as part of their omni-channel strategies (Deloitte, 2016). Even pure online players like Amazon are currently opening some physical stores.

While many retailers still keep focus on individual channels, the seamless shopping experience, which includes the ability to shop across channels will improve if customers can check product availability prior to going to the store (Accenture, 2016).

Customer Experience

I've learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel. (Maya Angelou)

As customers become increasingly demanding, retailers face the challenge of offering better and better shopping experiences, both online and offline. Customer journeys are strongly linked to omni-channel capabilities, as they must be integrated across all channels. Shoppers used to look for social referrals and/or interactions online before shopping. Now they even do it while navigating the aisles in-store.

According to Kilcourse & Rowen research (2015), 95% of industry professionals believe the store and the digital experience must be brought together for a continuous, seamless experience. They identify the top three consumer-facing opportunities: bringing a digital/ online experience to stores, getting a deeper customer engagement to drive sales through personalized offers, and more personalized attention/ service from retailers' employees.

Customers motivations, behaviors, and actions substantially differ. Leading companies concentrate on the critical impact of understanding their customers and rendering a service that maximizes their experience. Retail winners, those with above average performance, "have been investing in understanding consumer behavior since the initial rise of omni-channel… they feel the imperative to understand what consumers want (thus their concern about falling behind in the consumer-retailer technology arms race)" (Baird & Rowen, 2015). Companies must also develop deep empathy to design a compelling and distinctive customer journey (Lhuer, Olanrewaju & Yeon, 2015).

But, why should customers go to the stores if they can check the price and inventory levels online? A technologically augmented in-store shopping experience may provide the answer from a customers' perspective and may enable cross-sell and up-sell opportunities from a retailers'. But retailers are still on their way to switch from product-focused organizations to customer-focused merchandise suppliers. 93% of industry professionals agree retailers have to do a better job to accommodate a younger, more tech-savvy consumer (Kilcourse & Rowen, 2015).

IoT and Analytics

The Internet of Things (IoT) refers to a world with billions (potentially trillions) of connected devices. Thanks to sensors such as RFID, wireless, QR codes, and Beacons, most daily products can be brought to life in the digital world.

The sensors monitor a wide variety of data that will be analyzed as the basis for decision making. Knowing customers is key to customize marketing messages and increase sales. Online tools for analytics - i.e. Google Analytics, Omniture - provide information on visited pages, number of views, time spent in each site, conversion of visits into sales with breakdown by operating system, device… These analytics are being replicated in-store thanks to IoT, combining sensors and analytical platforms.

Beacons, small low-cost devices that transmit information on Bluetooth Low Energy up to a 50-meter distance, are probably the quickest growing devices, especially in the US. They can be used to monitor location within stores and to submit customized marketing messages, among others. Smith (2015b) estimates 85% of the top 100 US retailers will use these devices in 2016 (up from 8% in 2014) and in-store sales influenced by beacons in these companies will multiply 10-fold in a year, from $4.1 billion in 2015 to $44.4 billion in 2016. Even Facebook is already offering its own beacons to leverage the use of its social network at retailers stores.

IoT is not about sensors or platforms, but about improving services. Customers can now be accompanied and advised through the entire purchasing cycle, with more accurate and targeted information even when the staff is busy. IT systems fed by IoT sensors allow delivering automated customized information without any action from sales staff, for instance in-store navigation to items in customers' wish lists when we enter a physical store.

Collected data also allows companies to reach their customers in different moments during their purchasing cycle that were not available before. For instance, retailers can offer proximity services in-store to digitally identified customers, offering them useful information when they are simply near a digital sign. Or they can accompany customers in different moments of their purchasing cycles such as providing product information when customers are searching from home, allowing them checking if the product is in stock when they are moving to the store, or improving the sales service with staff who is aware of the products they are looking for, who help customers finding them, and suggest related items[7].

IoT will have a profound impact in retail and we will see it soon. 80% of industry professionals believe the IoT will drastically change the way companies do business in the next three years (Baird & Rowen, 2015).

Efficient Fulfillment and Convenient Delivery

Cutting-edge fulfillment capabilities become a competitive advantage available in some leading retailers. For instance, fulfillment from several stores may speed-up delivery. There is a special difficulty with food products, as delivery may imply working with both refrigerated and non-refrigerated perishable merchandise simultaneously. The last mile of home delivery is an unresolved problem from the perspective that online orders are still complex and expensive to manage.

The market evolves to improve speed, narrowing delivery windows to increase convenience for customers. But not all retailers are keeping pace: 56% have next-day delivery capabilities, while just 11%

can deliver on the same day (Accenture, 2016). Other alternatives such as click & collect are not yet widespread and reduce customer value by forcing them to collect the merchandise in-store when they substitute more efficient home delivery.

Amazon, acclaimed as a world-class competitor in terms of logistics and delivery, is getting ahead of competition. Its new service Amazon Prime Now was launched in December 2014, and first expanded abroad to London in June 2015 (Lomas, 2015). The service is already available for premium members in selected postal codes in 28 US cities, and selected locations in other 8 countries. Customers can choose a two-hour delivery window in the same day for free, or 1-hour delivery for a fee for all their orders above a minimum around 15USD/ 20€ /20 GBP depending on the country. The company also plans to reduce delivery time to 30 minutes using drones (unmanned aerial vehicles), though regulatory barriers must be overcome first.

"Delivery offers an incredibly effective means to differentiate from other competitors in the e-commerce landscape, a tool for boosting conversion rates and a powerful mechanism for building customer loyalty" (MetaPack, 2015: 2). It is so important than half of all customers would not buy online due to unsatisfactory delivery options and 96% would be encouraged to purchase again after a positive delivery experience (MetaPack, 2015).

OTHER TRENDS

- **Digital Payments:** As mobile establishes itself as the cornerstone of digital strategies, most innovative payment solutions focus on mobile apps. New solutions target both retailers and shoppers. New digital payments include: financed payments (Klarna, Affirm), NFC (Apple Pay, Google Pay, bank Wallets), Beacons (PayPal, Apple), credit card solutions (Square, iZettle), apps to access bank accounts (Trustly) or even banks via apps (Simple, Gobank).
- **Digital Fitting Rooms:** Popular in fashion. They are useful to try on digital clothes and increase conversion rates. As customers are willing to see how clothes fit their bodies, these fitting rooms remove a key adoption barrier. They can't actually try the garments on, but seeing themselves 'dressed' with them substantially encourages purchasing.
- **Dynamic Pricing:** Still to become widespread, dynamic pricing is supposed to be one of the future trends. According to Kilroy, MacKenzie & Manacek (2015), online pure players react to competitor prices in one hour, reprice top-selling items 3 or 4 times per day (up to 12), and sophisticated multichannel leaders change the price on 10 to 20 percent of their online assortment daily. Some retailers are also able to deliver personalized offers based on past shopping history. Whether or not personalizing pricing, product prices will differ in different moments and channels. Price changes must be carefully managed to avoid public relations problems.
- **Wearables:** New devices are being born and worn, providing new opportunities for retailers regarding in-store shopping experience, personalization and real-time marketing. For instance, an employee with a smart watch wired into the Internet of Things can effectively service new business moments via glanceable information. Bob O'Donnell argues that smart watches are the next kings of wearables in 2016 and head-worn devices, including virtual reality glasses, will be in 2020 (as cited in Anders, 2015).

DESIGNING DIGITAL RETAIL

A lot of people in our industry haven't had very diverse experiences. So they don't have enough dots to connect, and they end up with very linear solutions without a broad perspective on the problem. The broader one's understanding of the human experience; the better design we will have. (Steve Jobs)

Retailers must design solutions that may disrupt their existing business in order to satisfy customers who decide on when, how and who to interact with. They need a systemic view. Originated in the field of engineering by Forrester (1961) and adapted to business by management guru Peter Senge (1990), systemic thinking is the cornerstone to develop innovative business models and new services. Everything is interconnected: social shopping, mobile solutions, omni-channel capabilities, online and in-store analytics, etc. All these ideas merge from the value perspective to offer integrated solutions and IT departments should keep a systemic view in mind to digitize and transform organizations.

Former Apple CEO, Steve Jobs, is considered the father of the one-button smartphone, simplifying the use of an increasingly complex device with a bigger screen and users' fingers for any potential future use. Digital design must manage complexity through simplicity in a very similar fashion. As in the case of the smartphone, retail customers expect a new breed of apps, functionalities and services. But regardless of their being technologically savvy or not, retailers must keep simplicity in the front, i.e. an app that works with a simple button. While customer interaction is easy and intuitive, there may well be many processes, operations, and technologies working in the back, which is completely transparent for the unaware final user.

The Internet of Things is a good example of managing complexity through simplicity. For instance, customers enter stores and receive personalized marketing messages with special offers for the products they are more likely to buy. They are completely unaware of the backstage, where probably, the retailer's IT department has developed a platform to manage beacons, worked with marketing on the design and delivery of promotional messages and developed an app with an SDK (software development kit) embedded to make personalized communication possible. They simply downloaded an app at some point. All the rest just happens, like magic.

Personalization is another cornerstone. Hodkin (2014) explained how the Internet we experience as customers (The Internet of Me) is as unique as our fingerprints. Companies such as Facebook, Google or Netflix show us the information based on a 'relevance' algorithm, which means we receive only the information we want to see to the virtual exclusion of everything else. Customized content is "the new way of exposing users to the whole Internet through their own experiences, habits, and interests, using information that users are often not conscious of" (Hodkin, 2014). This Internet of Me "is changing the way people around the world interact through technology, placing the end user at the center of every digital experience" (Accenture, 2015).

This individualized customization is most obvious in e-commerce. Digital recommendations may rely in our specific tastes and purchasing histories to offer each of us the best of a myriad of alternatives leveraging *the long tail* (Anderson, 2006), or products with an individually low demand that collectively may generate more revenues than blockbusters, to boost sales.

The combination of a systemic view, simplicity and personalization is a winning value proposition for customers. Retailers should become more customer- centric. This has profound implications on how they think of their business in terms of assortment optimization, tailored advertising, marketing and promotions, improving service on loyalty programs, improving the shopping experience of target consumers,

and removing organizational, operational and technical barriers to enable multichannel shopper-centric ways of working (Mercier, Jacobsen, & Veitch, 2012). Changes go beyond IT, affecting the supply chain and the entire organization.

We should make an important distinction between traditional brick and mortar retailers, who, in general, still struggle to integrate the online channel with their stores networks, and more agile, digitally born, pure online players. The former, like the Titanic, need a considerable amount of time and money to change their practices, as they are slaves of their current systems.

Legacy IT systems and practices may be too heavy to get rid of, but there is no need to substitute everything. Gartner's bimodal IT framework suggests using a second team focusing on agility, working in short cycles and centered on the business instead of IT (Gartner, 2016). By developing bimodal IT capabilities, traditional retailers may keep their business as usual running while they set specific teams up to manage new digital projects.

New technological developments also rely heavily on the cloud in its three main alternatives: SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service).

SaaS is the most obvious as some of the most important software solutions are directly hired as a Service from top vendors. Instead of traditional implementations, retailers rely on cloud-based solutions managed by third parties. While they may lose the feeling of uniqueness, as this software does not allow much customization to the specifics of their business models, most of them discovered they were not as unique as they used to believe in the first place. Market solutions fit, in general, most competitors' needs, and offer substantial advantages in terms of ease and cost of implementation, maintenance, upgrading, and scalability. The time in which all software had to be developed ad hoc is gone.

PaaS and IaaS are useful for retailers who wish to develop their own apps. For instance, apps developed for social interaction and mobile phones/ tablets are very popular. PaaS is a middleware that offers a framework to develop, customize, manage and execute apps, usually through a self-service portal. IaaS ensures the required underlying infrastructure (hardware) is in place. With these cloud services retailers can focus on faster development and deployment, without worrying about scalability or existing infrastructure capabilities.

Outsourced to third parties, cloud services are typically rendered on the basis of SLAs (service level agreements) and have developed a variety of pay-per-use revenue models that allow optimizing computing power. Nowadays, an American, a European and an Asian retailer may share some servers as new models make no longer attractive to own the needed computing power. When peak demand exceeds by far average utilization, having dedicated computer power round-the-clock implies wasting resources. Cloud services make economic sense allowing to share this power among several companies that work on different time zones or simply have peaks in different moments.

Acknowledging the cloud global importance and its increasing presence in retail, some capabilities may still be developed in-house. Analytics is a good example, as it may imply major customization needs where market solutions may be insufficient. Kilcourse & Rosenblum (2015) state that "if retailers are serious about getting deep into customer data, a purpose-built data warehouse with analytics both built in and discoverable is a must." Retailers have an agreement on wanting to know the customer but many are still unable to make proper use of their business intelligence and analytics tools.

Regardless of developing ad-hoc solutions or buying from top software vendors, the best design takes place in the digital realm, where several functions merge to offer customer-centered solutions developed over an IT backbone. The CDO (Chief Digital Officer) should not be a senior project/ programme manager, buy a member of the executive committee, who helps defining the strategy and coordinating marketing,

IT, and other functions. Putting all functions to work together is a must for successful implementation and a prerequisite to digitize both retailer's front and back ends, leveraging SMAC technologies.

Digitization also requires new methodologies and a portfolio approach. The traditional role of hierarchies is being challenged and new project management methodologies are losing ground to agile ones in which the focus switches from the product to quick delivery and adaptability to changes. Constant interaction between functions with digital professionals leading technical decisions over more senior but technologically outdated managers may become commonplace. Minimum viable products may be preferred to fully developed ones, favoring speed over perfection and improving through a test-and-learn approach. And agile IT methodologies are just the tip of the iceberg: the whole organization should become agile, like a start-up. (Lhuer, Olanrewaju & Yeon, 2015). The new retail is quick, adaptive, and digital.

Digital design must be a strategic priority and must be appropriately managed. According to Bonnet (2016), "success (in digital transformation) comes from consciously managing your digital transformation as a strategic portfolio over time." Design must bear in mind the differences among projects in terms of impact, time horizon, and risk levels. Managing digital transformation as a portfolio implies addressing the why, the what and the how. That is to say, understanding the changes in the industry and new sources of value creation - the why -, designing a portfolio of initiatives that balance short-term improvements with longer term strategic and business model evolution - the what -, and the ability to execute at the right time - the how - (Bonnet, 2016).

THE NEW DIGITAL CUSTOMER

The customer is at the very center of retail. Digital is the cornerstone of a new purchasing experience of an increasingly commanding target customer. However, there is still a huge gap between retailers' reality and customers' growing expectations. This gap between consumers' digital behaviors and expectations and retailers' ability to deliver the desired experiences has been defined as *The New Digital Divide* (Deloitte, 2015).

Shoppers purchasing habits are evolving. An increasing number of shoppers start purchases online even if they finally buy at traditional stores, the so-called ROPO (research online, purchase offline). According to Deloitte (2015), 80% interact with brands or products through digital before arriving at the physical store. Others buy online and collect the merchandise in the store (BOPUS - buying online, picking up in-store). ROPO and BOPUS illustrate changing shopping trends that retailers should be able to forecast and adapt to.

Keeping pace with expectations proves challenging. Without trying to be exhaustive, retail customers are looking for (Accenture 2015 & 2016, PWC 2016):

- Ordering out-of-stocks via mobile devices while they are in the store
- Accessing free Wi-Fi, scanning products and having them shipped home
- Using their mobile devices to locate items in the store
- Receiving real-time promotions and earn loyalty points/ member-only discounts
- Navigating websites optimized by device
- Doing one-click checkouts
- Improved delivery (one-hour delivery, delivery by drone…) and free shipping
- Receiving recommendations based upon social media activity

- Reading feedback from friends for items they are considering
- And, maybe the most important, personalized shopping experiences

So, what is the role of the customer in the new retail digital landscape? We cannot unbind social shopping from customer experience, mobile from omni-channel or analytics from IoT. Everything is deeply intertwined. Retail is digital, omni-channel and SMAC. Social, mobile, analytics and cloud reinforce each other. "While each of the technology elements has the capability of delivering business value individually, however, in combination with each other they become a potent strategic tool for the enterprise to deliver higher value to its customers" (Parikh, 2014).

Customers are, to some extent, at the center of all technological developments. Some of them may be unnoticed. For instance, as customers, we don't really care if our retailers' e-commerce web sites are powered by ATG (Oracle), Hybris (SAP), WebSphere (IBM), Demandware (Salesforce), or any other solution. We really want them to work properly, a user friendly design, and, hopefully, some extra features: social interaction and recommendations. Platforms may evolve in different ways such as providing new cloud services, enhancing analytical capabilities, enabling mobile functionalities, or adding social features.

After retailers upgrade their services, it takes time for customers to realize and get used to the new possibilities. Top tier retailers are competing to develop new solutions that help us interact with our friends - i.e. product recommendations -, manage our wish or gift lists and facilitate transactions. The easiest for consumers, the better for retailers, as they will increase loyalty and repeat orders. Whenever possible, we will avoid downloading apps or logging in to online services. It is about managing complexity in the backstage while offering simplicity in the front.

Technology also enables new business moments in which companies can support the purchasing process providing information and help at virtually any moment: when we research from home, when we enter a store, or while we are in the store waiting for the sales staff. These actions require customer-focused developments, so clients are part of the design objectives and their needs become key before even starting to develop anything.

Finally, the customer-centric approach is also changing the role of the store to "storefronts to choose and order products" (Capgemini, 2012). Worth mentioning some online retailers are also developing their stores networks. In an omni-channel retail world in which customers expect the best personalized experience across channels, having both a digitally enhanced physical presence and a virtual store seems a winning value proposition.

CONCLUSION: WILL DIGITAL RETAIL PAY-OFF?

No doubt SMAC technologies offer great value. Offering social interactions, mobile functionalities, deriving customer insights and improving efficiency are some of the most valued assets. But, as any new investment with uncertain returns, is SMAC, and digital in general, only a way to remain competitive or does it have a real impact in the bottom line? Will retailers monetize their digital investments? Overall, not only it has become a need to remain in business because disruptors are already in the industry, whether incumbents adapt or not, but also the return is clearly positive from a financial standpoint.

The digital influence is surprisingly high. It is not limited to digital, but it already affects most in-store sales. In 2014, only 6.5% of sales were online ($305 billion) but the influence of digital and mobile on store sales is much greater and quickly growing. 49% of total in-store sales ($1.7 trillion) were

influenced by digital devices, up from 14% two years earlier. This figure is expected to have grown to almost two thirds (64%) in 2015. 28% of total in-store sales ($0.97 billion) were influenced by mobile devices up from 5% two years earlier (Deloitte, 2015). We also know consistent omni-channel offerings and improved customer experiences increase retention and boost sales.

The social impact is clear in customer behavior. Social shoppers are 29% more likely to make a purchase on the same day when they use social media, 4x times more likely to spend more on purchases as a result of a digital shopping experience in general and up to 6x times for those very influenced by social media (Deloitte, 2015).

Maximizing mobile or making it easier to purchase from smartphones and tablets, may be one of the most profitable steps retailers can take as there is still a huge gap between ease of purchase on physical stores - 92% of customers believe it is easy or very easy - versus online and mobile - 65% and 42% respectively- (Accenture, 2015). Mobile is also reshaping the in-store purchasing experience for the better.

The new priority in terms of business intelligence and analytics is gaining a better understanding of customers. The focus changed from a reactive approach - providing customers with contextual information under demand - to a proactive one - using information about them to react more quickly to changes in demand - (Kilcourse & Rosenblum, 2015). Trying to establish the ROI at this stage may be misleading as the different initiatives are not easily comparable.

Let's remember the profit (Π) of any company is a function of the price (P) minus the variable cost (VC), multiplied by the number of units sold (Q), minus fixed costs (FC): $\Pi = (P - VC) \times Q - FC$. Social, mobile and analytics focus more on generating additional revenues by increasing sales, mostly selling more units. Prices can also be raised in the long run if additional value is created (dynamic pricing would have an additional impact, when it eventually becomes a widespread reality). Retailers can also substantially profit from cloud solutions in terms of reducing costs and time-to-market, which leads to quicker sales. SMAC technologies directly affect profit components and retailers' bottom lines. But all conversion and ROI numbers must be taken as simple references. Even the best international research shows no consistent figures as methodologies, target participants, and geographies substantially vary.

One thing is for sure. Retail has been and continues to be disrupted by SMAC and other digital technologies. Digital Disruption is a fundamental change boosted by technology that alters the status quo by generating new business models, and innovative products and services that make existing competition obsolete, or even redundant. In order to compete, retailers must digitize, whether they keep a brick-and-mortar stores network, an online presence or both, they must be prepared to leverage technology on their respective offerings and to manage digital transformation strategically. And don't forget:

The future is already here – it's just not evenly distributed. (William Gibson)

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KEY TERMS AND DEFINITIONS

Analytics: The search for meaningful patterns in data to derive insights.

App: Acronym for application. Small and specialized computer program.

Cloud Computing: Term that refers to the delivery of hosted services over the Internet. It is broken down in three main services: SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service).

Digital Disruption: A fundamental change boosted by technology that alters the status quo by generating new business models, innovative products and services that make existing competition obsolete or even redundant.

E-Commerce: Buying and selling of goods and services through electronic networks, normally through the Internet. The most popular types of e-commerce are: B2C (Business to Consumer), B2B (Business to Business) and C2C (Consumer to Consumer).

Internet of Things (IoT): It refers to the idea of connecting any device, including daily life products, and even machine components to the Internet, where they will enjoy a digital presence.

Omni-Channel: Delivery of services through different channels indistinctly, looking to offer a seamless shopping experience.

Retail: The sale of goods or services directly to consumers.

SMAC: Acronym which stands for Social, Mobility, Analytics and Cloud.

Social Shopping: A kind of commerce in which technology allows involving friends and/or other customers replicating online the social interactions that occur offline.

ENDNOTES

[1] Amazon does not disclose this figure. A 2014 Forbes articles estimated $5.25 billion in 2013 or 7% of its total revenue. Extrapolating this figure to 2015 revenues we get an estimation of $7.5 billion.

[2] USD 479.5 billion translating the final figure at March 31, 2016 with a 6.449 Yuan/ USD exchange rate. USD 486.5 billion considering an average 6.356 Yuan/ USD exchange rate over the period April 2015 to March 2016. The evolution of the exchange rate would place Wal-Mart ahead of Alibaba in terms of GMV when this chapter was submitted. Alibaba was previously ahead. Its relative decline responds to a Yuan depreciation against the dollar. Growth in local currency keeps strong for Alibaba (+27% year on year).

[3] Estimated by the author. In order to estimate how much is Amazon able to sell in one day, the author took Adobe's Digital Index total online sales on Cyber Monday – the major online shopping day in the US ($3.07 billion) and Slice Intelligence estimation that Amazon generated 36.1% of the total online sales on that day. The result is $1.1 billion. Cyber Monday online sales are above those of Black Friday ($2.72 billion) and Thanksgiving Day ($1.73 billion). Alibaba's number are for Chinese 'Singles' day', the major shopping day in China.

[4] In 2014, Amazon's 3p sales represented $18.9 billion. $180 billion GMV implies around $109.9 billion from 3p sales or a 5.81 'multiplier' from recorded 3p sales to 3p GMV. Using this multiplier with 2015 data, we can estimate Amazon's 3p GMV at around 161.3 billion and total GMV at around 240.5 billion.

[5] You can see how it works in YouTube: https://www.youtube.com/watch?v=nJVoYsBym88.

[6] 'Mad men' refer to stereotypical marketing professionals in the 20th century, which were hired for their creativity. 'Math men' represent 21st century new professionals, who derive insights from data. This is also related to the dominance of the right hemisphere in the brain, associated with creativity or the left one, with logical thinking. Another way of referring to these skills is the debate on the 'art or science of marketing'. New marketing professionals should be able to combine both approaches, but they are 'math' men because their job has an increasingly reliance upon data.

[7] The author would like to thank fellow colleague Craig Templin, Director at Neoris US and head of the Neoris Global iBeacon Driven Initiative for his work on Beacons, that has been a key input to write the IoT section.

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Chapter 76
Driving Media Transformations:
Mobile Content and Personal Information

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ABSTRACT

The consolidation of the mobile ecosystem is deeply influencing the adaptation of traditional media industries to the digital transformations of business, consumption and audiences. Legacy media digitization comes along with a perfect storm where different kinds of crisis converge. This is also the ground where an eventual response to uncertainties about future may appear in the form of new opportunities and possibilities. Simultaneously, mobile content evolution brings forth a new habitus of consumption, an increasingly complex set of social rituals, content format syntax and technical requirements that constitute new consumption scenarios. This chapter aims at discussing a conceptual framework on how the techno-economic drift of the mobile ecosystem matches the evolution of content industries dynamics and content consumption scenarios in terms of dysfunctions and challenges. The theoretical ground is built upon the works from a three-year research project on the evolution of mobile content and the economic and sociocultural relevance of personal information management.

INTRODUCTION

The consolidation of mobile communication technologies has given rise to an entire new ecosystem within digital media landscape. Mobile ecosystem involves a complex and changing net of players (including telecomm operators, handset suppliers, software developers, content aggregators, content producers, new advertising players and users) that are becoming increasingly influential in the sphere of media and content industries (Feijóo, Pasu, Misuraca & Lusoli, 2009).

Legacy media digitization comes along with a perfect storm where different kinds of crisis (of financial resources, of business and management models, of audiences, of distribution systems…) converge. The dramatic drop of advertising expenditure (Perry, 2012) and of pay-per-access income (Pew Research

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Center, 2013), however, appears not to be exclusively due to global financial crisis, to the increasing fragmentation of audiences or to the fragmentation of users' time and attention in a growing number of devices and media practices (Purcell et alt. 2010). It is also rooted in deeper transformations that concern the whole of the cultural content value chain and which involve a reorganisation of players and influences among them (De Prato, Sanz & Simon, 2014). The impact of the mobile ecosystem in digital content industries is transferred to traditional media industries in the form of innovation vectors or trends that may give answer to some of the pending questions on the future of media: content formats, distribution systems, the role of personal information and new value networks in cultural industries.

The transformations triggered by the process of digitization are as well the ground where an eventual response to uncertainties about future may appear in the form of new opportunities and possibilities. On addition, media digitization is no only a matter of economic or technological challenges. These are intrinsically linked to social transformations. The social and cultural consequences of the mobile revolution have been –and still are- extensively dealt with by many scholars and researchers. But these changes also concerns to the social and symbolic side of mobile content. In this context, mobile content evolution brings forth a new habitus of consumption, an increasingly complex set of social rituals, content format syntax and technical requirements that constitute what we identify -following Goffman (1959)- as consumption scenarios.

In this chapter we intend to outline a conceptual framework for the study of the interrelations between mobile ecosystem players and media in order to understand how the techno-economic drift mobile technologies are driving matches the evolution of content industries in terms of dysfunctions and challenges. Our interest, however, is not solely focused on the economic landscape, but as well in the socio-cultural transformations that accompany the mobile side of the digital revolution.

In broad terms, the resulting picture strengthens the traditional media industry's perception of a collision with software and digital industries, to which cultural content has become a central issue. The conflict points delimited in this chapter (that is, the critical innovation vectors where traditional media show to be more dependent) are basically three: the influence of new distribution channels, the characterisation of content consumption in terms of social interactions and the increasing relevance of personal information in the redefinition of cultural content business models. These aspects constitute as well a relevant argument for consolidating mobile content environment as a specific field in the current development of media studies.

MOBILE PLATFORMS AND THE RE-INTERMEDIATION OF CULTURAL INDUSTRIES

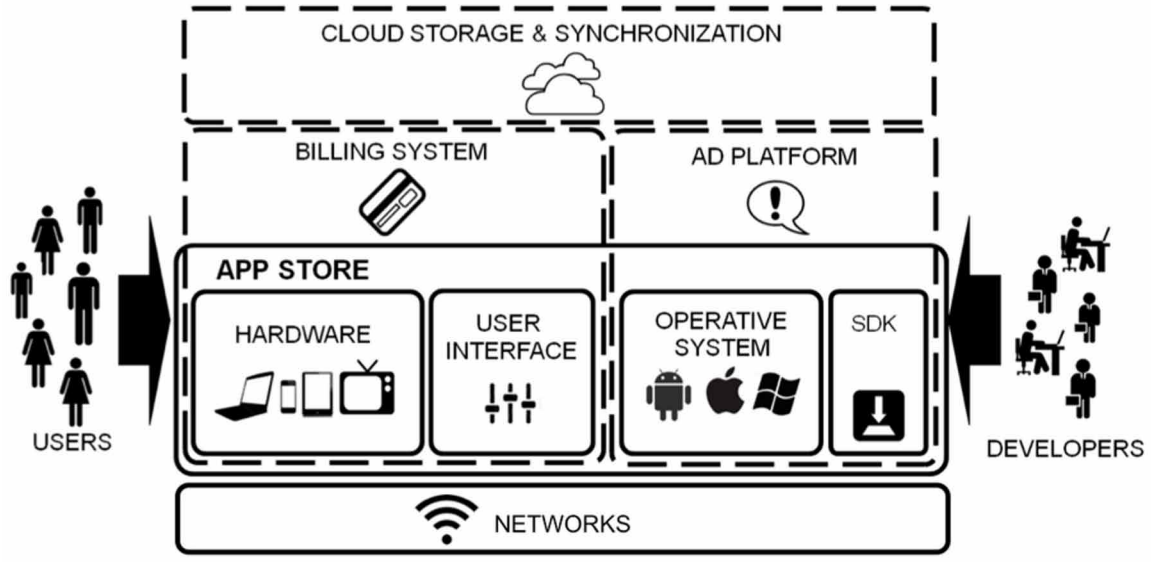
Mobile ecosystem has evolved in the last six years from a network centred structure, in which telecomm operators had a privileged position, to a platform centred structure, in which software developers (especially OS suppliers) influence the relations amongst the different mobile players. In this process of platformisation (Ballon, 2009) the main players tend to group together, in a loose or tight scheme, all of the required roles for a common set of hardware, software and other techno-economic specifications (Feijóo, Gómez-Barroso, Aguado & Barrero, 2012). Mobile platforms enact complex multi-sided markets with multiple interdependencies amongst involved players (DePrato, Sanz & Simon, 2014). Apple's iOS and Google's Android are examples of dominant mobile platforms that tend to create a more or less closed environment in which content becomes a relevant asset and a distinctive product at the same time.

These dominant mobile platforms integrate in an OS-based structure different roles, services and products that contribute to enable access to the mobile information environment: hardware (device specifications), access software (user interface), networks (mobile telecomm operators), distribution (application and content stores), billing systems and third party environments (like specific SDKs for application developers and service providers, and application publishing systems). Application and content stores play a key role in articulating mobile platforms around a viable distribution channel. Mobile platforms also include different added value services, be it addressed to third party players or to end users, such as cloud storage (Apple's iCloud or Google Drive, for instance), multi-device cloud-based synchronisation or mobile specific advertising platforms (like Apple's iAd or Google's AdMob) (see Figure 1).

The process of platformisation is not limited to the mobile environment, however. The relevance of mobile application and content stores (like Apple's iTunes/Appstore or Google's Google Play) as an evolution of online software distribution and the consolidation of mobile apps as a prevalent user interface for accessing content and services become a key issue in the reconfiguration of the content industries landscape. Due to its success, the model of application stores –the front of mobile platforms- is being exported to other media environments, like connected TV, desktop PCs, game consoles and photo cameras. As a part of that cross-device scenario, cloud content storage and synchronization services have become a strategic move for digital players. These services make possible to expand the structure of mobile platforms to a broader and increasingly mobile-influenced digital environment (Feijóo, Lindmark et al., 2013). But they also open the possibility for media and content industries to take advantage of cross-media ubiquitous offer. For instance, the cross-device strategy of The New York Times (so called 'NYT Everywhere') involves an integration of different products, access channels and income models.

The importance of mobile platforms is not accidental in this respect. Mobile technology introduces three key aspects that facilitate the drift of the digital ecosystem towards a cross-media landscape: personalization, integration and ubiquity. Mobile platforms perform a decisive role in integrating in-

Figure 1. Structure of mobile platforms
Source: Elaborated by the authors



formation environments into ubiquitous personalized access, fostering multi-device and multi-purpose coordination of actions in different contexts (searching, buying, having entertainment, self-expressing, socializing, accomplishing specific tasks, etc.) (Google & Ypsos, 2012). The search for diverse wearable devices –like Google Glass or Apple's iWatch- seems to be part of that same process.

The fact that controlling distribution channels is a crucial strategic aspect of media business needs no further explanation. Indeed, despite the importance traditionally given to content producers, it is upon distribution models that legacy cultural industries have always shaped their business and their social influence (DePrato, Esteve & Simon, 2014). And since they are a relevant part of ICT hardware or data based business models, taking over digital distribution channels has also become a decisive factor for the mobile ecosystem players (Manjoo, 2012).

Consequently, platformisation of the mobile and the ICT environment is about how the different players relate to control the value chain of ubiquitous information and content. In its actual shape, platformisation involves a set of latent conflicts, the most relevant of which concern telecomm operators, on one side, and content producers, on the other side. The first ones try to resist being trapped in the same 'dumb pipe' scheme that they already experienced in the Internet in late 90's (Aguado, Feijóo & Martínez, 2011; De Prato, Sanz & Simon, 2014). The latter (including legacy media), expect a neutral mobile ecosystem over neutral mobile networks that operate as a powerful ground for new forms of access to content and related services (Feijóo, Maghiros, Abadie & Gómez Barroso, 2009).

The relevance of OS developer-based mobile platforms lies in their success in implementing distribution channels and controlling users' access to services and content, which used to be the main asset of legacy media in the pre-Internet era. Application stores are the window for content providers and app developers to access users. They provide also the tools for content and service discovery. Consequently, application stores play a crucial role not only in shaping the market (Feijóo, Gómez-Barroso, Aguado & Barroso, 2012), but also in determining users' perception and access routines to mobile content (Bloem, van Doorm, Duivestein & Sjöström, 2013). As a consequence of that, mobile applications have become the prevalent user interface in the mobile Internet (Khalaf, 2013).

Mobile platforms' capacity to personalize and to provide direct access to end user has also fostered the disintermediation process of cultural consumption that already started with the Social Web in the first decade of the 21st Century (De Prato, Sanz & Simon, 2014). The very same channels and tools that allow content producers (such as legacy media) reaching mobile consumers favour also the transformation of content production into an object of cultural consumption. iBook Store or iTunes, not to mention Amazon Store or Google Play, become that way not only repositories for the products and services of legacy or new digital content industries, but also a direct platform through which professional and amateur content producers (writers, musicians, photographers, software developers, etc.) can directly access their audiences without depending on traditional, over-sized, cost-increasing cultural intermediaries.

This disintermediation process facilitated by mobile platforms is part of a re-intermediation strategy through which mobile platforms take the place of traditional cultural industries as content consumption intermediaries (Aguado, 2013; Feijóo, Lindmark et alt., 2013; De Prato, Sanz & Simon, 2014). Their success in controlling digital distribution channels and in shaping content discovery, access and management in an increasingly cross-device environment is well illustrated by one simple fact: in late 2012, the yearly income of Apple's iTunes and App stores (iPhone's and iPad's) exceeded in USD 300 million the combined turnover of The New York Times; Simon & Schuster (the publisher of the best-selling Steve Jobs' biography); Warner Bros. film studios (with popular film franchises like Batman or Harry Potter); and Time Inc. (the largest magazine publisher in the U.S.) (Lee, 2012).

Despite being relevant, typically considered factors such as ubiquitous availability of content, quality standards or cost-utility balance do not provide a sufficient explanation in understanding the privileged position of application stores as a dominant content distribution channel. The failure of mobile television constitutes a good example in that respect (Aguado, Feijóo, Martínez & Roel, 2012). The relational and context-attached nature of mobile devices underlies new forms of understanding digital content and its insertion into everyday consumption practices. In a sense, users' perception and attitudes towards content in mobile (and, by extension, in cross-device) environment have changed more than content producers'.

UNDERSTANDING CONTENT CONSUMPTION IN THE MOBILE ENVIRONMENT

Both in the popular media discourses and in the mind of users mobile devices are basically personal portable devices characterised by their attachment to situations and social interactions (Aguado & Martinez, 2010). Using mobile devices then involves different forms of availability and access to others' communicative presence. Digital content is obviously not alien to that premise. In fact, users' perception on the value of mobile content appears to be highly determined by two factors: the capacity of the user to act upon it and the ease of integrating it into social interactions. Experiences with users clearly emphasize a difference between traditional media (which are to watch, listen to, read…) and mobile media (García Jiménez, 2012). In the mobile context, users increasingly expect not only to access content, but to do things with content (and with others around content). In this very sense, mobile devices contribute to enhance the digital merge of cultural content and social communications. As a result of the evolution of mobile content, users' attitude and content consumption rituals have increasingly evolved towards an intervention paradigm (Scolari, Aguado & Feijóo, 2012).

The consolidation of mobile applications as the prevailing interfaces for mobile media (Khalaf, 2013) and as the prevalent distribution model (De Prato, Sanz & Simon, 2014) should be explained also as a part of that shift. Mobile applications are small pieces of software developed as specific task oriented tools. As any other tool, they do not solely involve the functional purpose they are made for, but also the symbolic frame and the operative instructions under which they are intended to work. It is in this sense that mobile applications involve also an interface: they enact meaning-action frames that presuppose the user (intentions, attitudes and competences) and an object of action (possible results) in a coherent, connected way (Scolari, 2009). As a tool, an app is something that allows (and is intended for) doing things. Since mobile content is increasingly accessed through native (platform based) or web applications (Khalaf, 2013), mobile environment emphasizes the specific connection between mobile content and user actions. Unlike media oriented computer software, mobile applications bring forth a tight semantic link among object (content), user (presupposed intentions, attitudes and competences) and specific tasks (Scolari, Aguado & Feijóo, 2012). Especially for users under age 45, their relation to his or her apps is clearly different from that to his or her desktop computer software. They feel mobile apps and software linked to their everyday life and to the emotional aspects of it. What they have installed in their smartphones (and even which apps they frequently use or what makes them to eventually uninstall an app) has to do with their, with their personal preferences and with their momentary impulses. The two ideas –"content is something to act upon" and "content and apps speak about who I am"- ideally merge in the perception and uses of mobile content applications.

The functional evolution of mobile content apps in the last five years supports these assumptions. Drawing on a semiotic analysis of a sample of 40 content addressed mobile apps, we have developed a

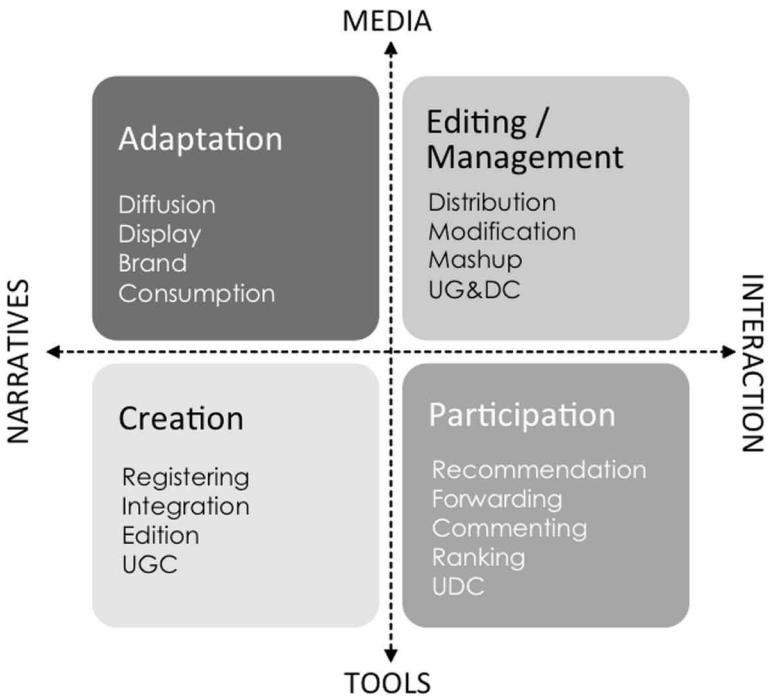
conceptual model defined along two axes (see Figure 2): media / tool orientation (considering a scale from the mere content display to high intervention capacity) and narrative / interaction involvement (from narrative focused apps –in displaying or instrumental terms-, to communication focused apps).

That scheme allowed us developing a general taxonomy of mobile content applications by differentiating four clear fields (Scolari, Aguado & Feijóo, 2012):

1. Adapted or repurposed mobile content apps, addressed to conventional media diffusion and consumption
2. Creative mobile content apps, addressed to facilitate registering, producing and editing user generated content (photos, videos, music, audio, etc.)
3. Content management mobile applications, focusing in organizing and transforming conventional media content (libraries, playlist managers, etc.), including some aspects of user generated and distributed content
4. Participation mobile apps, addressed to integrate mobile media and user generated content into social conversations (including, from the perspective of media, the so called 'user distributed content').

These broad categories were characterised by the prevalence of a given frame of presupposed actions and tasks:

Figure 2. A conceptual frame for the classification of mobile content applications (Scolari, Aguado & Feijóo, 2013)

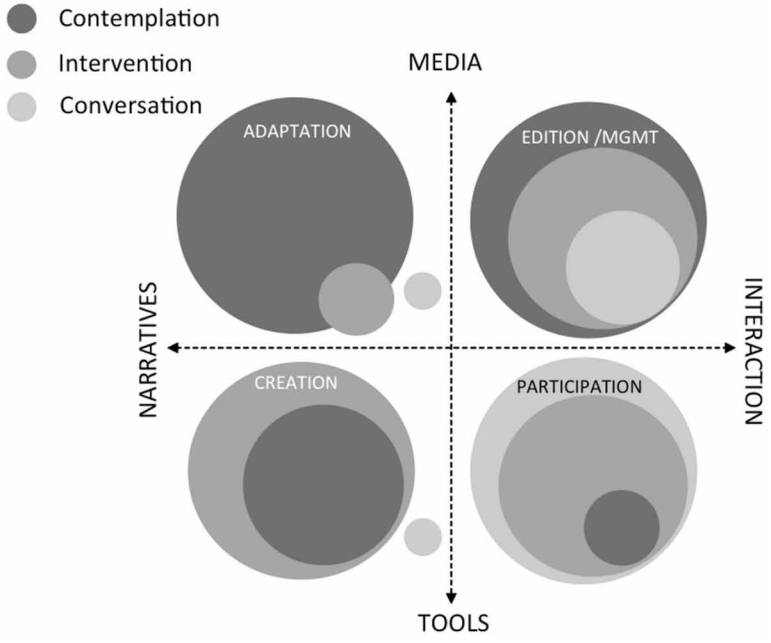


1. Contemplation, which involves passive consumption of conventional content (reading, watching or listening)
2. Intervention, which involves acting upon content to transform it (editing, managing, merging…)
3. Conversation, which involves using content as a source of meaning in social interactions (linking, recommending, commenting, resending…).

Figure 3 illustrates the structure of the involved prevailing actions that characterises the different kinds of mobile content applications. The size of circles in the graph represents relevance, while position (inclusion/exclusion) represents subordination. Accordingly, content apps within the category of adaptation (typically including traditional media apps, like mobile magazines or mobile news apps) presuppose contemplation as the main action guiding interface design and user's attitude, with intervention capacity having a subordinated role. Editing and management mobile content applications (such as content aggregators) perform contemplation oriented interfaces and related conversational functions, however with a more relevant role of intervention capacity. Applications within creation category (typically photo or video editors and music tools) invert the former correlation of actions, focusing interface in intervention and subjecting contemplation to the prevalence of acting upon –characteristically- user generated content. Finally, mobile applications within the conceptual field of participation (such as mobile social networks and messaging apps) perform a conversation-oriented interface that subordinates intervention and contemplation capacities.

One of the interesting points in this taxonomy is that categories are not closed either in conceptual nor in evolutionary terms. Characteristically, for example, networked mobile video games pose a singular merge of both content/tool and narratives/interaction values, involving tight interdependence among

Figure 3. Structure of presupposed actions in mobile content applications
Source: Scolari, Aguado & Feijóo, 2013.

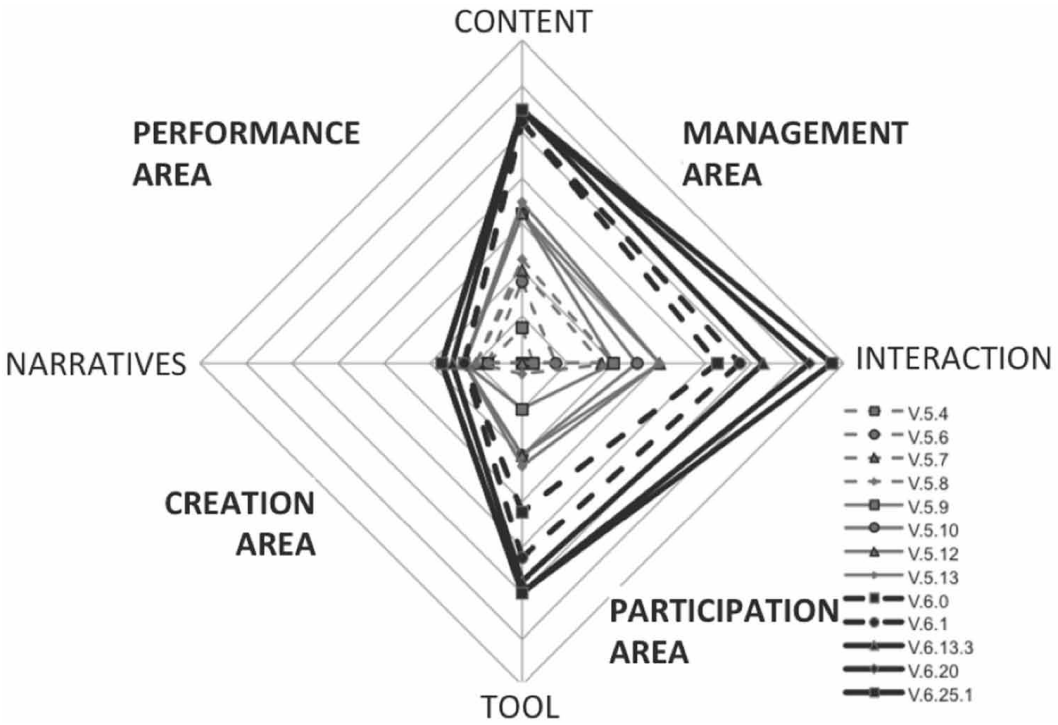


contemplation, intervention and conversation, hence they are located close to the middle point of the conceptual space. Furthermore, the model allows us locating a given app in a concrete place –according to the relevance of its features and the prevailing actions involved- and observing how it evolved through the conceptual space as long as its features changed in the consecutive software actualizations.

The model makes possible to visualize a drift of mobile applications towards the centre of the conceptual space: those applications from the creative and adapted areas progressively include more and more social interaction related features and instrumental functionalities. On the opposite side, those applications from the participation area progressively include more content related features. As a matter of example, the chart in Figure 4 depicts the score of the functional attributes[1] for the actualizations of Twitter app (in iOS) along the 13 versions updated from March 2013 to March 2015. It depicts a clear drift towards a functional relevance of content display and content management within an interaction driven app.

Some of the evolving consumption scenarios and the content formats emerging attached to them support these arguments. The growing importance of multiscreening (Google & Ypsos, 2012) and its semantic translation into transmedia narratives (Scolari, 2009) seem to be directly related to users' activity with content. The so called 'second screen apps' constitute a kind of software implementation for a consumption scenario that involves synchronising different content and social conversation related activities. Users have incorporated conventional media consumption (like watching TV series, sports or movies) to their mobile mediated social conversations in live time: for example, tweeting to friends about an episode of a favourite TV series in virtually co-present watching (Pew Research Centre, 2012). Content industries have turned their interest to mobile social networks and mobile applications as a new source for audience metrics (Noguera et alt., 2013) but also as a vehicle for promoting and expanding

Figure 4. Functional evolution of Twitter app during 2013-2015, from version 5.4 to version 6.25.1
Source: Elaborated by the authors



transmedia content (Scolari, 2009). Second screen apps contribute to systematize that integration between content and social interactions, be it connecting social conversation to a given content (like *The Walking Dead - Walkers Kill Count*, a social network game-like application about guessing the number of kills in an episode of the popular zombies' TV series-, providing extra content and information –like most of Disney's second screen apps-, promoting content related participation –like in the case of apps complementing media coverage of the last USA Presidential Election - or expanding stories in participatory terms –like 'twittersodes' that expand the story of TV series in the form of characters' conversations in which users can participate -.

Media users, in sum, increasingly conceive content as a part of their social interactions and, consequently as a matter to act upon, be it re-creating (transforming mainstream media content into forms of parody, irony, protest or support), co-creating (merging it into user generated content) or channelling (recommending, forwarding, commenting, etc.). This process that shifts content conception from the logic of seeing to the logic of doing poses a deeper connection between user identity and content consumption with two relevant consequences in both media and digital environments: it enters content consumption into the content distribution value chain and constitutes social relations as a specific object of cultural consumption.

PERSONAL INFORMATION AS A NEW VALUE DRIVER

In the previous sections we have outlined a conceptual background for the influence of mobile ecosystem's distribution structures and content formats in transforming conceptions about digital content consumption. But how this affects legacy media and digital industries from a business perspective? Describing mobile platforms as relevant players in a process of re-intermediation of cultural industries demands understanding why and how digital industries have embraced content business as an important part of their strategy. What has content business to offer digital players and what should legacy media learn form digital businesses?

Despite having substantially different business models, all of the big Internet companies –especially the so called "Internet Fantastic Four": Apple, Google, Amazon and Facebook- have rapidly become mobile centred companies giving strategic relevance to content aggregation and distribution (Manjoo, 2012). The central role content and media play in an e-commerce giant like Amazon needs no explanation. However, the convergence of the other Internet giants, with such different businesses like hardware (Apple), search engines (Google) or social networks (Facebook), may deserve a deeper look.

One relevant point these companies manifestly share is their effort to become the centre of a multiscreen platform, with mobile devices (smartphones and tablets) in its centre, but including in different degrees connected TV, desktop computers and game consoles, with cloud synchronisation and storage services (like iCloud, Amazon Cloud Drive or Google Drive) and OTT services (like Apple TV) above them. Amazon, for example, has developed a threefold strategy consisting of providing low-price hardware (Kindle Fire), an integrated distribution channel that complements Internet ecommerce portal (Amazon Appstore), and multi-screen content access (Amazon Instant Video, Amazon Game Studio), building a platform-like structure upon a tailored version of Android OS. Facebook, in turn, has adopted the shape of a platform-nested environment both in desktop and mobile devices, providing platform-like added services such as search, application store or content access (movies, games, etc.) under the umbrella of users' social ties.

One of the reasons for this strategic convergence over cultural content lies in the increasing importance of personal information in cross-device platforms. Data mining about users has become in the last five years a key aspect of Internet service companies (Acquisti, 2010): processing personal information and creating user profiles facilitates enhancing segmentation and adapting both advertising (like in Google and Facebook cases) and content or hardware supply (Amazon and Apple) to user profile and context (Punie, Lusoli, Centeno, Misuraca, & Broster, 2009; Manjoo, 2012). Information about user profile and user behaviour is not only the base for adaptive services in a context-addressed ubiquitous information environment. It is, at the same time, the main asset to support large scale selling or advertising based business models (Acquisti, 2010; Laurila et alt., 2013), including content distribution. For instance, in 2013 Google acquired Behavio, a company specialized in monitoring mobile devices activity (location, movement, proximity, app activity, etc.) and forecasting behavioural patterns. Facebook's strategy –integrating apps, search, browsing, contacts and social networks- is also addressed to settle an access ground to user behaviour without depending on the filters of other platforms, thus adding value to both its metrics and channels (Filloux, 2013).

Cultural content (entertainment, news, advertising, etc.) is a core element in everyday mobile activity: searching, creating, buying, sharing, commenting or simply consuming content (reading, watching or listening to) takes a big part of what we usually do with our smartphones or tablets (AOL-BBDO, 2012). Furthermore, cultural content plays an increasingly relevant role in our communications (Google & Ypsos, 2012; Bloem, van Doorm, Duivestein & Sjöström, 2012). Interviewed users –especially those aged under 45- agreed their attitude and expectations towards mobile device highly depended on content availability, even in the case of communicating to others. Natural behaviour around content becomes that way a valuable source of information not only about users and their world, but –precisely because of that- also about user attitudes towards devices, content, services and brands.

The personal and pervasive condition of mobile devices makes them extremely suitable as information gathering tools. Unlike desktop Internet user profiles, mobile user profiles are consistent (they are about a given user behaviour) (Aguado, 2012) and complex (they include context and location aware parameters). Pervasiveness and ubiquity considerably broaden the range of contextual scenarios in which information is both used and gathered. They also make possible to weave continuity and coherence among these different scenarios. The singular relation between mobile device and user, different from other digital devices, brings forth a specific horizon for both the operative and the economic value of personal information.

According to Acquisty (2010) and Feijóo & Gómez Barroso (2013), personal information involves data about users (user identification, like name, address, economic data derived from purchasing or banking, health related data, etc.) but also about what users do (behavioural information related to browsing, search, use of software and services, etc.) and information about how and when they use services (frequency, stickiness, etc.). Besides facilitating user profile coherence derived from processing usage activity, mobile devices provide additional relevant data concerning location and context related information, allowing to situate the 'how' and the 'when' in relation to behavioural and identity information.

By controlling software access to services, third party developers innovation (via SDKs and OS specifications), content distribution channels (via content and application stores) and hardware specifications (including built-in sensors), mobile platforms have a privileged position in accessing and managing not only mobile personal information. As long as the barriers between conventional Internet and mobile Internet dissolve, mobile platforms get a significant advantage in a cross-device ubiquitous information environment (Feijóo & Gómez Barroso, 2013). That concentration of the capacity to access and manage

personal information in the hands of mobile-centred Internet players disrupts digital business models and raises concerns about privacy protection and transparency (Xu, Rossom, Gupta & Carroll, 2012; Luchetta, 2013; Feijóo & Gómez Barroso, 2013).

EXPANDING DIGITAL CONTENT VALUE CHAIN

In the case of traditional media industries, involved as they are in their very digital transformation, all the above mentioned involves a radical change in the value chain of cultural content. Legacy media business model was characteristically content-centric media dependent. In short terms, content used to be the core and the end of the value creation process. Through controlling production and distribution, legacy media ensured the attention of wholesale audiences, which was in turn monetized in pay-per-access schemes or, more often, via advertising. The whole process ended up in content consumption: there was no value after content was read, watched or listened to. In order to maximize control over production and distribution, the whole productive structure was designed according to media requirements (printed paper, radio or screens), including expensive, complex –and often slow- distribution infrastructures. The confluence in the last decade of digital media development and financial crisis puts that model in serious troubles: the dramatic drop of advertising expenditure (Perry, 2012), the rigidity of over-sized media dependent production structures (Westlund, 2012) and the problems attached to licensing and intellectual property management (Punie, Lusoli, Centeno, Misuraca & Broster, 2009) seriously challenge the viability of conventional media industries.

Legacy media confront thus an urgent need of adaptation to deep changes in production, distribution and consumption. Because of the different structures, players and consumption scenarios that characterize digital environment, old media business models show important dysfunctions in that adaptation: digital advertising is less effective as a revenue source than it used to be traditional advertising, and pay-per-access formulas resist to work in a content saturated environment with hundreds or thousands of free access alternatives (Wolff, 2013). Digital environment, in addition, raises two disruptive conditions that alter the structure of legacy media business: de-materialization of content and its integration into users' social dynamics.

According to the general drift towards dematerialization that characterizes digitization (De Prato, Sanz & Simon, 2014), cultural content is becoming increasingly less constrained by the requirements of the médium and consequently more adaptable to a diversity of consumption scenarios. Dematerialized contents can be accessed through, and deployed in, different media (mobile devices, paper, big screens, etc.), whether in complementary or in alternative forms. New cross-media distribution models take advantage of this, and mobile platforms are becoming the basis for multidevice, malleable content circulation where controlling distribution channels becomes even more crucial. Cross-media distribution fosters (and is equally favoredby) cross-media consumption. The growing interest in transmedia storytelling (Scolari 2009) is connected with that transformation of content and its impact in distribution and consumption (Google & Ypsos 2012)

The second disruption factor coming along digitization and mobility is socialization. Mobile technology poses an increasing merge of media and communication that facilitates the integration of media into social dynamics. It is true that the internalization of media activities as a part of the social global conversation is not strictly speaking a new phenomenon: almost any media effects theory considers in one way or another how media activity gets into everyday life. Furthermore, commenting latest news

while having a coffee with colleagues or recommending a movie to friends are natural ways in which media become part of our social interactions. The difference now is that media related social interactions are not just *about* media, but rather *within* media, and they are taking place in the same digital environment (and often in the same consumption scenario) in which content is accessed and consumed. In other words, social interactions are attached to and share space with media consumption. From the perspective of media industries, this opens a brave new horizon of possibilities, expanding the value chain of cultural content to include what comes after (or around) content consumption. In this respect ubiquity, personalization, integration and pervasiveness are key characteristics that ensure a natural merge of media consumption and the social situations they take place in.

Social networks (and especially mobile social networks) contribute to create new added value for media. The merge of media use and social networks contributes to settle user information management as a relevant asset for digital cross-device oriented media (Purcell et alt, 2010; Noguera, Villy, Nyiro, De Blasio & Bourdaa, 2013). In that context, emerging media players tend to provide the highest number and diversity of possible interactions in order to gather intensive data about user behaviour. The effective management of user information allows tailoring services and products to user's profile and context and (b) it adds value to profiled advertising lowering costs and increasing efficiency through programmatic buying and through escalating inventories and buyers' networks (Feijóo, Gómez Barroso and Martínez, 2010).

However, social networks do not only constitute a new vein of personal information (that enhances content as a source of user data): as argued before, they are changing the focus of media consumption from passive reception to media related social interactions. This change in focus is not about media including (and getting advantage of) social interactions. It is rather the opposite: social interactions including (and getting advantage of) media. In other words, it is the social relationship that constitutes a valuable object of consumption (Noguera et alt., 2013). Media become interesting to the extent they contribute (as a language, as a topic, as an object of parody or emotional positioning, as a matter of re-creation and transformation) to the ritual of social interaction.

As a result of these disruption factors, the digital content value chain is being transformed as well. It is no longer a stable linear process of value creation with its core in distribution-focused legacy media companies. On the contrary, it is rapidly becoming a complex network of heterogeneous players coming from different ecosystems (telecom players, software industries, traditional media, users, new regulators…). The privileged position of some of these players (the so called Internet giants) in accessing end users through content distribution centred platforms drives a re-intermediation process in which legacy media looses its traditional control over audiences. In exchange, as content consumption and social interaction merge, new possibilities for value creation emerge.

Content consumption related social interactions contribute to expand content value chain at least in two ways. In first place, significantly amplifying the role of content consumption as personal information driver. Social conversation around content –and even the use of actual content narratives as a social language (Aguado & Martínez, 2010)- efficiently merges three relevant spheres of information about a person: identity presentation, personal contacts and socio-cultural situation (who you are, to whom you relate and what/where are you doing). As stated in section 3, enhancing the capacity to do things with content is a prerequisite to socially integrate content consumption in a ubiquitous communication environment. In second place, by merging content to social interactions users become a relevant distribution

channel. In fact, content curation, rating and sharing has become a relevant activity for social networking sites and apps. Some of them, like Facebook and Linkedin, are including content recommendation and curation functionalities. Similarly, some content curation oriented aggregators, such as Flipboard, are clearly shifting towards content centred social networking functionalities.

CONCLUDING REMARKS

The impact of the development of a platform centred mobile ecosystem has contributed in a relevant way to shape the horizon of problems and challenges that legacy media and traditional content industries face in adapting to the digital environment (Aguado, Feijóo & Martínez, 2012). The kind of transformations induced by the mobile ecosystem is not limited to diffusion related aspects commonly considered, like mobile device penetration or content access normalisation. Mobile ecosystem evolution is actively contributing to change the nature of players involved in the digital content value chain and the structure of strategic relationships among them (Feijóo, Lindmark et alt., 2013). These changes result as well from a mobile-grounded transformation in users' conception about digital content consumption (Aguado, 2013). This transformation is marked by aspects like intervention capacity and content integration into social interactions, which support the consolidation of content mediated social interactions as an emerging form of cultural consumption. Three main innovation vectors condense these changes:

Firstly, the implementation of new distribution systems, characteristically shaped by the pattern of mobile application stores, which constitute the core of the mobile content ecosystem, disrupts traditional content intermediation structures. The so called 'platformisation' (Ballon, 2009) over application oriented environments favours a re-intermediation processes by means of which legacy media are displaced from value attached relevant positions and raises a category of cloud-based, multi-device accessible and medium independent content that challenges the viability of advertising or copy-centred pay-per-access based traditional business models.

In a complementary way to that, new distribution models and new software based content formats facilitate the redefinition of users' perception about valuable cultural content, driving new content formats that take advantage of the mobile/digital ecosystem's possibilities (integrating user's activity with content, adapting content to user's situation and context, etc.). The consolidation of mobile applications as a prevalent interface involves in this respect a shift from a 'seeing-oriented' logic to a 'doing-oriented logic' that particularly fits mobile's characteristic relational and context-attached nature and constitutes a user-centric environment –instead of the traditional producer-centric one (Westlund, 2012). The application of taxonomy oriented conceptual model for the functional analysis of mobile content applications (Scolari, Aguado & Feijóo, 2013) supports the observation of a shift in mobile content consumption from a contemplation paradigm to an intervention paradigm. This shift allows expanding traditional content value chain by including user activity with content (sharing, transforming, commenting, etc.) into monetizable digital processes (Noguera et alt., 2013).

Finally, the integration of what users do with content into cultural content value chain is implemented upon the availability of personal information and the capacity of digital players to process this information in the forms of profiles that enhance the identity and situation driven adaptation of advertising, products and services (Feijóo & Gómez-Barroso, 2013).

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KEY TERMS AND DEFINITIONS

Consumption Scenarios: A consumption scenarios involves the physical, social and symbolic aspects of a situated content consumption by a user. In its physical aspect, it includes hardware, software, and the usual spaces (public or private) in which it is supposed to take place. The social dimension of a consumption scenario includes presupposed rituals and roles, whereas the symbolic dimension involves meaning frameworks and values.

Ecosystem: Referred to techno-economic environments, like the mobile communications one, an ecosystem is here understood as a complex net of interdependent players and environmental factors that (through co-operation and competition) internally generates its own order. The ICT ecosystem, for instance, would include four characteristic layers that group along diverse functions different groups of players: Equipment providers, network operators, content and applications providers, and users.

Interface: Any kind of meaning-action frames that presuppose and connect users (intentions, attitudes and competences), actions and objects of action (tokens) in a coherent and meaningful way (including pragmatic recipes and expectable results).

Mobile Content Applications: Any mobile application whose identifying functions are address to operate about content in terms of performance, creation, management or participation.

Personal Information: Personal information or personal data refer to all those data derived from the digital identity, digital records and online or off-line activities of a given user. Mobile personal information includes also data obtained from the mobile devices' built in sensors (thus converting off-line activities, like walking or running, location, etc., in digital information). According to different policy and regulation traditions, personal data can be understood in either restricted or expanded conception. The restricted conception refers to that information strictly related to digital identity and personal records (like financial parameters, health records, etc.). The expanded conception of personal data includes data derived from what users do (buying, searching, playing, navigating…), how they do and where or when they do, regardless if this is connected or not to digital identity. Digital profiles are coherent sets of personal data.

Platformisation: It refers to the process in which ICT players tend to group together, in a loose or tight scheme, all of the required roles for a common set of hardware, software and other techno-economic specifications. In the mobile environment, since 2007, platforms have been gaining increasing relevance around OS and hardware providers. Apple's iOS and Google's Android are examples of software based mobile platforms.

Value Chain: A value chain or a value network identifies the process, players and relations involved in the creation of value around a given product or service, and how this value is distributed amongst the different players.

ENDNOTE

[1] The scoring model is an adaptation of functional content analysis in which the different actualization items are attributed binary values (0,5 to 1). Versions and actualization items not directly dealing with content (such as "adaptation to retina display" or "minor bug solving") were not considered.

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Chapter 77
Change Management in Information Asset

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ABSTRACT

We are passing through information age with lightning communication speed. Information asset storage in Cloud and retrieval in the net has become the new invisible corporate voyage into the information space. Information Assets are a valuable source of Knowledge for both Information asset creator as well as the user. These are fluid assets that change overtime based on several internal and environmental factors! This paper seeks to address these aspects of Change that impacts such "fluid" Information Assets and the need to raise up to the changing expectations of the millions of users by satisfying the ever growing information hungry businesses. Providing unreliable information and sub-optimal analytical tools can destroy the user in the first instance and can lead to self-destruction as Information asset provider will find no takers in the long run. In this context this assorted information on Change management is chosen carefully and it is hoped, will benefit the reader who may be a technical expert in his field.

1. INTRODUCTION

Information in any form has been recognised as an asset, now come to be known as, "Information Asset". "An information asset is a body of knowledge that is organized and managed as a single entity". Change is a major threat to the Information asset and key risk to digital continuity. Information can have a short lifecycle and tends to depreciate over time based on the type of information the asset represents, and how accurate the information can remain over time. Its value increases in direct relationship to the number of people who need the information in question. Some information assets an organization carries leave organizational foot prints for the competitors to follow and hence must be preserved from public domain. It is clear in the business world by now that a business seems to be run not just from boardroom but from the offices of the software industry you chose to associate.

Information loafing in files that cannot be used is considered to be a liability in certain cases or could have archaic value for future reference for some others. Such information could still be useful to

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competitors, and should be managed or destroyed as per a pre-decided schedule and method—depending on the confidentiality classification and future use.

Hence information gatherers and generators need to be careful while dealing with data or/and information. Cloud computing techniques have come handy in such cases to keep engaging the information scientists and users to draw from the cloud the needed information by means of "just-in-time" techniques instead of carrying the information load in their hardware systems.

Information asset assumes various forms over time starting as mere data and undergoes metamorphosis in a way. Such data resides in various physical forms/resides in devices or other component of the environment that supports information based activities as well as in invisible form when encrypted. A simple data can generate various forms of information to the analysts at different points of time and means differently for different users at various points in time and mercurial in nature. Corporates invest huge amounts in not only collecting and collating such data but also for its security from illicit access, disclosure, alteration, destruction and/or theft when the data is residing in any device or moving to various domains through networking. The information security mission is to ensure the confidentiality, integrity, availability of information assets when needed. This needs pro-acting by imaging possible threat sequences and taking counter measures like firewall and encryptions of data. This is change management from illicit data manipulation. When performing risk analysis, it is important to weigh how much to spend protecting each asset against cost of losing the asset. Probability of loss occurrence, intangible costs involved are factored thereon. Intangible costs may take various forms like loss of reputation to punitive measures taken by the user. I.T information risk management has evolved into a huge important area today. Attrition in the IT Sector is a big risk and Change mangers should guard companies from this factor by ensuring proper documentation of their works and with sound HR policies.

One of the most important aspects of information management is to understand the implications of change on the information asset. Changes in IT lead to innovation, new business models and services. Change management and how people deal with it has gained attention across various fields. Finding effective ways for managing the process of changes is key to success in a highly competitive/global business environment.

There are two types of change management programs:

- Systematic organization-wide change initiative that involves an organization-wide transformation effort.
- Specific internal change management or change control program that involves providing tools and processes to control daily operational or project-specific changes.

Change management differs from project management in its ultimate objective. The process of how organizations change draws on many disciplines from psychology and behavioural science to engineering and systems thinking is intriguing. The underlying principle is that change does not happen in isolation. It impacts the whole organization and each individual associated with it.

Information asset is a broad expression and is in a perpetual cycle of change. This paper seeks to study only change management perspectives of lasting value at corporate level and omits all discussion and models dealing with routine change matters or project management/ operational changes. For example, iPhones or Windows software is passing through frequent changes based on certain critical parameters like speed, user friendliness, information management routines it deals with, connectivity or power to hear/battery power or spread across various media or camera lens/photo making capability

or some other intrinsic capability, physical features changes or compliance matters etc. Of course these products modifications/ upgradations constantly take place to stay and compete in the market. But we do not deal with these in this paper.

This paper seeks to study the impact of change on information asset by trying to argue that information managers and owners must welcome change and become change agents instead of trying to avert change to retain information asset as a static body and a lifeless tool in the hands of its users. Change management seeks to adapt to positive change signals at the same pace at which change occurs and mitigates the impact of negative signals by delaying the process of negative change in order to avert damage. It must be realized in this context that the phenomenon called *Change* is enforced mostly due to factors outside the organization on which only proactive change leaders have a prior understanding in an otherwise dormant social system. Change takes place to avert an impending environmental threat in many cases.

Sometimes experience carries the Change from one company to another when people migrate. Before we analyse impact of change on information assets let us first understand what constitute an information asset based upon some published literature.

The rest of the paper is organized as follows. The aspects of information assets and the various technological changes that have occurred over the past decade is covered in Section 2. In Section 3 some interesting existing models of change management are discussed. Section 4 proposes a new model for change management of information assets. Further, the study concludes with conclusion and future research in section 5.

2. LITERATURE REVIEW

2.1. What Is an Information Asset?

The major steps required for asset classification and controls are:

These steps were elucidated as under:

2.1.1. Identification of Assets

What are Information Assets? (Bulgurcu, Cavusoglu, & Benbasat, 2010).

Information assets are grouped by Information Asset Development, Inc. as under

1. End User (external) Information Assets,
2. End User (internal) Information Assets,
3. Business Process Information Assets,
4. Client Staff Information Assets (training, participation and execution).

IT Assets are seen as under:

1. Information assets,
2. Software assets:
    a. Application software,
    b. System software,

3. Physical assets,
4. Services.

The next question is What are the critical assets? This needs an answer to take decisions regarding ownership, acquisition, retention, providing budgets to encircle with security cover for the assets, back up policy etc.

2.1.2. Accountability of Assets

The next step is to establish accountability of assets. This is not difficult for the tangible assets like physical assets. A more difficult task is establishing ownership for the information assets. There will be a number of users for these assets. But the prime responsibility for accuracy will lie with the asset owner and any addition or modification to the information asset will only be done with the consent of the asset owner. Information technology staff will can only make the changes (Government of Alberta. 2004), physically with the consent of its owner. But ownership clearly lies with the business head who has the prime responsibility for the content in the customer database. (Cabinet Office.2013). Using such criteria, we need to identify the actual owners of each of the information assets. Only an owner of the asset will be able to decide the business value of the asset and we cannot identify the security requirement of the asset without its value.

The next step is identifying owners of the application software. Application software implements the business rules. As such the business process owner should be the owner of application software. But the responsibility of maintaining application software to accurately reflect business rules will be vested with the application developers. As such, the accountability for application software should be with the application development manager.

System software ownership could be with the appropriate persons within the IT team. The owner of these assets will be responsible for maintaining all the system software including protecting the organization against software piracy (Kang, Donohoe, Koh et al., 2002)

2.1.2.1. Assets Valuation

What is the value of an asset? Is it replacement cost or written down value? Or is it its utility value? A seemingly small item may be immensely difficult to replace today. True value of the asset will lead us to identify realistic measures needed for protection of the asset.

2.1.3. Preparing a Schema for Classification

The next task is to create classification levels. The criteria for the classification of assets could be in terms of:

1. Confidential
2. Company only
3. Shared
4. Unclassified

Classification based on value could be high, medium or low value. A detailed explanation should be prepared giving the reasoning for this classification. A critical component costing a few rupees may be a very high value item as it is not easily available and could stop the production of a high cost item.

Access rights need to be defined for individuals as well as groups. Who is cleared to access confidential information in the organization? And who decides the access rights? Logically, it will be the asset owner who will decide these access rights.

Destruction should be a scheduled and controlled activity. The information that is no longer needed by the company but which could still be useful to competitors, should be destroyed as per a pre-decided schedule and method—depending on the confidentiality classification. For information recorded on hard disk, mere deletion of files does not obliterate information. A more stringent procedure like multiple overwriting may be needed.

Classification schema should lead to an implementable structure. It should be simple to understand and identify.

2.1.4. Implementation of the Classification Schema

The real test of classification schema is when it is implemented. Information is a fluid resource. It keeps changing its form. The implementation should lead to a uniform way of identifying the information so that a uniform protection could be provided.

Asset classification is thus the key to various security controls that need to be implemented for asset protection.

2.1.4.1. How are Information Assets Valuable to a Company?

Information Assets serve to quantify and qualify business process, function and development. Information Assets remove ambiguity among multiple Information users. Information Assets serve as a means of benchmarking products and services.

Information Assets promote effective corporate communication. Information Assets enable organizational efficiency. Information Assets can be used to support PDM, NPI, ERP, CRM and MRP applications.

2.2. The First “Change” Impact on Information Assets

A book “Computers in Crisis” by Jerome and Marilyn Murray published in 1984 triggered discussion among USENET groups and among a slew of earlier slow motion Internet users and snowballed into a sort of fear psychosis among CEOs by 1990s that all software would reset itself on 1 January 2000 including that deals with time and space. Unaddressed, this would collapse the information assets of all (Ho & Smith, 2001). and 1 January 2000 will be a doomsday for all businesses in general and public opinion on software industry would touch its lowest mark. Businesses were set up to address this impending crisis known as Y2K (Year 2000). We all know, the danger was averted thanks to the millions of newly born ‘software engineers’. In the history of businesses all over the globe no other change management program has galvanised businesses like Y2K bug did. A global disaster was averted by change management of Information Assets belonging to successful or sick organizations, and big or small entities alike. The lesson we learnt here was that Change management requires not only strategy and organizational change

but rapid adoption of quickly found lasting solutions that can beat the speed with which change occurs. Change in Y2K scenario demanded no less than swift action on short notice. The problem was simple -

Earlier Computer Programs were designed to abbreviate four-digit year say 1999 as two digits '99' .to save on memory space. These computers recognise 99 as 1999 but would be unable to recognise 00 as 2000. So by mid-night of 31 Dec 1999 software needed rapid repair or revision or replacement. Projected data malfunctions unless software changes are made rapidly. Banks would collapse if Y2K bug remains on computer. Even computer chips needed replacement in all automated CNC systems like Elevators, Temperature controllers, Medical and Industrial Machinery, Air Crafts etc. Over $300 billion was spent. Even Auditors needed to collect from all clients Y2K Compliance certificates and declarations. Ultimately, 'Millennium bug' was cleared. Y2K thus come to be known as first change management in the information asset.

2.3. Collecting Right Data

Information assets acquisitions, and maintenance involves huge costs. Thus it is important that managers must first concentrate on collecting right data before applying analytical tools to draw information from the data. False metric's lead nowhere. For example, in a digital marketing scenario one should not be carried away by counting on millions of Facebook followers or millions of viewers as prospective customers. Here the challenge is to acquire prospective customers, drive the customer traffic, digital experience or converting the traffic and retention or keeping consumers returning in a cyclical manner. It's a sort of football game with customers or visitors of the webpage bringing them to the goal post of actual purchasing of goods on the digital platform. Call centres, email messages or SMS or loyalty rewards are all to keep customers engaged on the product you promote. Customer Analytics needs a different diagnostic to count on 'recency'-how recently (Ho & Smith, 2001). and how frequently such 'customer' has actually bought (Blanchard, Messatfa, Lorin, 2009). What we need to compute is realised customer value(RCV) of each and every customer. This needs analysis of customer mobilization costs and customer-wise contribution analysis. This analysis lead to new information on sales returns opted by customers based on existing policy and paved the way for evolving new exchange/return and rewarding policy (Russo & Lancaster, 1995).

In another case if you were to collect data on audience response for advertisements in a news channel, (Russo, J. M., & Lancaster, D. R. 1995) you would first classify viewers into "watchholics," at the highest end of the scale of viewers, followed by casual viewers, international viewers and passive viewers or "workholics" at the lower end. This is done by analysts based on 'cluster analysis'. To keep the watchholics engaged being high-valued customer group, direct email contacts, and SMS notifications etc. were tried. But in the same breath while analytics tried on 'workholics' data, it was revealed that they were selective viewers based on inputs of broadcast schedule from the home page news channel's website. Armed with this insight, if analyst created a collection function, placed near the schedule, so users could enter their email address to be notified when favourite shows were airing, it would of course have yielded valuable information about these previously anonymous users. It was reported that one famous news channel in USA did the same and concluded "It flipped the valuation curve a little bit on its head, because while I was supporting the hundred-plus million-dollar digital business, the reality is that the billion-dollar business was within the passive users that were actually driving broadcast eyeballs," analyst reported. This means right data collection and intelligent analysis are drivers of this information age.

This means we need to conclude that a data is correct only after testing the data through suitable analytics. There after 'right data' is retained and basic data preserved in the cloud?

Change management requires that both service providers as well as service takers need to be on constant whistle and acquire right skills or provide right services. It is clear in the business world by now that a business seems to be run not just from boardroom but from the offices of the software industry you chose to associate. This is due to the fact that technology is the driver that controls the value chain in a sense as technological developments and upgradations impact the way businesses are conducted. Competitions and differentiation is now being rested on technological revolutionary changes and not just on the products corporates innovate. Communication of new product concepts holds the key and this is pocketed by owners of 'constantly changing technological developments'. Dynamic pricing, digital marketing, banking styles and methods and even governance is rendered technology dependent. Businesses have driven technologies for their growth and existence and it is now the turn of technologies to lead businesses by constantly providing inputs in the supply chain and financing. Reconciling to this reality, one must pro-act as to what changes are in vogue and what technological innovations will keep the businesses float.

"Net neutrality" has provided a ray of hope for learners with poor background to acquire technologies and remain visible on the net.

In short, the future of work of many will be at stake and move them away from the value chain cycle if right technologies are not acquired by the workforce. Even acquiring a language at the right time can help them remain with the employer due to perhaps some export commitments the employer did. It is different to say that a singer or a dancer or a musician or a journalist/writer can survive with his innate skills and is not influenced by technological innovations. He keeps engaging by being available to the new technological platform and perform the same old art. But what about the millions who do not have such skills. Similarly, if corporates redefine their business by saying 'our business is to take care of our shareholders and not all stakeholders"?

All this argument drives us to the fact that the future hangs on large scale businesses who can afford all this change and bundled up into change agents. It remains to be seen whether these large business houses remotely run governance of a country. But one ray of hope hinges on all employees that as long as they remain cheaper, they tend to get hired. But slowly even this hope is dwindling as cheap labour can become costlier when they tend to handle unknown technologies!

2.4. Internet of Things (IOT)

The next big thing in technological changes that would influence industries is Internet of things and the information flow from this leading to new ways of conducting businesses. IOT, it is said can help businesses to increase productivity, cut costs, improve products and offer new products/services and press into force new business models. IOT needs technology integration and skilled staff for implementation. (Xia, Yang, Wang et al., 2012). Even a simple plumber and service provider for household goods needs to upgrade and get trained. In a paper published in Wharton Journal experts from Wharton and Dell Digital Business Services argue why companies cannot ignore IOT in the digital age to gain competitive advantage." It also often creates new demands around security and interoperability — the capacity for varied computer systems and applications to "talk" with each other" the experts aver (Xia, Yang, Wang et al., 2012). "Across the world, everyday devices are getting connected to the Internet — thermostats, water meters, home alarms, kitchen gadgets, medical equipment, factory machinery and even cars. Col-

lectively, this ecosystem represents the next frontier in the digital revolution — the Internet of Things or IoT. And unlike the simple automation of machinery, IoT is also mobile and virtual, and features a continuous Internet connection (Wortmann & Flüchter, 2015).

The IoT ecosystem consists of data sensors, networks, cloud storage, applications and devices, all working together to help companies and consumers manage their digital lives in a smarter way:

"By converting all passive things around us to active things that share information about themselves, IoT enables us to understand them better than ever before and thereby helps us to bring about huge improvements in everything we do," says Raman Sapra, global head of Dell's digital business services unit. IoT will also drive the next level of digital adoption across consumer industries, manufacturing, supply chain and other areas. "This in turn will result in operational excellence, new revenue models, enhanced employee engagement and a superior customer experience," he adds. (Nah, Lau, & Kuang, 2001).

The story of John Deere, who developed the first commercially successful, self-scouring steel plow, closely parallels the settlement and development of the mid-western United States. He offers a case in point. "The company has been making steel ploughs since 1837 and the name brand is synonymous with farming and tractors in the U.S. But beginning in 2012, John Deere embedded new sensors in its products and marketed connectivity as a key product benefit (Ashton, 2009). Today, those sensors provide farms with decision-support information on where to plow, what crops to plant and when to plant. That information is potentially more valuable over time than the tractor pulling the plow" it was stated in the Journal of Wharton.

IoT works in real time to provide massive amounts of data with great precision. It can help synchronize connectivity when it gets integrated into an organization's enterprise systems, such as enterprise resource planning (ERP), customer relationship management (CRM) and product lifecycle management (PLM). Ajay Jasti, practice leader of IoT at Dell digital business services, agrees that IoT will result in "new products, new services, new business models and enhanced customer experience."

"A German manufacturer of optical microscopes, for example, saved more than $500,000 annually by avoiding 400 on-site visits using an IoT model. Predictive maintenance, meanwhile, can mean fewer claims on warranties, while less downtime for customers means improved customer satisfaction, leading to repeat business". The paper in citation above states. Similarly, in a Hotel, if IOT is implemented sensors would alert to switch off and switch on HVAC systems and other systems to save on unnecessary power bills and save on costs.

IOT has some problems too like security breach and threats from Hackers to make systems collapse. Even disgruntled employees can resort to these games to invalidate systems.

2.5. Change Management Demands From External Environment

The objective of change management in this context is to ensure that standardized methods and procedures are used for efficient and prompt handling of all changes to control IT infrastructure, in order to minimize the number and impact of any related incidents upon service. Changes in the IT infrastructure may arise reactively in response to problems or externally imposed requirements, e.g. legislative changes, or proactively from seeking improved efficiency and effectiveness or to enable or reflect business initiatives, or from programs, projects or service improvement initiatives. Change Management can ensure standardized methods, processes and procedures which are used for all changes, facilitate efficient and prompt handling of all changes, and maintain the proper balance between the need for change and the potential detrimental impact of changes (Bloodgood, & Salisbury, 2001). Existing academic research

has paid little attention to the fact that external variables have contributed to a disjointed process of organizational reform. When the issue of change has been examined within the public safety and security context, it has most often focused at the micro-level.

2.5.1. Understanding Change

We used the expression 'change" in many contexts above. It is time we understand the essence of Change before we think of managing change by trying to be ahead of it or in order to invent change. Infinity and uncertainty are the parents of Change that is growing into the future! If you can't find it invent it and become the change maker or change leader!

2.5.1.1. Genesis of Change

Change can occur in any one or all or some of the following forms at different times or at the same time. Change includes original form of change due to environmental change or due to strategy revision necessitated by external factors or due to correcting missed out factors in the original strategy considerations. It also includes change within the organization, which is made in response to another change. Buckley and Perkins in 1984 advocated that 'change' and 'transformation' vary in that change is gradual and small, whereas transformation is change on a significant scale. Transformation in organization (major overhaul in job definitions, reporting lines etc.), transformation in the way the system operates (communication, processes and working relationship), transformation in employee consciousness (beliefs, myths, attitudes, experienced etc.) is all on a significant scale. Managing change is not a matter of applying standard solutions to standard problems. Well-informed and well-motivated individuals can bring out successful change and there are no standard tools to counter change or implement change. Diagnosis of a situation holds the key for deciding among the best alternatives to manage the change. Surveys, team-building activities, inter group activities; efforts to change corporate culture have one thing in common- change management by trying to pro-act *(*Stevens, Caralli, & Willke, 2005). In his book on 'Management Challenges for the 21st Century' Peter F. Drucker identified the following as the new certainties: These are change agents, modified and presented as under.

Change in composition of demographic influences in the market Accordingly, product mix, production processes, R&D efforts, marketing strategy and corporate strategy, business mix and mission, social mission etc. keep changing.

Shifts in the distribution of disposable income are certain. During 21st century the impact of the above on the industry of any kind has to be understood by clarifying what do we mean by a 'growth', 'mature' and 'declining' industry. A growth industry may be understood as one in which the demand for its products grow faster than national income and/or population.

If such factors are equal, it is a mature industry and if the demand for its products does not grow at the pace at which its income/ population grows, you are hitting a declining industry even if its absolute sales volume still continues to grow. This industry composition varies from one country to another and hence globalization is resorted to in order to give new lease of life to a declining industry of one country to enter growth phase of another country. Financial services, BPO, Information technology and the ever green power sector and water management and agriculture/food sector health care and education become the key investment areas apart from infrastructure based adventures. One sign of decline is that products will become commodities and cost reduction and improvement in quality will be demanded

keeping the managements in a big dilemma whether to invest in R&D or not. This is the reason for global competition will increase since MNCs revolve around countries that have population with growth trends in distributional/ disposable income and apply strategies to squeeze the purse (Ćirić, & Raković, 2010).

How 'performance' is defined and measured varies over time. But ultimately, 'power follows property' and businesses follow performance.

Global competitiveness: The growing incongruence between economic globalization and political splintering.

2.5.1.2. The Flow of Change

- Environment
- Product mix and services it opts to provide
- Technology and working methods
- HR policy changes
- Organization Structure or size

2.5.1.3. Change, Its Nature

Changes can be brought about or thrust on an organization in different ways.

- *New Technology*
- *Reorganization*
- *Working conditions*
- *Change in personnel policies and management styles and communication channels*

It has been established by Burns and Stalker's theories on mechanistic and organic organizations that nature of organizations destines dealings with change.

Effectiveness over elapse of time during the organizational life cycle is the true test. Organizations go through phases of set up, growth in size and scope, slackness in expansion showing signs of ensuing maturity and decline. But such a life cycle may not occur as a rule. The Sigmoid Curve shown below predicts that a corporate would be inclined for change only if decline is certain and in the midst of crisis at point B. But some of the wise managements would act if needed even at point A of upward growth phase in the cycle showing signs of another Sigmoid Curve at A. This leads them into survival and growth.

Apple Computers even though invented first PC with Macintosh user-friendly interface, did not license its technology to others for long and thus failed to set any benchmark. On the other hand, a later entry Microsoft kept off from hardware and went ahead licensing its MS DOSS and Windows. Globalization demanded change and companies that have slept on this never woke up. Successful companies remain at high peak when they practice the acrobat of walking over the waves of the change perpetually! (Engelsman, 2007).

2.5.1.4. Growth Is Also Change

The price of success is growth. If success is not followed by growth, success sinks successful people or organizations.

Greiner (1972, 1998) describes how companies go through a series of phases as they grow. Greiner growth model postulates:

Phase 1: Growth through Creativity.
Phase 2: Growth through Direction.
Phase 3: Growth through Delegation.
Phase 4: Growth through Coordination.
Phase 5: Growth through Collaboration.

Quin argued for logical incremental change, suggesting change management takes place around the need for change in the environment and not through any rhythmic life cycle stated above. Greiner's model of life cycle theory is not reflective of real life situations, though provides some broad perspectives. For example, mergers, setting JVs might skip some early phases. Also growth and effectiveness are different perspectives. (Terra & Gordon, 2003)

2.5.1.5. Issues of Size Have Started Sizzling!

Size has become a hot topic. Change management styles and comforts rest on size of companies.

Smaller size organizations have certain advantages but have proved a failure in handling change.

2.1.5.6. Laddering the Change

When occurrence of Change is an uncontrollable factor, wise managements try to convert this 'threat' as 'opportunity' by pro-acting or laddering the change phenomenon. By pro- acting we mean by initiating the change process on yourself before it is dictated by circumstances. This needs continuous interaction with the environment and introspection with in. To ladder the change, the way you want the following strategy has been proven to be useful. (20)

1. Determine the need or desire for change in a specific area by analysing the elements that trigger change. For example, E-Merk a pharmaceutical company accelerated change by making a strategic alliance with a service provider. Similarly, see the Time Warner merger and Tata Tea and Tetley merger, where their managements pre-empt the change event by inviting the change of themselves instead of waiting for things to happen. This is what we mean by change management (Pandya, Singh, Mittelstaedt et al., 2004).
2. Prepare a tentative plan by examining alternatives to avert the possible change or find rolling up of slow change events into one big alternative.
3. Analyse probable reactions to Change.
4. Bring out alternative strategies and make a firm choice.
5. Define and evolve a time frame with in which change should be landed in various parts of the organization. (Möller & Svahn, 2006).
6. If change is thrust, time frame has no relevance for initiating change management and in such cases immediate action to counter or damage control change is imminent. However, time frame to conclude the change may also be difficult, if such change management becomes continuous. For example, automation of inventory control system or production process can be taken up on a pilot project basis before shifting to total automation of the whole company. Similarly, automation in a bank can be implemented among some selected branches before going for all round automation.

7. Similarly, divestiture of various divisions can be taken up on a step-by-step basis, by first initiating action in one division. Implement the change by continuously reviewing the change process, evaluating various alternatives and incorporating best suitable model relative to the demands of the changing scenario.
8. Organizational changes and change management must be in line with the strategic plan and must fit into strategic formulation process, so change management is integrated into the total strategic framework.

2.4.2. Change and Corporate Culture

Cultural change involves identifying and exposing hidden assumptions of the new culture, trying to identify the conflicts and devise mechanisms for change.

2.4.2.1. The Change Leaders

Change leaders must know why Change fails. Allowing too much complacency, failing to create the required guiding coalition, under estimating visionary outlook, playing into obstacles that block vision, keeping off vision from tasks and doers, failing to create mile stones as short term wins, declaring victory sooner than when it's really won, neglecting to anchor/not just embed changes firmly in the corporate culture, neglecting the HR factor have all contributed to failure among other at all cross roads of change. Change leaders require according to Peter F. Drucker some of the following: Policies to make the future and build future by abandoning past.

1. Organized Improvement.
2. Exploiting success.
3. Systematic methods to look for and anticipate change by innovation.
4. The right way to introduce changes, both within and outside the organization.
5. Policies to balance change and continuity.

2.4.3. How to Implement Change? (Kotter and Cohen, 2005)

Understand the change perspective and dimension and explore piloting change. Implemented as pilot project sometimes helps accomplishing a win-win situation. Establish sense of urgency and take up issues on war footing. Core the challenge and becoming change agents. Create a guiding coalition: Match right people for choicest tasks. Team them up. Ensure the team develop a creative strategic vision and net around it the strategies: Move beyond the numbers game and conceptualize and create. Ensure the team address the creative components of vision and develop the right vision and strategy for the change effort.

Communicate the change vision to all concerned and allow work in transparency and buy change and fly with all its wings. (Markus, & Robey, 1988). Empower broad based action by removing key obstacles and create systems to encourage the team to act and follow visionary change along the strategic path. Real change requires people to adjust their behaviour, and that behaviour is often beyond the control of top management.

Create short-term goals and winnings short enough to energize the change helpers enlighten pessimists, defuse the cynics and doubting Thomas and build momentum for the effort. Fewer resist the change

process and goals. Years of study and experience have shown that the things that sustain change are not bold strokes but long marches. So one has to consolidate gains and move forward until vision is realized.

Anchor new approaches in the culture by creating a supporting structure that provides roots for the new ways of operating. New and winning behaviour need to continue despite pulls of tradition, turnover of change leaders etc.

The next section brings to light some unique existing models for change management of information assets.

3. EXISTING CHANGE MODELS

In order to handle effectively change management of information assets, there are several existing frameworks or models i.e. over 30 are known of which we have listed commonly used 21 for consideration of user' assessment. They are:

1. Kotter's 8 Steps.
2. Change Equation.
3. Prosci's ADKAR (Awareness, Desire, Knowledge, Ability, and Reinforcement) Model.
4. Leadership Change Model.
5. PDCA / Kaizen.
6. Efficacy-Based Change Model.
7. Meaning-Making Change Adaptation Model (MCAM).
8. Bolman & Deal's Reframing Change Model (Four-Frame Model).
9. Swedish Organizational Change Model.
10. Jick's 10 Step Process for Implementing Change.
11. Garvin/GE's change model.
12. FEEL IT.
13. Satir Change Model.
14. Dynamic Stability (Eric Abrahamson).
15. Tichy's TPC (Technical, Political, Cultural) Framework.
16. Burke-Litwin Model.
17. Bridges' Transition Model.
18. Evaluation, Re-evaluation & Action (ERA) Model.
19. Trans theoretical Model of Change (TTM).
20. Osborne and Plastrik's 5 Cs.
21. Lewin/ Schein's three-stage process.

In this paper, we attempt to deal with some of these models only.

3.1. ADKAR Model (Awareness, Desire, Knowledge, Ability, and Reinforcement)

The objectives of this model are:

1. To provide and guide the stakeholders during process of change or transitioning while the change management is taking place.
2. To diagnose and treat the resistance shown by employees towards change.
3. To come up with goal congruence in employees with organization during the change.

3.1.1. Benefits of ADKAR Model

- The model offers the capability of Identification and evaluation of the reasons why changes made are not working and why desired results are not being obtained.
- The model makes it possible for one to break the changes into different parts and then figure out the point where change may not be as effective as planned.
- It offers both business dimension of change as well as people dimension of change.
- When applied to organizational change, this model allows leaders and change management teams to focus their activities on what will drive individual change and therefore achieve desired organizational results.
- ADKAR provides clear goals and outcomes for change management activities.
- It provides a simple, easy-to-use framework for everyone in the organization to think about change.
- Employees, managers and senior leaders alike can all use ADKAR to describe and discuss change together.

3.2. Lewin/ Schein's Three-Stage Process to Change

It is common knowledge that experience is rewarded if it is coupled with accomplishing desired results. Specific managerial skills and team work is Organizational Capital. But there are situations where experience will no more be bliss and becomes a curse! Learning in the words of John Hunt involves not only re-learning but also trying to unlearn what is already known. In some cases, change requires such unlearning and demands fresh learning. Lewin/ Schein's three-stage process to changing human behavior is depicted in Figure 1.

Figure 1. Three-stage process of change

3.3. DICE Model

In their illuminating article "The Hard side of Change management" Harold L. Sirkin, Perry Keenan, Alan Jackson have brought out four key factors which were guarded in most of the successful projects. These are Duration, Integrity, Commitment and Effort (DICE) (The Hard Side of Change Management.2005).

In their words:

D. The duration of time until the change program is completed if it has a short life span; if not short, the amount of time between reviews of milestones.

I. The project team's performance integrity; that is, its ability to complete the initiative on time. That depends on members' skills and traits relative to the project's requirements.

C. The commitment to change that top management (C1) and employees affected by the change (C2) display.

E. The effort over and above the usual work that the change initiative demands of employees.

They suggested a method to evaluate the success of the project based on DICE score which is awarded by the executives based on a set of questions put to them covering each of the four factors. The executive must grade each factor on a scale from 1 to 4 (fractions no bar), and lower the score the better it is about positive outcome that the factor is important for project success.

DICE SCORE = D+(2*I) + (2*C^1) +C^2+E; where C^1 is senior manager level commitment and C^2 is commitment at local level.

Scores were categorised as WIN zone, WORRY zone and WOE zone depending on the scores in the DICE factor score. It is important that DICE scores are awarded by knowledgeable people who have equal commitment to excel in the project and are competent in all respects to participate on equal footing and were properly trained to provide dependable scores and have interest in the survey and are not biased to any set of senior management executives. More light on participating executives is needed. Similarly, sometimes Duration is dictated by urgency caused due to change thrust on the company, like say legal requirement.

The next section proposes a new model in change management of information assets to effectively and holistically manage change.

4. PROPOSED MODEL

Having touched upon topics of change management, we now switch over to the discussion on how we would react to change as information mangers handling the crucial corporate asset the "Information". For this purpose, a new step-wise model has been formulated as follows:

Step 1: Know what information you have and how to manage(protect/exploit) it through transition due to change. If the organization is facing change (administered either due to internal compulsions or external forces) either an organizational one or technological one such as upgrading a key system or due to the fact that top management is preparing change process keeping in view an impending

major change scenario in future, follow the process without having any initial hiccups about your job security or change in your duties/designations. Do not waver from continuing to do your existing routine unless specifically advised otherwise. During change it is very easy for things to move out of alignment, for technology to stop supporting the use of your assets in the way that you need, or your information assets to fail to provide the data that new business requirements call for. Ensure existing data is loaded into the new format without data loss.

Step 2: Understand the Change model suggested: The following were suggested to manage impact of change on Information Assets:

- Understand your business drivers for this investigation and frame your objectives accordingly
- Identify your information assets
- Understand your business requirements for using information
- Document the relationships between your business requirements and your information assets in a way that supports your objectives

Step 3: Setting Objectives:

a. Ask yourself why you are tinkering with the existing information and what you desire to achieve after the exercise? Is it incident based (causing some loss) or more a preventive prescription (with probability of occurrence mapped)? Can you defer action of change as the incident is not repetitive in nature? Is the impact of change likely to be felt on a specific business unit or on whole organization? Can you prioritize your action of change and bring it into any time frame? What impact it will have on employee working conditions? Have you done any Cost benefit analysis of change now and change later? Who did it?

b. How to manage digital continuity of information to enable us to use it as we need?
   Stage 1: Plan for action
   Stage 2: Define your digital continuity requirements:
   Stage 3: Understand the change scenario which varies from time to time
   Stage 4: Ensure digital continuity:
   Stage 5: Digital continuity in change scenario.
   Stage 6: Final steps:

Step 4: Find out how you need to use your information

a. How will you find the desired information and where?
b. Who has access and how he got it and how he does it?
c. How do you need to be able to work with the information? (editable? accessible to disabled user? Who will read and who will write and can you maintain formulae embedded?
d. What are you expected to know about the information? (links to data etc.)
e. Is the information held is reliable and how to check it? (access incidents log etc.)

Step 5: Business requirements and information assets available recorded

a. Are you maintaining Information asset register(IAR) having all details? (description, users, date, assess status, purpose, value, retention schedule, how do you need to use it? Risk perception associated to each)?
b. Identify asset owners
c. Maintain and update IAR

Step 6: Technical review and management:

a. Map to technology dependencies for each asset to meet business needs and understand in the process potential impact of change on them and budgetary preparations to meet the future needs due to change impact.
    i. Know your technical environment in which your information assets are functioning.
    ii. What technical dependencies to be recorded? (how to find/who can access/what to do with the asset/what more to know about it/how far and how long it is reliable?)
    iii. Is your IAR update?
    iv. Capture and record technical dependencies (key data repositories- IAR/CMDB/software registers/hardware registers/IT Help Desk data/facilities & estate management data base)
    v. Key information flows and work flows – (data flow, work flow, software tools, roles and responsibilities
    vi. Monitor and review output
    vii. Understand how mapping helps deliver your usability needs
    viii. Measure them against business objectives
    ix. Review and audit
    x. Review documentation and processes
    xi. Undertake risk assessment, exploit opportunities, assess change impact,
b. Understand your information management needs
c. Identify and mitigate risks
d. Identify opportunities for disposal/use/ savings and efficiencies
e. Manage Change.

The steps are graphically represented in the Figure 2.

In an illuminating paper "Change management information systems development and implementation projects" the authors Zoran Ćirić and Lazar Raković published in Management Information Systems expressed as under:

As demonstrated by numerous research studies, a major number of information system development and implementation projects tend to end in failure. As an inevitable factor of contemporary business operations, changes make a strong impact on the success of a project. (Ćirić, Z., & Raković, L. 2010)

The following pictorial presentations as shown in Figures 3-6 and Table 1 elucidate his argument further.

Some of the hard factors identified by experts handing change have listed them as under and these will affect a transformation initiative. These are the time necessary to complete it, the number of people and mix of people who are required to execute it, and the financial results that intended actions are expected to achieve. So, information scientists must involve in the process of framing the change strategy and provide their valuable inputs in deciding the DICE factors and should not become sacrificial goats while accepting the stupendous task of change management by sacrificing the DICE in favour of change seekers- ask for duration needed, supply tons of integrity, muster commitment from all team members and make all efforts in integrating information assets into the new scenario after change and feel your relevance into the future with confidence. You must remember work comes in search of competence! So be aware at individual level the business exigencies for change. Express your willingness and desire to participate in the change. Learn the change process and change outcome by involving in teams. Muster

Figure 2. Proposed model

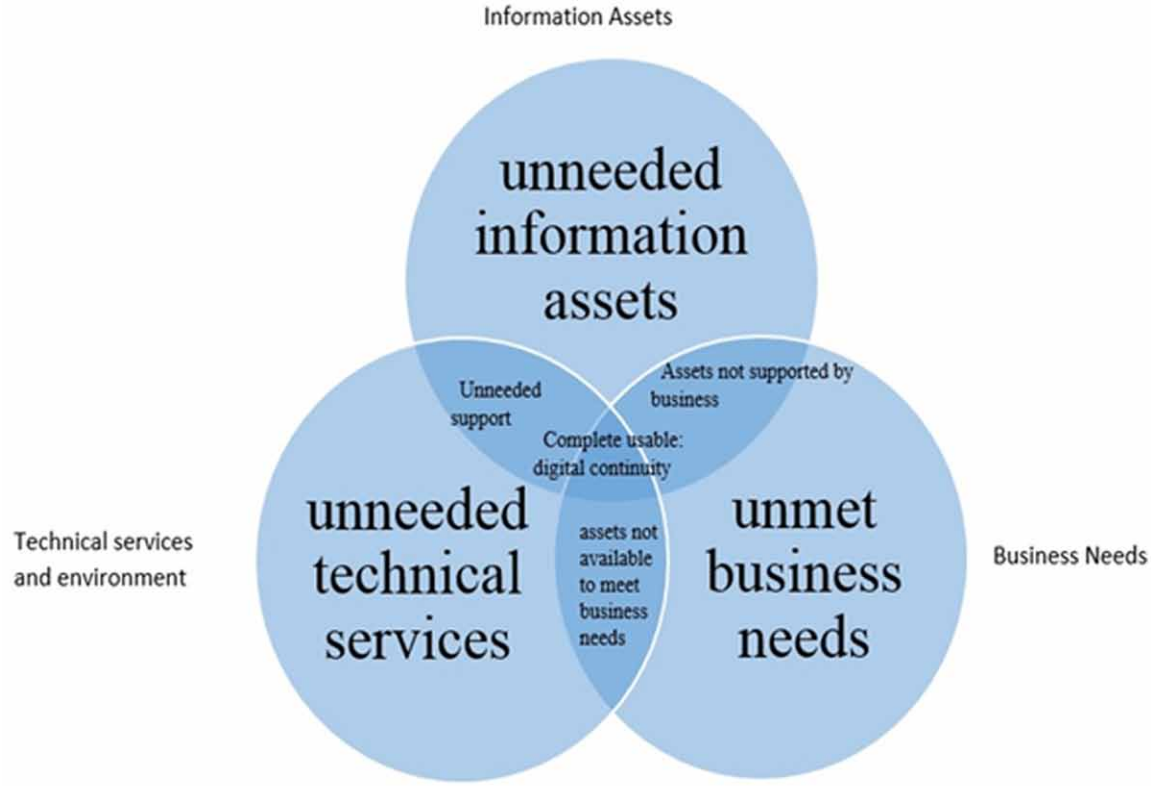


Figure 3. Success rates of information system development projects (Martineau & Shumway,2009)

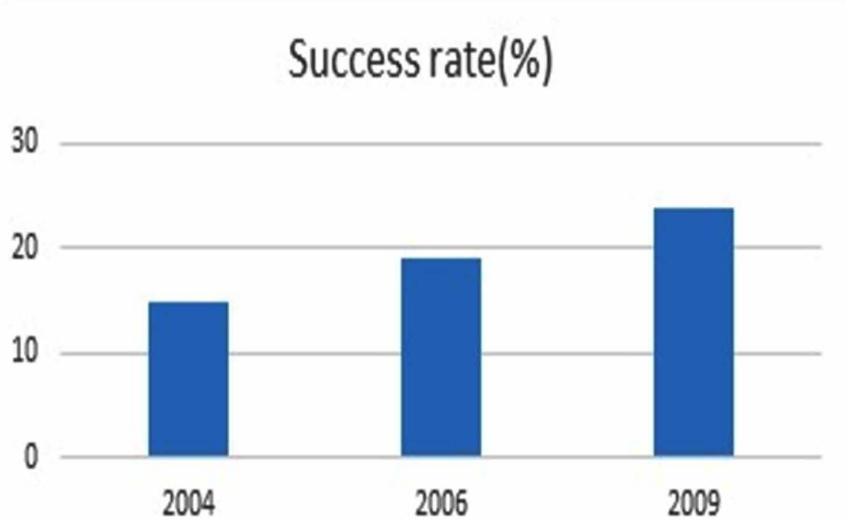


Figure 4. Monitoring change implementation (Partridge,2007)

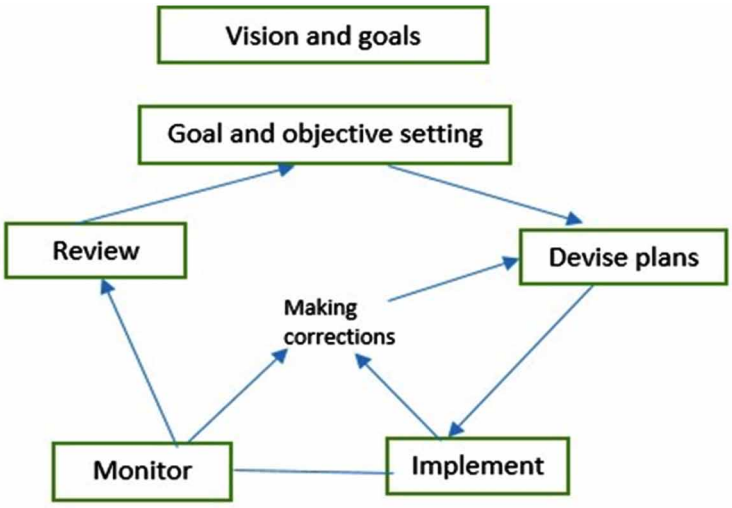
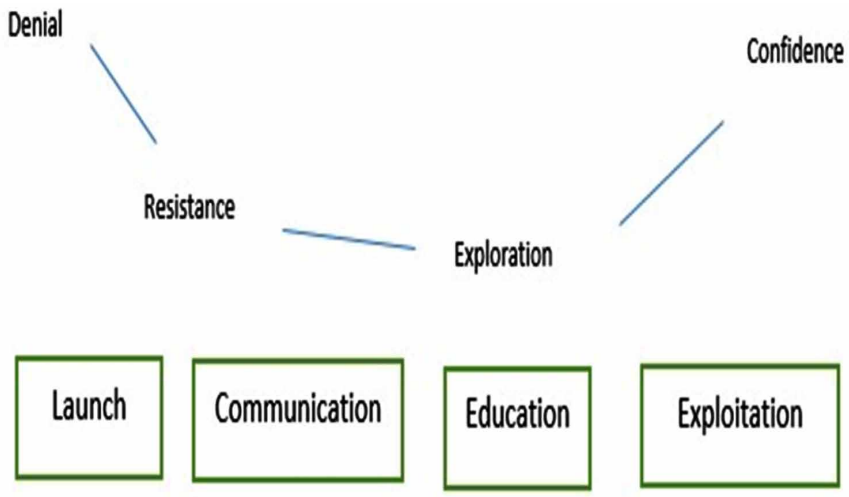


Figure 5. The stages of change (Cadle & Yeates, 2008)



strength and ability to implement the change expected at your level. Old habits die hard. So ensure change sticks and reinforce confidence in the new and improved measure to adopt change.

There are umpteen number of models developed for change management to work. But the common thread passing through all of them is that change may be coined, imagined and scripted by an individual change leader, change may be induced by him but unless it is seasoned with the people's participation and built brick by brick to their imagination and spread across all the desired areas through right information channels, it is difficult to secure required outcome. Information asset will always have to remain current and updated to new business realities. These must be allowed to flow along the business lines.

Figure 6. Change competence/commitment matrix (Cadle &Yeates, 2008)

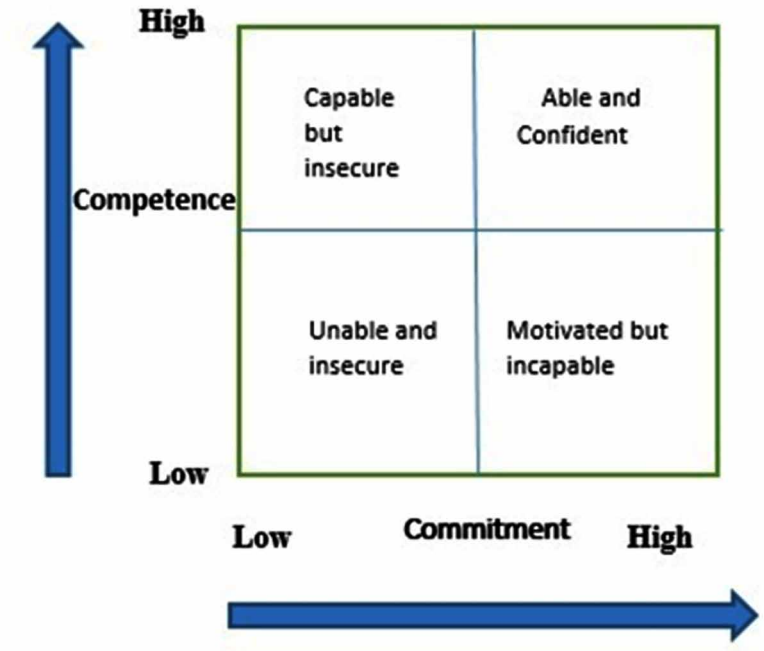


Table 1. Time and change matrix (Cadle & Yeates, 2008)

Change Type	Short-Term (3-9 Months)	Long-Term (>1 Year)
Radical	Restructuring and redeployment of staff	Business process re-engineering
Incremental (gradual)	Process automation and refinement	TQM, innovation schemes

It is neither a game of DICE nor any gambling. Change leaders carry information in their heads and on their shoulders, people and their interests in their nerves and business interests in their heart while finding their path into the uncertain future of ever charging change.

5. CONCLUSION

Change management of information assets is a very serious topic that needs further probe among the channels opened up as above. Technology changes are a key threat to digital continuity, as it is very easy to lose necessary usability of assets during transfer. Change is triggered more often from outside the organization and hence needs mature handling. Information assets belong not only to their creator but more importantly to all its intended users. Calls of Change have to be felt in advance to gear up information assets to the impending change. Companies can claim to hold useful information assets only if these assets foretell impending change. Often the problem lies with the analysts who dive into the information assets but not able to draw meaningful conclusions about impending change. Change managers will not be able to lead change in the industry unless they are equipped with or confident of quickly acquiring meaningful information systems that can withstand change paradigm.

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Chapter 78
Development of Innovative User Services

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ABSTRACT

Higher education is continuously progressing toward globalization and openness, and models of teaching, scientific research, and learning are rapidly changing. Due to macro-environmental changes, academic libraries must actively adjust their functional positions and explore new methods for user services. To satisfy users' increasingly diversified needs for information, academic libraries are continuously extending user service functions, and gradually evolving from libraries that provide lending services to centers of learning, teaching services, knowledge, and culture on campus. Through functional repositioning, academic libraries are constructing more systematic and diversified user service systems by improving basic services, deepening support services, extending services in teaching assistance, boosting services for cultivating humanistic literacy, developing spatial services, and expanding new technical services. Throughout the above-mentioned development processes, there has been a clear trend of change in terms of the contents, marketing, and cooperation of user services.

INTRODUCTION

With the evolution of an information-based society, the development of tertiary education continuously progresses toward globalization and openness. Digitalization, intelligence, ubiquity, and mobility in teaching, scientific research, and learning are becoming increasingly prevalent, with rapidly-changing models and contents. Due to macro-environmental changes, academic libraries must face challenges, repositioning, and transformation in expanding both the objectives and functions of their user services.

This chapter first gives an overview of the repositioning of user services in academic libraries in Mainland China and the reconstruction of the service system framework in new environments. It then focuses on several cases of new types of services, concluding with a summary of the development trends of user services in China.

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REPOSITIONING OF USER SERVICE FUNCTIONS

As we enter the digital era, information resources and services are becoming increasingly ubiquitous, which challenges the role of academic libraries as a traditional information center. To satisfy users' increasingly diversified needs for information, academic libraries are continuously extending user service functions, and gradually transitioning and repositioning from libraries that provide lending services for books and periodicals to being centers of learning, teaching services, knowledge, and culture on campus.

Learning Center

Along with the changes in higher education models, e-learning, blended learning, and collaborative learning are gradually on the rise. To adapt to this trend, academic libraries are integrating information resources, digital technologies, modern equipment, and multimedia services in order to create a functionally-powerful, one-stop learning center. Through these new services, academic libraries support group learning, as well as collaborative and personalized learning, with abundant resources, improved facilities, and powerful technical equipment and support.

Teaching Service Center

Traditionally, formal instruction at colleges and universities was solely performed by teachers, while libraries only played the role of passive literature providers. However, with the increasing need to cultivate innovative talent in higher education, academic libraries are gradually becoming part of the primary education process, and are providing increased support services for instruction.

On the one hand, libraries directly participate in the teaching process and the undertaking of pedagogical tasks, which includes opening elective courses related to topics such as information literacy and learning literacy. Libraries also provide information literacy training embedded in professional courses and information push services that support professional courses. Models of teaching include classroom teaching, open remote video seminars, massive open online courses (MOOCs), and more.

On the other hand, libraries provide instructors and students with powerful support services, such as reading rooms specifically for course reserves and service platforms for electronic course reserves, in order to facilitate access to reference materials. These services may also include providing teachers with courseware production services for their classroom teaching, flipped classroom teaching, and more.

Knowledge Center

Libraries fully fulfill their traditional functions through knowledge organization and knowledge services. Information resource construction has been implemented based on the disciplines of individual colleges or universities, and libraries establish knowledge systems with comprehensive collections according to the demands of the relevant academic disciplines of the colleges or universities. By collecting, preserving, and disseminating knowledge for the various disciplines, libraries are able to meet the demands of teaching and scientific research with regards to information resources. In addition, libraries provide teachers and students with powerful support for their scientific research and innovations by offering services such as research project consultation, sci-tech novelty search, citation retrieval for research

evaluation, patent and intellectual property services, competitive intelligence services, analyses of scientific research trends, applications of scientific research tools, decision-making support, data support services, subject services, and so on.

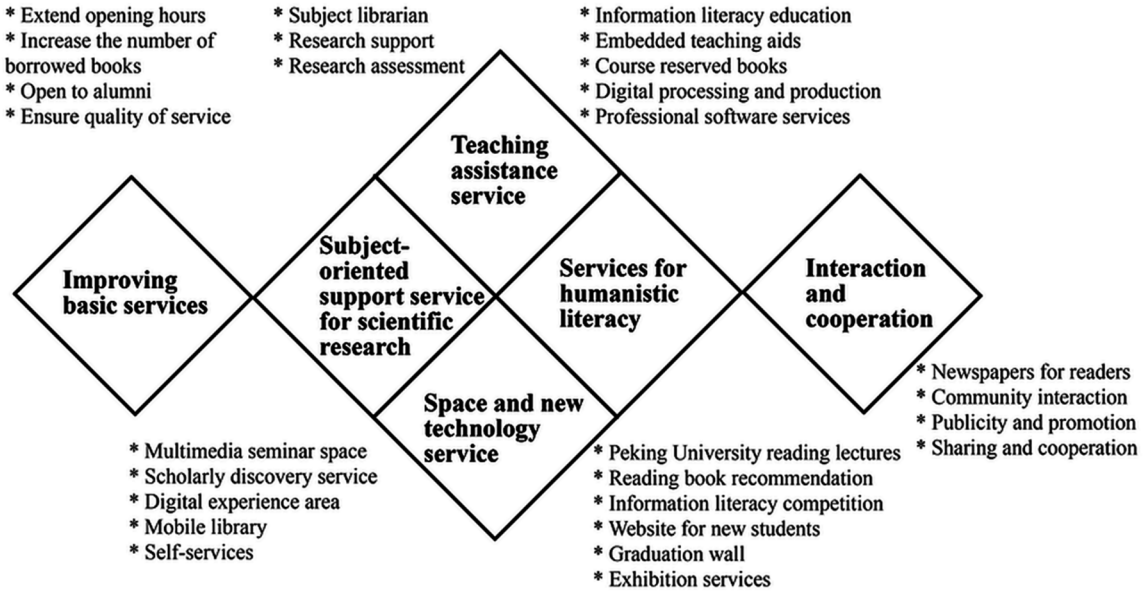
Cultural Center

Academic libraries play a crucial part in the development of campus culture and undertake important responsibilities for preserving and communicating cultures as well as improving the overall quality of university students. Not only do abundant collections play an indispensable role in disseminating human culture, but libraries also serve as activity centers for promoting campus culture. By hosting events such as reading activities, academic salons, expert lectures, calligraphy and painting exhibitions, music appreciation, and film screenings, the humanistic literacy of students can be improved, the cultural tastes of libraries can be projected, and the cultural brand of the campus can be forged.

RECONSTRUCTION OF THE USER SERVICE SYSTEM

Through functional repositioning, academic libraries are gradually breaking down the barriers of traditional service patterns by exploring new models and approaches in user services. They are also gradually constructing more systematic and diversified user service systems. The real-life example in Figure 1 is a schematic diagram illustrating the user service system of Peking University Library, which reflects the reconstruction of the service system.

Figure 1. Schematic diagram of the user service system at Peking University Library



Improving Basic Services

Contemporary society is transitioning from being 'e' (electronic) to being 'u' (ubiquitous). With the assistance of the Internet and new types of information tools, as well as the application of diversified service methods, the traditional services of academic libraries, such as book lending and reference services, have changed fundamentally in order to bring library services to users anywhere and at any time (Pan & Lan, 2008). For example, the use of self-service borrowing and returning machines, mobile borrowing machines, and other related equipment has facilitated a self-service circulation system. In addition, basic services can be further improved by taking certain measures, such as extending library hours or increasing the number of items patrons may check out at one time. In terms of reference services, aside from traditional forms of face-to-face, e-mail, and telephone consultation, many academic libraries also provide real-time virtual reference services with the help of Instant Messaging software. In recent years, academic libraries have increased real-time reference interactions on social media such as WeChat, Microblog, and Renren.com, to accommodate user habits, thereby truly integrating reference services into the daily lives of users.

Deepening Support Services for Scientific Research

Using their resource advantages and information capabilities, academic libraries are deepening support services for scientific research in the following ways:

- First, by continuing to advance the implementation of the subject librarian system, thus delivering more targeted support for teaching and scientific research. Based on the needs of individual schools and departments, as well as developments in different disciplines, academic libraries are able to deliver tailored services such as subject consultation, resource retrieval and application training, information measurement and analysis, information push services, and so on.
- Second, by delivering embedded support for scientific research, including consultations on topic selection, literature surveys, feasibility analyses, data surveys, and more. Academic libraries also deliver services such as sci-tech novelty searches and certification services for indexed and cited papers to facilitate applications for research topics, appraisal of project achievements, applications for papers, and more (Li & Yan, 2014).
- Third, by providing in-depth services in relation to intellectual property, including patent retrieval, consultation for patent evaluation, intelligence analysis on subject competition, and so on.
- Fourth, by using bibliometrics to explore services for scientific research evaluation, including performance appraisal of research achievements, analysis of development trends within a discipline, and so on.

Extending Services in Teaching Assistance

In addition to guaranteeing resources for teaching activities, libraries are gradually participating more directly in instruction at colleges and universities. This includes the following:

- Establishing an all-round and multi-dimensional system of information literacy education, in order to improve students' information awareness and information capabilities. The system includes

relatively short, flexible, and frequent training seminars, campus-wide elective courses related to information retrieval and utilization, and remote service-oriented video-recorded open classes, MOOCs, and e-learning, in addition to face-to-face, interactive small-group training.

- Moving further to the forefront of teaching by providing embedded training related to resource retrieval and utilization. One such type of training is embedded in instruction platforms, where discipline-related resources and teaching courseware are published. In addition, libraries communicate interactively with students to solve difficult problems related to retrieval using a variety of forms such as Internet instant messaging tools, emails, forums, and microblogs. Another type of training is embedded in professional classrooms, where librarians fully participate in the process of course design, instruction, and evaluation; they are responsible for imparting knowledge about information retrieval that is specific to individual courses or projects according to the subject features and the requirements of the course in order to improve students' information literacy.
- Providing course reserves to meet the needs of teachers when starting new courses. Libraries emphasize searching for and managing course reference materials requested by teachers, as well as being equipped for the full-text retrieval of electronic reserves. Librarians spend more time providing resource preparation and support for flipped classrooms due to the increasing popularity of this model of teaching.
- Offering digitizing services, including filming academic conferences and lectures, courseware creation, literature scanning, digitization of film and audio-visual materials, editing of multimedia contents, metadata production, resource publishing, and personalized printing.

Boosting Services for Cultivating Humanistic Literacy

Humanistic literacy, or the literacy in history, philosophy, literature, politics, economics, and law sciences, is an essential quality in the life of a university student. During the process of improving humanistic literacy, academic libraries have fully exhibited their traditional advantage in culture and focused on humanistic care, and have promoted services for humanistic literacy by hosting exciting and diverse activities.

Promoting reading has always been a key highlight in the work of academic libraries in delivering services related to humanistic literacy. By providing services and hosting activities, such as reading lectures, exhibitions of classical bibliographies, new book recommendations, regular release of book borrowing rankings, reading salons, and book review competitions, libraries advocate for reading more and better books and build a positive reading culture on campus.

In addition, academic libraries are typically equipped with lecture halls, exhibition galleries, and multimedia audiovisual spaces. By hosting expert lectures, calligraphy and painting exhibitions, music appreciation events, movie screenings, and other enriched and diversified activities, the humanistic and artistic literacy of the students will be improved, and their diversified and multi-dimensional cultural needs will also be met.

Developing Spatial Services

Along with the arrival of the post-digital era, mainly characterized by a ubiquitous knowledge environment, an increasing number of users are accessing information, literature, data, and knowledge on the Internet anywhere and at any time. Academic libraries have begun to transcend traditional services that

regarded print materials as the library's core to pursue cross-boundary development of new services. The evolutionary trend in which libraries gradually become the Third Space (the social place outside of the living space and studying space) of the campus is inevitable (Xiao, 2013). The spatial services that come with this trend reflect the value of the academic library as a place.

Specifically, this means that aside from conventional reading rooms, universities and colleges need to open up a great amount of space that is solely used for services, such as learning spaces, information commons, makerspaces, leisure spaces, communication spaces, or experiential spaces. These spaces, which are not usually associated with library collections, are designed to provide a friendly and enlightening cultural venue for users to study, research, conduct exchanges and discussions, and maintain social interactions.

Expansion of New Technical Services

Rapidly-changing information technology has created challenges and opportunities for academic libraries, and has exerted a profound impact on both libraries themselves and their user services. To adapt to the significant changes in the information environment and provide users with more convenient information services, academic libraries maintain a high sensitivity to technological developments, and increase and expand their technical services in novel ways, such as offering one-stop academic resource discovery platforms, promoting mobile library services, offering experience services in digital applications based on equipment such as new tablet computers or e-readers, offering 3D printing, delivering training for software applications, and so on.

CASE STUDIES OF INNOVATIVE USER SERVICES

Data Services

In the Big Data era, data has permeated all sectors and industries, and there is increasing emphasis on its value. Within this context, academic libraries spare no effort in actively expanding new types of data services, including: support services for scientific research data, such as the storage, sharing, and mining of research data; and support services for data-related learning, including training in data literacy and data learning. Based on the above services, joint working groups, such as the China Academic Library Research Data Management Implementation Group, have been established to cooperate in promoting this area of work.

Case Study

In May 2013, trial operations began for the Fudan University Dataverse Network (Dataverse), a platform jointly developed by the Fudan University Library and the School of Social Development and Public Policy, as well as the School of Computer Science (Zhang, Yin, Zhang, Guo & Zhang, 2015). This platform was developed based on open source software known as Dataverse, and it was designed to provide data submission, storage, management, and sharing services for teachers, students, researchers, and academic institutions of the university. The functions of the platform include the following:

1. **Data Management:** Submission, review, and release of scientific data, research results, and derivative publications based on scientific data, as well as validation and conversion of file formats for scientific data; for example, when uploading data, file formats are automatically converted to compatible formats required by current mainstream statistical analysis software including SPSS, Stata, S plus, and R data.
2. **Data Analysis:** Online analysis and data visualization; for example, supporting the online analytic display of time series visualization. Recoding and regrouping of data is possible, as is descriptive analysis and advanced statistical analysis. The results of relevant analyses are displayed in the browser window.
3. **Data Exchange:** Supporting background data harvesting and exchange between social scientific data sharing platforms based on data protocol (e.g. OMI-PMH Protocol, Nesstar format protocol, etc.) and other foreign and domestic data-sharing platforms. For example, the Fudan University Dataverse Network can establish data exchange and harvesting mechanisms with social scientific data centers at Harvard University and the University of Michigan.
4. **Data Curation:** Granting users access to data files according to various user roles, such as restricted site visitor, data contributor, data administrator, Dataverse administrator, and Dataverse network-level administrator; setting separate access rights for Dataverse, programs, and files to ensure data safety; version configuration management, such as updating scientific data; and curation and long-term storage of scientific data.

Furthermore, to effectively reveal and share scientific data, a Data Documentation Initiative (DDI)-based metadata description standard was established, thus solving many existing problems, such as failing to effectively manage research data, vague descriptions of research data, and unstandardized metadata. With the help of this platform, secure and shared access to standardized metadata descriptions and restricted data was achieved, further promoting the sharing and services of the university's scientific data.

Thus far, this platform has integrated a total of 54 data sets and 1,041 data files, including social change surveys on the Yangtze River Delta area, data on the Hangzhou urban economic circle, databases on energy flow and carbon emissions factors, and so on, thereby preliminarily achieving the long-term storage and public access of scientific data. In terms of scientific data sharing, the platform has already brought about shared usage among various research groups and databases. For instance, the Center for Energy Economics and Strategy Studies at Fudan University and the Chinese Population Geographic Information System (GIS) research group have successfully integrated databases on Chinese population and consumption and carbon emissions via the shared platform. The resulting database vividly illustrates the energy distribution, flow directions, and carbon emissions in various regions.

Information Literacy Services

Information literacy education is one of the most important responsibilities of the subject services provided by academic libraries. In recent years, the demand for reform in teaching models and for the cultivation of innovative talent have further promoted the innovative development of information literacy education in academic libraries. An increasing number have started to offer packaged courses and training lectures related to information literacy education, and they have begun to explore and practice embedded instruction. Information literacy education has gradually been integrated into the education systems of colleges and universities, and has become an important step in cultivating innovative talent.

Case Study

In order to cultivate basic information skills and inspire innovative thinking in students, the Shanghai Jiao Tong University Library has gradually developed an information literacy education system with three dimensions: popularizing, expanding, and deepening (Gao, Song, Guo, Li, 2013).

Popularizing Information Literacy Education Through Regular Courses and Training

Regular courses and training are the foundation of the campus-wide popularization of information literacy education at the Shanghai Jiao Tong University (SJTU) Library. It includes regular courses, rolling training, and library orientation for freshmen. Of these, regular courses are open to all undergraduate students across the campus. They are divided into general core courses, public elective courses, and a limited selection of professional courses. Rolling training, which is open to all teachers and students of the university, has an online registration system, adopting a 90-minute model that combines classroom teaching with hands-on computer practice. Library orientation for freshmen consists of two parts: a training lecture on how to use the library, and a field visit. There is also a special column on the library website which offers content-rich library guides and online courseware.

Expansion of Information Literacy Education Through Featured Lectures and Innovative Programs

Subject service teams have organized featured lectures and innovative programs based on the professional disciplines. These events are diverse in content and form, and include two major aspects: thematic training for schools and departments, and training programs for information specialists. Thematic training for schools and departments is a thematic and personalized training program on information literacy which is tailor-made by the library's subject service teams according to the needs of the individual departments and scientific research teams. SJTU offers subject service offices in three departments—Science and Engineering, Biomedicine and Agriculture, and Humanities and Social Sciences—as well as ten profession-oriented subject service teams which facilitate the organization and implementation of various forms of training on a flexible basis. Information specialist training programs, specifically targeted at scientific research teams of all schools and departments, are designed to cultivate scientific researchers with a higher level of information literacy. The training, which involves developing all aspects of information literacy, tends to focus more on project survey, situation analysis, and other related knowledge and skills that are conducive to scientific research. Since its implementation in 2009, this program has enjoyed increasing popularity across the university. It has produced 649 information specialists in hundreds of scientific research teams.

In-Depth Development of Information Literacy Education Through Multiple Types of Embedded Teaching

There are various models of embedded teaching in the SJTU Library, including: locally-embedded instruction, which means that the content of lectures on information literacy is tailored to the needs of teachers and students for a particular professional course, while the knowledge and skills necessary for the course are taught in a focused and one-off basis; tracked progressive instruction, involving planning

and customizing advanced training content via the tracking of a four-year course taken by undergraduate students, and then conducting training and consultation services on a progressive basis, from simple to complex levels according to different learning phases from Freshman to Senior; and fully-immersed instruction, which means working closely with teachers on a specific professional course, whereby subject service teams participate in the whole process from setting the objectives, planning curriculum, and designing assignments to performance assessment and so on.

Publishing Services

Given the importance of scholarly publishing in recent years, and new development trends toward digitization, networking, and openness in scholarly communication, an increasing number of academic libraries have started to focus on and provide publishing services, and have offered support to formal or informal scholarly communication in various ways, including digital publishing of dissertations and theses, paper publishing and video release of academic conferences, the establishment of institutional repositories to provide digital storage services, and the development of an open access platform to provide related services. The scholarly publishing services offered by academic libraries have a thematic and subject-based focus as well as rapid publishing speed, in order to reflect the academic development of the university in a timely manner.

Case Study

Peking University Library is committed to participating in campus publishing activities in order to promote the presentation, dissemination, and storage of the university's academic achievements. In March 2013, Peking University Library and the Office of Humanities & Social Sciences at Peking University jointly launched the Peking University Journals Platform, which was designed to integrate the academic publications edited and published by Peking University, to promote scholarly communication, facilitate academic research, carry out digital publishing, and advocate open access.

Since the project was launched, the library has undertaken a large number of investigations. It has investigated domestic and international progress on the research and implementation of integration platforms for institutional publications, online publishing, and the construction of Open Access Journal (OAJ) platforms. It has also meticulously performed a thorough investigation of all journals, collected papers, and internal publications published by Peking University in order to gain a better understanding of their digitization process, development of editing systems, copyright agreements, and more. After completing the survey, the library systematically sorted through the requirements needed for the platform in terms of layout and functions, and assisted a professional company in completing the construction of the platform. In addition, the library signed contracts with various journals for content construction in order to decide the given format and time of release for recently-published journal issues, thus standardizing working procedures; manual online data capturing was performed for back issues.

On September 10, 2014, the Peking University Journal Platform went online. During the first phase of construction, metadata construction for twelve journals was almost complete, of which five had complete full-text databases from the initial issue to the start of 2014, supporting journal title, ISSN, and full-text retrieval based on keyword searching. This platform was the first online integration platform for journals based on open access among Chinese universities. It has provided support for journals published by Peking University in terms of information release and digital publishing, which has effectively

improved the speed of the entire publication process from submission to publication of academic theses, thus increasing the influence of Peking University journals at home and abroad.

New Media Services

Characteristics such as low entry barriers, convenience, and interactivity have enabled social media to gradually become an important tool for academic libraries in conducting service marketing and creating a new user environment in the age of New Media. Academic libraries actively utilize all kinds of popular social media platforms, such as Microblog, WeChat, Renren.com, Douban.com, and Youku.com, and embed them in the user space for the purposes of promoting and publicizing library resources and services. As of April 5, 2014, among the libraries of 112 national key universities, 69 (62%) have launched Sina Microblogs services, and 39 (35%) have launched WeChat services (Huang, 2014).

Case Study

To connect with the information channels of young students, and to narrow the communication gap, Peking University Library launched their official social media (Microblog, WeChat, and Renren.com homepage) in June 2013. These web pages have become important tools in developing new media services for the library. As of May 17, 2015, the three social-media accounts have a total of 53,402 followers, while their popularity and influence are both on the rise. New media service is a novel concept when compared to the traditional marketing activities of libraries. Over the years of experimentation and continued exploration, Peking University Library has gradually determined a set of characteristic and effective measures:

1. **Organizational Structure:** The Library has established an interdepartmental operations team to shape a dynamic and creative team culture. The new media service team is headed by the deputy director of the library. The Departments of Reference Services, Circulations, Multimedia Collections, Special Collections, Rare Books, Collection Development, and Systems and Director's Office, among others, have also assigned junior and senior librarians to join the team as part-time members. Members of the team take responsibility on a rotational basis for the daily operations of social media. Creative plans for thematic activities are generated via brainstorming among team members. Through a working mechanism that focuses on the reasonable allocation of tasks and collective wisdom, the team has developed a new media service that is quick to respond and is close to their readers.
2. **Information Release:** Information that addresses user interests is provided in order to improve the attractiveness of content. Firstly, regular columns have been meticulously established, such as the Treasured Library Collections, Reading Salon, Library Book Recommendations, Today's One-hour Lecture, Featured Movie Screening, 3D Movie of the Day, Videopedia, Music at Teatime, Photographic Library, and more, which involve content such as recommended resources, knowledge sharing, release of the latest news, and artistic appreciation. This enables the full promotion of library resources and services using textual and graphic illustrations. Secondly, the team monitors news and information related to reading, culture, campus life, and other related topics, and repost the interesting information, so the content of the three major platforms can be further enriched. Thirdly, online publicity and releases are synchronized while the library is organizing major activi-

ties in order to increase the popularity and influence of the activities via the radiative effect of the Internet.

3. **Interaction with Users:** Particular attention is paid to real-time interactive communications, so as to establish the image of an enriched, erudite, innovative, and friendly library. Library self-media has achieved a greater effect by pushing enriched and colorful information to attract attention, becoming closer to users with the use of warm and lively language, as well as by increasing their own levels of activity, affinity with users, and practicality. For example, between February 16, 2015 and May 17, 2015, there have been a total of 302 blog posts published on the official Microblog of Peking University Library (of which 250 were original blog posts, and 262 included pictures, videos, or music), 1,169,482 blog views, and 1,473 interactions (receiving 547 forwarding links, 121 comments, and 655 "likes"). There has also been a net increase of 2,763 followers, bringing the total number up to 23,030.

Digital Processing Services

To fulfill the needs of digitally-processed materials for teaching and scientific research, many academic libraries have provided data and digital processing services with the support of various technologies, resources, and equipment. The scope of these services mainly consists of the following: (1) digital processing, collection, and production, including scanning of text and images, scanning of microfilm documents or films, digital shooting, digitization of audio and video materials, collection of multimedia programs, filming services for academic activities, and 3D processing; (2) editing and compiling digital information resources, including a digital resource catalog, content editing, and multimedia editing and production; and (3) releasing and using digital resources and storage.

Case Study

In 2009, Peking University Library established the Data and Digitization Center open to all teaching and research units across the university. It delivers a full range of digital processing services that involves literature scanning, digitization of films, digitization of audio and video materials, collection of born-digital and featured multimedia resources, editing of multimedia content, metadata processing, digital resource publishing, downloading of teaching resources, and publishing and printing on demand.

Among the above-mentioned services, collection of born-digital and featured multimedia resources includes the following:

1. **Filming Services for Academic Activities:** The library provides filming services for academic conferences, lectures, events, and forums that are hosted or sponsored by teaching and research units. It offers free services for units that are able to share conference resources.
2. **Recording of Oral Histories by Scholars at Peking University:** This is a part of the oral history project by renowned college and university scholars. It is jointly recorded with the Department of Information Management of Peking University and the Modern Educational Technology Center.
3. **Collection of Multimedia Programs and Other Related Services:** The collection of born-digital resources has further expanded the genre and scope of information resource development at Peking University Library, and has provided new avenues for the library to perform its basic functions in the digital era.

At present, the annual processing capacity of the Data and Digitization Center has exceeded 50TB. Featured digital resources that have already been produced include: the Chinese Rare Collections Database, Systems for Periodicals Published during the Republic Period (1911-1949), Dissertation and Theses of Peking University, E-reserves Database, Peking University Lectures, A Historical Database of the National Southwestern Associated University, CADAL Publications of the Republic Period, engineering drawings of Peking University Archives, dialect survey data from the Department of Chinese Language and Literature, and old archives in the Office of Human Resources. The above-mentioned resources have benefited not only Peking University, but also scholars across the country.

Reading Promotion Services

The promotion of reading is a natural and important responsibility of academic libraries. In the rapidly-developing Internet age, the importance of reading promotion is increasingly prominent. There are two objectives behind reading promotion: to help students to develop good habits in reading, and to guide students to read good books. In order to promote reading more effectively and build a positive reading culture on campus, many academic libraries in China have explored several useful practices. For example, stereoscopic reading in Tongji University Library, Living Library services in Shanghai Jiao Tong University Library, and mobile reading in East China Normal University have all achieved positive results.

Case Study

Peking University Library is committed to the promotion of reading. In particular, since the establishment of an inter-departmental promotion and publicity team in 2011, the library has organized many creative and welcoming activities.

Hosting Featured Activities to Establish a Library Brand

Since 2012, Peking University Library has organized an annual series of activities before and after World Book and Copyright Day that are varied in content and form. The activities usually last for about two months. For example, between April and May of 2014, with "Elegance of Reading Amidst a Sea of Flowers" as the theme, the library planned and organized many activities including the Peking University Reading Lectures, annual awards for the Weiming Star Readers, an exhibition of bibliographic recommendations and photography on reading, the "Beauty of Books" video program screening, book-crossing, and the "Do Not Let Your Phone Take Control" campaign. After years of development, the above-mentioned series of activities for World Book and Copyright Day organized by the library have become a featured brand in the campus culture of Peking University, with a good reputation and great popularity.

In addition to the annual activities for World Book and Copyright Day, the library also invites three to five renowned writers and scholars to the campus each semester. They hold discussions revolving around certain books or a certain genre of books, and are encouraged to talk about their experiences of reading and share insights about their creations. Since its launch in April 2012, dozens of reading lectures have been held at Peking University. Oriented around vivid themes and filled with abundant content, these lectures have gained great popularity among readers, and have become a well-known brand of cultural activity in the university.

Maintaining the Sustainability of Activities by Offering Regular Services

The library hosts exhibitions of bibliographic recommendations with various themes one to three times per semester. Before carrying out exhibitions, librarians will conduct a survey on reading interests to better understand the reading habits of their users so that targeted reading guidance can be made for different groups of readers.

For example, freshmen may be full of curiosity about and have expectations of campus life, but they likely also feel a sense of discomfort caused by being away from home. Therefore, when holding recommended book exhibitions at autumn orientations for new students, Peking University Library fully takes into account their reading needs. Based on themes such as "To know and love Peking University," and "To read more as knowledge has no boundary," Peking University Library meticulously selects an assortment of books that are suitable for freshmen, and has received a good response. For graduating students, it is not only important to accommodate their sadness in parting and bidding farewell, but also their dreams for their future. Therefore, the library chooses a reading list recommended by certain distinguished alumni as heartwarming gifts for graduating students.

Strengthening the Attractiveness and Popularity of the Above Activities by Innovating the Forms of Activities and Through Three-Dimensional Publicity

Unchanging activities for reading promotion are very likely to generate aesthetic fatigue among readers. Therefore, Peking University Library pays significant attention to novelty when considering the forms of activities. For example, during the activities for World Book and Copyright Day in 2014, the library held the "Elegance of Reading Amidst a Sea of Flowers—An Exhibition of Peking University Library Bibliographic Recommendation and Photography on Reading" (referred to as the 'Bibliographic Recommendation/Photography Exhibition' below). In addition to the recommendations of 30 books, 30 pieces of photographic work imitating Western paintings on reading were displayed. This activity creatively combined the recommended books with elegant reading photography, and the imitations of paintings immediately attracted the attention of users. Popularity and attention were significantly increased.

In addition, every time the library hosts an activity, it makes integrated use of traditional media and social networks to carry out multi-directional and three-dimensional publicity in order to ultimately strengthen the visibility and influence of the activity.

Mobile Services

With the popularity of smartphones and other mobile terminals, as well as the development of 4G technology, the application environment of mobile Internet is becoming increasingly sophisticated, and mobile services are gradually becoming a basic service provided by academic libraries. The service began with the earliest short message service and Wireless Application Protocol (WAP) service, and has been extended to include information searches, mobile reading, and video services.

Case Study

Tsinghua University Library began looking into the idea of the mobile library in 2006. In 2007, the library launched the first-ever mobile service in the form of short message service. Later, the library

fully developed the Tsinghua University Wireless and Mobile Digital Library System (TWIMS). Over the years, a series of mobile services with functions that support academic resources retrieval and full-text reading, OPAC search and book reservation, notices of training and lectures, and more have been launched online. All teachers and students of the university can make use of library resources and services anywhere and at any time.

At present, the major functions of the university's mobile library are as follows:

1. **Short Message Service:** If a user lacks Internet access, they can check personal borrowing information, search, make and cancel reservations, and renew books via mobile messages. They can also receive various kinds of information released by the library via mobile messages.
2. **Multimedia Messaging Service (MMS):** The MMS notification service for the latest information on e-journals provides the latest articles in 132 e-journals, including *Tsinghua Science and Technology* and *Nature*. After completing a journal subscription on the TWIMS Web platform, readers may receive regular MMS messages containing information of the latest articles.
3. **Mobile Website:** Mobile websites are compatible with a variety of mobile device browsers, providing library newsletters, OPAC search functions, individual borrowing information search functions, book reservation and renewal, a map of the library collection, retrieval of electronic resources, full-text reading, and many other services.
4. **Client Applications:** Two types of client applications are provided (iPhone and Android) which allow for one-stop resource retrieval, borrowing information search functions, and reservations, and they support both streaming and layout reading formats.

Moreover, Tsinghua University Library introduced a two-dimensional code in the development of mobile services. Specific areas for applications include supplying bibliography information (e.g. book name, call number, and shelving location), guidance for the premises and layout of the library, obtaining a reader's manual, etc., so as to create a more convenient environment (Zhang, Zhang, Jiang & Dou, 2013).

Spatial Services

In recent years, the spaces of academic libraries have experienced tremendous change, from collection-oriented spaces to service-oriented spaces. Aside from traditional learning spaces, academic libraries now provide spaces for leisure, discussion, and exhibition. They have further established Information Commons (IC), Learning Commons (LC) and Makerspace, equipped with more advanced facilities, richer resources, and better-qualified staff.

Case Study

Shanghai Normal University Library began its IC service in November 2007. The IC is located on the sixth floor of the library at the Fengxian Campus. It occupies the entire floor, covering a total area of 1,600 square meters. The IC services include books and journals, references, information retrieval, information communication, subject navigation, audio-visual education, and media production, as well as education and training on information literacy. The actual spaces of the IC are divided into eight areas: reference and consultation, individual learning, group discussion, document reproduction, literature

resources, leisure reading, reader training, and audio-visual presentation. In addition, the IC is equipped with rich virtual resources; all databases in the library can be accessed via computers in the IC, and colleges using the IC subject services have set up professional databases and related software that they have purchased on IC workstations, which has enriched the IC digital resources. The IC provides links to subject blogs and receives online reference forms and reservations for discussion rooms. When booking the physical discussion rooms, the users can also apply for virtual ones, so that those who cannot participate on site can better understand the on-site dynamics in real-time and express their viewpoints via virtual rooms (Du & Liu, 2009).

Shanghai Jiao Tong University Library provides Learning Commons services using group-study rooms. Group-study rooms are divided into thematic research rooms, general discussion rooms, and innovative learning rooms, which are limited to use for academic discussions, course discussions, communication training, and innovative group activities. Take the innovative learning room as an example. The aim of this service is based on the planning and organization of innovative activities, as well as the cultivation and stimulation of an innovative mindset, where users are able to conduct open communication, brainstorming studies, exercises in simulated learning, community activities, public-speaking practice, group discussions, experience sharing, and other themed activities. Group-study rooms are available by reservation. This provides users with a one-stop service environment, including a wireless network, movable tables and chairs, projectors, and small bookshelves. The overall environment on each floor is comfortable, equipped with all-in-one self-service machines for printing, copying, and scanning (Wang & Song, 2011).

Software Services

For teachers and students at colleges and universities, the use of various items of software is an indispensable part of their daily research activities. At present, there are several academic libraries that deliver software services to teachers and students. These services provide powerful support for users in their research and learning, including various types of licensed software, as well as training on software use, technical consultation, and more.

Case Study

Peking University Library launched its professional software services in 2009, including the following:

1. **Sharing of Genuine Software across the University:** SPSS, AutoCAD, Zinemaker, NoteExpress, EndNote Online, and other related software have been provided to the university as a whole through shared platforms for genuine software, CD-ROM systems attached to books, and multimedia resource platforms.
2. **Training on Software Use:** This includes two specific types of training. One type is targeted at tools commonly used in the process of academic research, such as Microsoft Excel, Visio, SPSS, NoteExpress, or EndNote Online, and it involves drawing, statistical analysis, literature management, and other related fields. Explanations on the usage techniques of above-mentioned professional software and application examples can help users improve their efficiency in scientific research and dissertation writing. The other training type is related to the use of software such as

Photoshop or iMovie, which involves image processing, video editing, and other related fields. The teaching method mainly involves large classes in the form of explanations by a librarian plus hands-on computer practice. For SPSS, Photoshop, and iMovie, the library also adopts a reservation system allowing five to six persons to provide interactive and personalized small-class training and instruction.

THE DEVELOPMENT TRENDS OF USER SERVICES

To summarize the development of user service positioning and systems, as well as innovations in user service, we can see that academic libraries are actively adjusting their functional positions and continuously exploring new patterns and methods of user service. Based on this foundation, they are also reconstructing the user service system. During a series of processes in transformation and development, there has been an obvious trend of change in terms of the concepts, patterns, contents, highlights, marketing, cooperation, and other aspects of user service.

Concept: From Resource-Centered to User-Centered

In recent years, the resource-centered concept which focuses on library collections has gradually been transformed into a user-centered concept which focuses on users. The people-oriented service mindset, which is driven by user needs, has been strengthened by the practices of academic libraries. In the future, academic libraries will pay more attention to user needs and humanistic care, and will communicate and interact with users with a more proactive attitude. Humanistic and personalized services will become increasingly popular.

Model: From a Uniform and Extensive Model to a Refined and Diversified Model

Traditional library service is focused on the single-ended service of borrowing, reference, and retrieval; the user service policy and models are relatively extensive. With the progress to date, service has become increasingly refined. For example, for different kinds of users, users in different subjects, and users with different needs, libraries adopt an increasingly targeted service model which is personalized and refined, while the corresponding service systems are showing a more diversified trend.

Content: The Growing Influence of Subject Services

The subject service of academic libraries in China was initiated at the end of the twentieth century. Following decades of development, it has gradually come of age. The service content has gradually been extended from early participation in the construction of subject collections, consultation, and communication with schools and departments, to deep integration with the frontline of teaching and research, providing more personalized services for teaching and research, such as user education embedded in professional courses, research support, scientific research assessment, and other services. It is foreseeable that subject service in the future will have an increasingly significant impact among teachers and students, and will become an indispensable core service for users in their research activities.

Highlights: Data Services in the Big Data Era

The arrival of the Big Data era and the widespread application of related technologies have brought about the instant retrieval, accurate analysis, and deep mining of data that is massive, complicated, and multi-structured. This will bring about many areas of growth in the user services provided by academic libraries.

Firstly, libraries will develop scholarly publishing services, and increase open access to scientific research data. For example, establishing institutional repositories and data-sharing platforms for the libraries themselves to store, manage, and share all kinds of academic achievements and scientific research data.

Secondly, libraries will develop services for data gathering and analysis. For example, gathering data of scientific achievements, conducting assessments of the competitiveness of scientific research at various schools and departments, and offering policy support for subject development.

Thirdly, libraries will deeply mine and interpret user data, publishing statistical reports related to library business, and presenting library service content and types in a vivid and understandable style.

Fourthly, libraries will deliver data literacy services to cultivate users' sensitivity to data and their application competence.

Marketing: Publicity and Public Relations in the Age of New Media

University life is colorful and diversified. Students are often swamped by numerous community activities, expert lectures, and competitions; thus, their attention becomes to some extent a scarce resource. Therefore, academic libraries are paying more attention to their own marketing and promotion. They refine activity planning and practices based on research on users' psychology and needs, while also promoting and publicizing library resources and services via various useful channels.

In the age of New Media, the marketing of academic libraries is becoming more diversified, multi-dimensional, and intelligent. New development trends have presented themselves. First, libraries have set up self-media by using popular social networking platforms to approach users through multiple channels, thus enabling libraries to actively interact with users to build an image that is full of vitality and enthusiasm. Second, they pay attention to activity marketing. Ample investigation of user needs, innovative planning, and the integration of resources, services, media, and even sponsorships can help libraries to achieve recognition, promotion, involvement, and use of library services, as well as establishing well-known activity brands. Third, libraries utilize more multi-dimensional channels and means of promotion and publicity, including posters, other paper-based publicity materials, online library homepages, social spaces, videos, and so on.

Cooperation: Increasingly Prominent Role of Services Sharing

In today's open society, cooperation and sharing can create enormous energy, and academic libraries are no exception. User service is a systematic project involving many factors, such as information resources, technologies, and professional staff; therefore, the opportunity for cooperation and sharing is extensive. In the future, the role of services sharing will become increasingly prominent. Shared services, such as interlibrary loans, joint reference, cooperative open publication, unified integration of resources, joint training, and public archive of resources, will increase in popularity. Additionally, there will be an all-round expansion of cooperative partners beyond cooperation among libraries, establishing a more extensive

and closer cooperative relationship with relevant scientific research organizations, public communities, technological fields, publishers, and even individuals. Libraries will strengthen cooperation and openness by sharing information resources, knowledge, and technical achievements, so as to significantly improve the development and excellence of user services.

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Chapter 79
Criminal Defamation, the Criminalisation of Expression, Media and Information Dissemination in the Digital Age:
A Legal and Ethical Perspective

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ABSTRACT

Criminal defamation and the criminalisation of communication in general often result in severe punishment for the media and other content producers accused and prosecuted for committing such 'crimes'. There are severe financial penalties involved and /or the incarceration of those who are convicted of breaking the law. This chapter studies the existence and feasibility of criminal defamation in largely contemporary Africa, but also making references to 'older' democracies in the Western hemisphere. In short, the chapter critiques criminal defamation and the criminalisation of expression, making a strong legal and ethical perspective quite often using empirical materials from the courts. The inception and proliferation of new digital technologies amongst ordinary citizens also means that besides the traditional media or fourth estate, ordinary non-professional communicators are also highly likely to get into trouble over defamation, criminal defamation and other forms of crimes associated with the criminalisation of communication.

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INTRODUCTION

Criminal defamation and the criminalisation of communication in general often result in severe punishment for the media and other content producers accused and prosecuted for committing such 'crimes'. There are severe financial penalties involved and/or the incarceration of those who are convicted of breaking the law. This chapter studies the existence and feasibility of criminal defamation selected contemporary African countries, but also making references to the USA as an 'older' democracy. The chapter critiques criminal defamation and the criminalisation of expression, making a strong legal and ethical perspective quite often using empirical materials from the courts. The inception and proliferation of new digital technologies amongst ordinary citizens also means that besides the traditional media or fourth estate, ordinary non-professional communicators are also highly likely to get into trouble over defamation, criminal defamation and other forms of crimes associated with the criminalisation of communication. Firstly, in a criminal case a prosecutor on behalf of the state brings charges against a defendant, whereas in a civil suit the plaintiff brings suit (Creech, 2007). Secondly, the chargeable offense is considered grave or serious that it can result in the imprisonment of the defendant (Feltoe, 2002, p 12). Criminal defamation and other criminal offences that are linked to utterances and or publication of information is a common and long standing feature of most legal systems. Their existence is justified on the basis that freedom of expression as with other rights, is not absolute and has to be exercised in cognisance of other rights and as such, it can be limited. Even in one of the oldest democracies - the USA - there are debates on whether or not America's First Amendment confers absolute rights of the media and expression, or there are specific justifiable limitations (Packard, 2010).

Criminal charges can be invoked for disturbing public peace through publications in the conventional media (fourth estate) or in the new media (fifth estate). The internet is a fairly easy and accessible medium for committing the publications or communication related crimes, in the same way conventional defamation can be committed against individuals and organisations there. There is need to trace how libel or criminal defamation charges have been instituted in countries of the North and South such as Zimbabwe and Tanzania, and the USA against communicators that use internet and other channels of public communication. When assertions are made that criminal defamation is undemocratic, archaic and backward, is this a statement to dissuade and censure countries of the South that are often viewed as lagging behind in adherence to ideals and tenets of modern democracy? These countries seem to have a higher prevalence of such type of litigation. Are criminal defamation and the criminalisation of expression, including sedition and criminal insults of powerful politicians, a universal phenomenon found even in so-called developed and progressive nations? When a country such as the USA arrests and gives a lengthy sentence to Chelsea Manning for leaking sensitive materials in the so-called Cablegate case, or when it demands the arrest of activists such as Edward Snowden or investigates a man like Julian Assange, what are the ethical and legal implications given that some sections of global society view these accused as iconic proponents of freedom of information? Again are states justified in intruding into the personal communications of all citizens, and alternatively, do 'whistleblowers' such as WikiLeaks have a right to publish personal information which is not of 'public' importance? All these questions have a bearing on criminal libel.

METHODOLOGY

This chapter uses the words 'defamation' and 'libel' interchangeably. This chapter purposively selects archival materials on publication on criminal defamation and other criminal charges pertaining to utterances and publications both in the traditional media and in new internet based media in Africa and the rest of the world. The literature review seeks to establish what has been prevailing especially in older democracies such as the United State of America. Materials are then presented on recent cases where utterances or publications were criminalized with or without successful prosecution in selected African countries such as Zimbabwe, Tanzania, Mozambique and South Africa. The focus is also important especially in instances where criminal defamation arose out of publications on new internet based media platforms such as blogsites and Facebook. The researchers used both published books and the internet to establish conveniently selected cases that were brought before the courts of law in the twenty-first century and what verdicts were passed on criminal defamation and general criminal offenses pertaining to utterances and publications, in digital media of whatever form. The methodology is particularly aware of the nebulous area of criminal defamation and its intersection with other criminal charges like sedition, where 'whistleblowing' and disclosure of state secrets raised controversies on the public's right to know and states inclination to keep 'secrets' or protect the public peace and order. Packard notes that 'defamation … has always been the bane of traditional media, but is now increasingly applied to 'average people' who post damaging accusations on websites, blogs and listservs." (pviii)

Again the methodology of selection of cases might appear 'over-stretched' because there are various technologies used for the different digital media platforms that make communicative action possible. For instance, Packard (2010) outlines the ubiquity of 'digital media' and its equally wide-ranging relationship and implications for media law. Digital media law, just like digital media, "is characterized by it general applicability". Alongside the conventional or traditional media such as newspapers, books, television and radio there is now the electronic forms of the very same 'traditional/conventional' media channels, as well as digital media channels such as websites, web logs, pod casts, vod casts, videos on U-tube, and social networking sites. While the wide-rangingness of media and digital media are openly both beguiling and intimidating from a conceptual point of view, escaping neat definition and demarcation in most cases, the same applies to the possibility of cases or law suits that can arise from the use and infringements of communication on these platforms or channels. For instance, Packard's ambitious book reflexively entitled *Digital Media Law* claims that within the orbit and confines it seeks to address a plethora of media law and digital media law issues and concerns. Packard (2010, p. vii) argues knowledge about media law should not be confined to traditional media organisations since the revolution in the production and access to information through digital media means "(w)ith the right equipment, anyone can produce a website, listserv, blog or video with the potential to reach a mass audience. When *anyone* can become a media producer, *everyone* should know something about media law – both to protect their own rights and to avoid violating the rights of others".

Cases cited in this chapter range from threats of arrests, arrests with or without prosecutions in courts of law, and those that have been tried in courts of law leading to final verdicts. The 'legal' process is intricate and problematic with citable cases wielding different 'legal' status hence the need to cite these diverse cases in their diverse stages of occurrence. What is important is that they appeared in the public domain through publication in the mass media. Zimbabwean cases dominate due to the availability of these to the authors and researchers, but also because Zimbabwe has received incessant media coverage in the last two decades and the Zimbabwe state is also often accused of blatant disregard for media

freedom, much as section 61 and 62 of the new Zimbabwe constitution categorically extend to citizens freedom of information and freedom of expression and freedom of the media (Mhiripiri, 2015). A case is also cited from the African Court on People's and Human Rights in order to ascertain what the overall projection of perception on the issue of freedom of the media and expression is in a court that adjudicates over a continent which is generally viewed as lagging in development and adherents to modern principles of human and media rights. The chapter is also cognizant of the existence of legislation on cyber-crime such as Tanzania's Cyber-Crime Act of 2015.

THEORISING CRIMINAL DEFAMATION AND CRIMINALISATION OF EXPRESSION

According to Steve Forster (2003, p. 436-437) "(a) defamatory remark is one that causes a person to be shunned or avoided, or subjected to ridicule, hatred or contempt. Alternatively, the statement must lower the person's reputation in the eyes of right-thinking members of society". Zimbabwean lawyer Jeff Feltoe (2002) notes that criminal defamation, is qualified from civil defamation on the basis of the gravity or seriousness of the former. However, several other scholars make a distinction on the fact that criminal defamation involves state prosecution of the offending party on behalf of the party whose reputation has been injured, and there is the possibility of imprisonment of the guilty party (Beyene, 2011; Creech, 2007; Crone, 2002: Pember & Calvert, 2005/6). In some instances, state institutions can file criminal defamation suits to protect their own image or reputation in the public perception as was the case in Zimbabwe where some laws prohibited the media and individuals from bringing state institutions into public "disaffection" (Mhiripiri, 2013).

Underlining defamation and criminal defamation is the need to protect reputation. Invariably, it can be protection of reputation and dignity of an individual, an organisation or even state institutions and public officials from reckless or malicious injury to their character and self-esteem in the eyes or regard of other people in society. Criminal defamation, according to Zimbabwean media law scholar Geoff Feltoe, is of 'a serious nature and courts consider factors such as extravagance of the allegation, the extent of the publication and whether the words are likely to have results that may detrimentally affect interests of the state and community' (2002: 12). Kenneth Creech (2007, p. 348) makes a distinction between civil and criminal defamation cases as follows situating the definitions in the US context:

Civil law provides monetary awards for successful plaintiffs. On the other hand, jail sentences are part of the punishment for those who violate criminal law. Many states have criminal libel laws on the books. These laws were designed to punish those who might utter words that provoke riots or otherwise threaten the public order and are rarely enforced today.

The area of defamation, criminal defamation and the criminalisation of media and communication in general are slippery and tricky terrain as it is contextual and situational. For instance, the US government entities do not sue for defamation although public officials and bureaucratic can sue in their own personal capacity. Packard (2010, p. 180) clarifies on the same US system:

Government entities may not sue for defamation under the theory that the government should not be permitted to use public funds to prevent the public from criticizing it. But government officials are en-

titled to sue on their own behalf. By necessity, public officials are subject to greater scrutiny than private citizens, so courts require them to meet a higher standard of proof in defamation cases.

Where the American state permits an individual to sue for criminal defamation the theoretical understanding is that there are critical instances when it is proper for the state to act on behalf of the party harmed by the libel and bring criminal charges against the defendant (Pember & Calvert, 2005/6). The state takes responsibility due to the perceived gravity of the matter and in order to eliminate the possibility of citizens taking the law into their own hands and eventually provoking anarchy.

The Zimbabwe government on the other hand has used legislation to protect the state President and institutions, to such an extent where a public official may claim that their reputation has been injured beyond a personal level, but to extend the injury to the very status of the public office they occupy.

Zimbabwe's Criminal Law [Codification Reform] Act's (Chapter 9:23)(No 23 0f 2004) Chapter 111 on "Crimes against the State") states that speakers, authors and publishers can attract criminal charges if they are deemed guilty of:

30. *Causing disaffection among Police force or Defense forces.*
31. *Publishing or communicating false statements prejudicial to the state.*
33. *Undermining authority of or insulting the President.*

Again, the country's Access to Information and Protection of Privacy Act's Section 80 on Abuse of Journalistic Privilege criminalizes publication of information, which (a journalist) intentionally and recklessly falsified or fabricated in a manner that:

1. *Threatens the interests of defence, public safety, public order, the economic interests of the state, public morality or public health; or*
2. *Is injurious to the reputations, rights and freedoms of other persons.*

These acts explain why several politicians and government officials have sued the media for criminal defamation, although fortunately there have never been successful convictions. The insult laws which protect the image and reputation of the state President have also caused many people to stand trial.

Don Pember and Clay Calvert's book *Mass Media Law* has provided comprehensive material on how libel can be committed on Internet. Indeed scholarly publications that draw empirical examples from the countries of the North still cite criminal charges against both media and individual communicators. In the US nowadays more criminal libel charges are often made against individuals operating websites than journalists. In worse situations, naïve students who use the Internet to criticise their schools have also fallen foul to the law (Packard 2010, p. 193).

Several countries still have criminal defamation statutes which continue to be evoked to control both unprofessional media practices or just to stifle genuine critical media. Yes, indeed, the media are not all saints and can be operated by unscrupulous persons without regard for other people's rights and dignity. For instance, in Kenya there is a 'gutter' press that appears and disappears unceremoniously, and quite often blatantly scandalizes politicians and public figures without respecting the best norms and practices of media. The state has been forced to use criminal defamation and other restraining measures to bring order amongst these. Some of Kenya's fly-by-night publications have been described thus:

Kenya's gutter or alternative press would best be described as "now-you-see-them-now-you-don't" after their nature of appearing only when there is a major scandal involving the nation's politicians or socialites. These papers range from a single A4 sheet to as many as 12 pages. It may be sold on news-stands, but more often on street corners for less than half the price of the daily newspapers. Most are technically and editorially mediocre with occasional but unpredictable flashes of brilliance. Generally, these publications have no fixed address, no known publisher, and tend to focus on rumor and sometimes make very spectacular claims. These papers often draw the ire of the Kenyan government. Three are worth mentioning: The Weekly Citizen, Kenya Confidential, *and* Independent. *The later was recently shut down after the publisher-editor was arrested and jailed for criminal libel. He has since been released on presidential clemency. (Fackler et al, 2011, pp. 632-33)*

In another East African country, Ethiopia, media scholar Zenebe Beyene (2011) notes that "many press defendants were accused of criminal defamation laws and were charged by prosecutors" (p. 724) and actually served time in prison (pp.717- 724). Unlike in the U.S where precedence was set in the *New York Times vs Sullivan* case, in Ethiopia public officials are not open to scrutiny and often win the criminal libel suits. Beyene contrasts Ethiopia with the U.S:

In the United States it is nearly impossible for a public official to win a libel suit. "Public officials and public figures have to prove a higher level of fault than do private individuals." *Government or public officials must prove actual malice to win libel lawsuits. Cases such as* New York Times *vs. Sullivan are evidence of this. Public officials should be open to public scrutiny. (Beyene 2011, p. 721, emphasis as in original)*

While law might be used to restrict speech and expression, it is still prudent to "minimally" use regulatory powers of the state to curtail excesses of expression or the media. Freedom cannot be absolute. Some scholars prefer restrictions confined within the precincts of civil defamation to protect individuals from unreasonable injuries to their reputations (Adam, 2009; Mill, 1967). Seditious libel or expression or media crimes committed directly against the state should also be "legitimately… used to protect democratic institutions from disruptions that would prevent them from operating." In his widely celebrated thesis, *On Liberty*, John Stuart Mill justifies limits on speech where speech, the press, or what we commonly refer to as the media today, might incite rioting or subject an individual or group to risk (Adam, 2009, p.325). These *justifiable* restrictions to speech and expression, must on the whole promote a higher humanism, justice, peace and stability, and they are applicable to both traditional media (the fourth estate) and non-professional mass communicators who constitute what is now known as the fifth estate most of whom operate digital media platforms (Chiumbu, 2010; Mhiripiri & Mutsvairo, 2013).

It is now possible to abuse journalistic ethics and professionalism through social media and citizen journalism, in the same way it is possible to publish litigious materials that constitute all forms of defamation or are just potentially criminal. Social media and citizen journalism are part of what is now defined as the Fifth Estate. This is that emergent space where ordinary people who are not necessarily media professionals who neither work for specific media institutions publish their stories (Hyde-Clarke, 2010). While features of the regular 'Fourth Estate' include institutionalization through bureaucratic media organisations, capitalization, regulation and professionalism, the emergent Fifth Estate is largely

a de-institutionalized, de-capitalized and de-professionalized space. There are also erroneous assumptions that the latter is also de-regulated although cases involving the arrest and prosecution of those who have published supposedly offensive materials on social media shows evidence to the contrary. The Fifth Estate is quite often on the Internet appearing as blog sites or social media networks such as *Facebook*, *Twitter*, *Badoro*, and *Linkedin,* or it is the publications on smartphones using Whatsapp, twitter, etc. In short, professional and non-professional users of the World Wide Web and other digital media must realise that courts regard communications and publications here similarly to what is published or disseminated through so-called traditional media such as books, newspapers and magazines (Pember & Calvert, 2005/6, p. 146). While whistleblowing is traditionally considered a normative role of the media, evidence below shows that courts and the state can be harsh and intolerant to whistleblowers who are not 'journalists' in the conventional sense, but leak sensitive information online or via the media.

ETHICS, CRIMINAL DEFAMATION, AND THE CRIMINALISATION OF MEDIA AND COMMUNICATIONS IN THE DIGITAL AGE

Media ethics are usually compatible with legal expectations except in a few instances. Ethical standards are supposed to bring creditability and respect to the media profession. Professional standards of communication are outlined by most media organisations and civil society. Nonetheless, private citizens who participate in both interpersonal and mass communications are generally expected to respect the best communicative norms and values, notwithstanding that there have been a laxness with regards to how they are penalized if they breach ethical codes. For instance, it is not unusual to find private non-professional communicators publishing certain materials recklessly, even when such materials have no legal repercussions. A good example is how some individuals insensitively publish horrific scenes of violent accidents without giving consideration to how this can be distressing to their 'audiences'. Just because non-professionals are capable of being mass communicators using digital technologies the same ethical expectations that govern the mass media (see Wilkins & Christians, 2008) must be applicable to this new breed of 'mass communicators'. Some countries now have codes of standards for digital media. Voluntary Media Council of Zimbabwe (VMCZ) in 2015 crafted a code of ethics that is applicable to all media houses and those individuals involved in mass communication. This Digital Media Code of Ethics which is widely distributed, including on the VMCZ's website[1]. While there are no remarkable or exceptional characteristics of the code that differ from the best practices expected of traditional media, it is notable that digital media is receiving timely attention and consideration. The emphasis on the technical qualities of the mode of publication seems not to demand any really new ethical consideration worth underscoring due to the very nature of the technology used. The same old ethical requirements for traditional media remain relevant, although there is a renewed emphasis on digital media. It is commendable that ethics and digital media are beginning to receive the attention that they deserve as shown from scholarship from developing countries such as Zimbabwe where media and public communication are often presented as under siege from an over-bearing state system (Chari, 2013; Moyo, 2015.)

Whereas Codes of Ethics for traditional media appear to be targeted at professional journalists and media practitioners, the VMCZ code has a wider application. It is expected to apply over "groups and individuals, traditional media practitioners (print and broadcast), registered and unregistered organiza-

tions/companies that share information using digital media and have agreed to be bound by this Code and have to submit to the disciplinary jurisdiction of the Voluntary Media Council of Zimbabwe (VMCZ)". This new digital media code does not directly refer to 'protection of reputation' or libel or defamation, although it is inferable that these critical issues subsist within the conceptual framework of various ethical clauses.

THE PUBLIC INTEREST AS DEFENSE FOR FORMS OF DEFAMATION

There are several recognised defenses for defamation and criminalisation of the media, paramount of which is the public interest. While countries such as Zimbabwe have declared criminal defamation is unconstitutional and unacceptable in a democratic society, the citizens' right to know crucial information remains pertinent and over-riding. Citizens have to make important decisions in the general conduct of their lives, from making business choices as well as making decisions on the election of political leadership. The Press Complaints Commission Code of Practice of the UK, whilst it has no legal standing, defines 'public interest' from the perspective of the journalist. Public interest includes but is not limited to, amongst other crucial components:

1. Identifying or revealing crime or serious impropriety,
2. Protecting public health, peace and safety,
3. Protecting the public from misleading statements or action by an organisation or organisations,
4. Protecting freedom of expression (Bloy, 2007: 59-60).

The media have however the responsibility to prove that they are serving the public interest when publishing any contentious materials. When the media seem to contradict ethical requirement such as the reporting of sensitive materials leading to the disclosure of identities of minors or victims of sexual assault, the editors must demonstrate that public interest 'overrides the normal standards of journalistic practice such as protecting the interest of the child or of victims of sexual assault. Some information might 'interest the public' but do not carry convincing justification of public interest. It is therefore arguable, in the public interest, to show that a government such as that of the US is becoming too intrusive and overbearing over citizens' right to privacy if that government snoops into the private details or communication of private citizens who do not pose a danger to other citizens or society in general. Therein lie the major controversies of exposures made by people such as Chelsea Manning, Julian Assange and Edward Snowden.

CASES OF CIVIL DEFAMATION OR CRIMINALISATION OF COMMUNICATION AND INFORMATION DISSEMINATION

Chelsea Manning, Julian Assange, and Edward Snowden and the Public Interest

Three computer and internet linked people are remarkable icons of the debate on media law, ethics and social justice in the digital age. These are Chelsea Manning, Edward Joseph Snowden and Julian As-

sange. Manning, who worked in the US army, leaked information to WikiLeaks about US war crimes and other major revelations of public interest. Considered by many as a hero, Manning was apprehended and is serving 35 years in prison for leaking sensitive information. Snowden, an American computer professional and former Central Intelligence Agency employee, also leaked to the mass media classified and highly confidential information from the US's National Security Agency in 2013; and Julian Assange an Australian born computer hacker published the WikiLeaks. Snowden leaked information to *The Guardian* and *The Washington Post*, before the same material was published in *Der Spiegel* and *The New York Times*, following which it was picked up by all sorts of global media. His disclosures made known to the world how NSA with the cooperation of telecommunications companies and European governments willfully subjected world citizens to global surveillance disregarding their privacy. The fight against global terrorism makes governments such as that of the US codify anti-terrorism statutes that empower them to snoop into private citizens communications as a preemptive measure to stop mindless terrorism especially in the wake of the 9/11 attacks. However, this 'noble' action means a majority of innocent law abiding citizens are subjected to constant monitoring thereby compromising their privacy and dignity. The powers of states and companies are therefore questioned when counterposed to the rights and privacy of such innocent citizens. Due to Snowden's disclosures the US Department of Justice charged him for violating the Espionage Act of 1917 for theft of state property. Snowden is currently a refugee in Russia, but his actions triggered a debate on whether he is a hero and whistleblower working in the global public's interest, or a dissident and traitor. Mass surveillance, government secrecy, national security and information privacy became poignant moral, ethical and legal subjects, especially when viewed within the context of anti-terror statutes such as the Patriots Act and cyber-crime acts enacted in various countries.

Besides Snowden, Australian citizen Julian Assange is another controversial notable 'media' figure in the digital era. Assange who describes himself as Editor-in-Chief of WikiLeaks, in 2006 founded with his colleagues the secret information and news leaks site. The site specialised in publishing thousands of protected documents of public interests, documents which Assange described as "a giant library of the world's most persecuted documents"[2]. Again Assange has elicited different responses and attitudes from world leaders and governments, celebrated by some and vilified by others. In Australia his work was considered 'illegal' by the Prime Minister although Australian police noted that Assange had broken no Australian law.[3] The US government purportedly investigated Assange and WikiLeaks with the intention of prosecuting him under the Espionage Act of 1917. When someone engages in hacking and publishing the secret information online, it is possible for complainants – organizations, states and individuals – to sue the perpetrator wherever they are. Writing specifically on defamation Bloy (2007, 17) notes that the internet transcends jurisdictional boundaries because literally anyone throughout the world can access the websites in question; hence the person allegedly defamed can logically sue wherever they believe their reputation has been damaged. The claimant only needs to show that the tort (wrong) was committed in that specific area, and that he or she has a reputation of a sufficient magnitude to protect or uphold within that jurisdiction or area. Both the Snowden and Assange cases definitely pose the problematique of whether global citizens are willing to forego their individual rights in preference over global security, but immediately critiquing the possibilities of states and companies abusing the private information their acquire from 'unknowing' innocent citizens.

Traditional media that have relied on informants who request confidentiality in exchange for vital information leaks also now largely using computers and internet in their news gathering, production and dissemination. This has forced to them to find ingenuous means of concealing certain information from

state surveillances. Some of the efforts are to protect whistleblowers such as Manning and Snowden, but others are merely to protect the media in the digital age when storage of sources and sensitive information is in computer files prone to state surveillance or direct seizure (Lowenthal, 2015).

NEW WIKILEAKS AND EMERGING ETHICAL COMPLEXITIES

Whistleblowing is not always steeped in the values of presenting accurate information to the public in the most responsible manner as Sandra Upson (2016) has divulged in the article "WikiLeaks has morphed from journalism hotshot to malware hub". Since investigative whistleblowing is also bedeviled with the vagaries of personality and state politics, paranoia, fear and other challenges which make online activists vulnerable and frail, such activists can easily degenerate into non-admirable psycho-political states of existence. Assange's case is remarkable. He no longer has an amicable relationship with the public media which partly publicised his radical efforts. He is holed up as a refugee in the Ecuadorian embassy and threatened with a sexual harassment case. The US government's arrest and sentencing of Manning to 35 years in prison unnerved Assange and Snowden. The relationship between Assange and newspapers such as *Guardian* and *Times* soured. WikiLeaks became more critical of conventional journalists. The new WikiLeaks releases are criticised for "wanton release of personal data", disclosing personal details of private citizens who remotely have links with public administration or corruption. WikiLeaks' stance in the US 2016 Presidential run-up is also viewed with suspicion as there seems vindictiveness in bringing down Hillary Clinton at all costs. The sites' discretion and competence in judging what type of content ought to be disclosed has been questioned. Information mismanagement is another indiscretion. Casual visitors to the WikiLeaks sites are also endangered as hackers can install a bot that enables hackers to take over computer files of unsuspecting readers. Some visitors have been forced to pay "ransom" when their files are encrypted and a payment is demanded. Files are infected and WikiLeaks does little to warn its visitors who visit thinking they are going to read 'public truth'. Besides carelessly disclosing the names of Afghans that collaborated with the US military, thereby putting these Afghans lives to imminent danger, the journalists and the public seeking 'truth' from the WikiLeaks files risk emerging infected. Writes Upson; "WikiLeaks has degraded into a malware snakepit".

ZIMBABWEAN CASES

In Zimbabwe limitation of the right to freedom of expression was provided for under the Lancaster house constitution that was adopted at the time of independence from colonial rule in 1980, and is similarly encompassed in the current constitution of Zimbabwe Amendment Act no. 20 of 2013 as is the case with other national constitutions albeit to differing degrees. According to Mhiripiri (2013) in Zimbabwe there were lots of court actions for criminal defamation prior to the rendering of the crime as unconstitutional in 2014. The Zimbabwean Supreme Court ruled in a case in 2014 that the charge is undemocratic, archaic and a disproportionate punishment for any form of defamation. Then, Criminal defamation cases were frequently instituted by public officials and politicians who argued that their reputations were not only injured in their personal capacity, but that there was adverse harm on the integrity of the very offices they occupied.

Despite the 2014 ruling there continued a tense debate with government insisting on the relevance of criminal defamation and the need to retain the offense on the statures. Pro-criminal defamation exponents argued it provided a deterrent to media excess and maliciously reckless communication. Freedom of the media activists argued that criminal defamation is often used in Zimbabwe and other developing nations as an instrument of press censorship in order to brow-beat the media into submission and compliance. Politicians and the public officials holding state position use criminal defamation as a convenient arsenal against pertinent media scrutiny.

There followed an increasing number of cases referred to the constitutional court challenging the constitutionality of various laws that criminalise expression including criminal defamation. Most of these referrals have been in respect of provisions of the Criminal Law (Codification and Reform) Act, [Chapter 9:23] such as section 31 which criminalises the *publication or communication false statements prejudicial to the State*, section 33, which provides for the offence of *undermining authority of or insulting President* and section 96 which provides for the offence of *criminal defamation* among others.

What has been particularly common in the determination of recent cases particularly by the current constitutional court of Zimbabwe, is the fact that while freedom of expression and media freedom are not absolute rights, their limitation has to be carefully balanced to avoid a situation whereby they are severely limited to the extent of eroding the constitutional guarantee altogether. The constitutional court has also emphasized the need to employ the most appropriate and proportionate measures in limiting freedom of expression. Both the old Lancaster House Constitution and the new constitution adopted in 2013 provide that freedom of expression can be limited by a law in the interests of defence, public safety, public order, the economic interests of the State, public morality or public health besides the protection of reputations of other citizens.

Three recent cases in particular, have had extensive effect on the criminalization of expression that is, Constantine Munyaradzi Chimakure, Vincent Kahiya & Zimbabwe Independent Publishers v The Attorney General [Constitutional Application No. SC 247/09], Nevanji Madanhire & Nqaba Matshazi v Attorney General [Judgment No. CCZ 78/12] and recently that of MISA-Zimbabwe & 4 others v Minister of Justice, Legal and Parliamentary Affairs & 2 others [CCZ7/15].

Aside from the MISA-Zimbabwe case, the judgments in these earlier cited cases elicited increased national discourse on the validity of criminalising people's expression such that in 2015 alone, more than three cases were filed or referred to the constitutional court seeking declarations of invalidity of criminal defamation in terms of the obtaining constitution.[4] [5]This was amidst growing confusion of the fate of these laws in light of the fact that on one hand judgments in the aforementioned cases had indicated that the declarations of invalidity of these two cases had been in terms of the former constitution. On the other hand, the state including the minister responsible for Justice legal and Parliamentary Affairs, insisted that the laws remained in force[6].

Despite the uncertainty that lingered on whether the false news and criminal defamation laws survived the declaration of constitutional invalidity, the Zimbabwean constitutional court in aforementioned cases made a number of insightful and key pronunciations regarding the balancing of freedom of expression on one hand and state and public interests on the other and to what extent and by what means the right to freedom of expression can be justifiably limited. The two cases are discussed below briefly. A few other Zimbabwean cases will also be discussed that bring different dimensions to criminalization of other forms of expression, specifically, online expression.

We acknowledge this chapter ought to focus more on the digital media and their interaction with the criminal law or criminal libel, rather than traditional media. However, the cases involving traditional

media can provide a solid background of what has been prevalent before and allude to the implications for social or digital media in some African context. Admittedly, most African journalists have been prosecuted for their publications in traditional media as compared to new media, probably because the latter are a relatively new phenomenon.

Constantine Munyaradzi Chimakure, Vincent Kahiya, and ZimInd Publishers (Pvt) Ltd v Attorney General of Zimbabwe [Judgment No. SC 14/2013]

The two appellants, a journalist and editor of "*The Independent"* a privately owned Zimbabwean newspaper, and the third applicant a representative of their publishing company, were in 2009 arrested and charged for the *publication or communication of a false statement which harms or is likely to harm the interests of the State in the performance of its functions*. The offence is provided for under section 31(a)(iii) of the Criminal Law (Codification and Reform) Act [*Cap. 9:23*) ("the Criminal Code"). This followed two newspaper stories that they had written and published collectively.

After the initial court appearances at the Magistrates court, the trio applied for referral of their case to the Supreme Court claiming that the provision under which they were charged was in contravention of the right to freedom of expression as provided under section 20(1) of the Lancaster House constitution. In trying to determine whether or not there was any infringement of the applicants' constitutional right to freedom of expression, the Constitutional court looked at a number of key aspects relating to the nature and scope of freedom of expression including what follows below.

Scope of Freedom of Expression

The court outlined that the right to freedom of expression as guaranteed in section 20(1) had three dimensions that are intertwined and which should be respected equally[7]. The three were described as;

1. An internal dimension (the formation and holding of opinion, ideas and information);
2. A communicative dimension (the expression of opinion, imparting of ideas and information); and
3. An external dimension (the effect of opinions, ideas and information on the addressee or the audience i.e. on the rights of others or public interests listed in s 20(2) (a) of the Constitution.

It was further clarified that the right to freedom of expression guarantees protection to the communicative process as well as the effect on the audience that is caused by a particular dissemination of ideas or information. Nevertheless, the state may interfere only when the activity or expression poses danger of direct, obvious and serious harm to the rights of others or the public interests listed in s 20(2) of the Constitution.[8]

Protection of Freedom of Expression and Truth

The court also emphasised that limitation of freedom of expression is not per se, derived from the falsity of a statement or publication but more on the actual or potential harm caused. In emphasis of this point, the court pointed that;

What is protected is really the indivisible freedom of everyone to speak even when they may after they have done so be called liars. Anyone has a right to impart or receive ideas and information about the activities of security service institutions regardless of the falsity or truth of the message conveyed, provided no harm or real likelihood of harm to the rights of others or public interest results in breach of law[9].

Permissible Legislative Limitation of the Exercise of Freedom of Expression

The court also noted that any kind of freedom can be abused and thus harm others or the public interest and as such its exercise has to be limited but the measures to limit this right must conform to the principle of proportionality.[10]

The interference imposed in terms of the impugned law must be limited to being a restriction or hindrance of the enjoyment of the exercise of the right to freedom of expression and it must be exclusively directed towards the pursued legitimate aim.

Proportionality of Measures Employed to Limit Freedom of Expression

The applicable penalty was also analysed to see if it was a proportional to the legitimate aim being pursued and the seriousness of the offence and the court went on to hold that the twenty year imprisonment term impossible for this offences was "draconian" and that the only inference that could be drawn from such a lengthy maximum penalty of imprisonment was that it was intended to have a chilling effect on the exercise of the right to freedom of expression by all citizens rather than to simply deter persons from the prohibited acts. Having determined thus, the court went on to hold that;

- The chilling effect of the disproportionate threat of the period of the maximum penalty of imprisonment to which a person convicted of the offence is liable harms operations of a free media.
- By authorising the discretionary imposition of a maximum punishment of twenty years imprisonment for offences amounting to attempts, s 31(a) (iii) of the Criminal Code has a serious inhibiting effect on the exercise of the right to freely criticise public institutions in the performance of their functions.
- A strong constitutional protection of freedom of expression cannot tolerate the imposition of self censorship on free speech and press through fear of lengthy sentences of imprisonment for offences of publishing or communicating false news.
- Taking into account the fact that freedom of expression is peculiarly more vulnerable to the "chilling effects" of criminal sanctions than any other fundamental right as stated by the UN Special Rapporteur on freedom of opinion and expression, penal sanctions particularly imprisonment, should never be applied to offences of publishing false news.
- The higher the level of the maximum penalty of imprisonment the greater the chilling effect on freedom of expression.

With this, the court declared that section 31(a) (iii) of the Criminal Law (Codification and Reform) Act [*Cap. 9:23*) ("the Criminal Code") was in contravention of the right to freedom of expression as provided for in section 20 (1) of the Lancaster house constitution in operation at the time and therefore void.

Nevanji Madanhire and Nqaba Matshazi v Attorney-General [Judgment No CCZ 2/14]

The two an Editor and journalist at "*The Standard* " newspaper at the time, were in 2011, arrested and charged with criminal defamation as defined in section 96 of the Criminal Law Codification and Reform Act following a story written and published by the two Applicants collectively. The offence of criminal defamation criminalises the intentional publication of false material which causes serious harm to another person's reputation. If found guilty of this offence one faces a fine or imprisonment of up to two years or both. Following their arrest and appearance at the Magistrates court, the two applied for the offence of criminal defamation as defined in s 96 of the Criminal Law Code to be declared unconstitutional and struck down and ultimately for the perpetual stay of their prosecution for this offence. The determining the constitutionality or lack thereof of criminal defamation, the court analysed a number of key aspects including the following.

Whether or Not Criminal Defamation Is a Justifiable Limitation of the Right to Freedom of Expression

The court conceded that criminal defamation is one of the permissible derogations or limitations of the right to freedom of expression but aimed at the protection of the rights and reputations of other persons. However while this objective was so observed and well accepted, the limitation of this right to this and such means was questionable in as far as its proportionality to the harm likely to be caused and to the interests as stake. The court thus considered at length whether it was necessary to criminalise defamatory statements in order to protect the said interests. In considering thus, the court made a number of observations including that criminal defamation has a stifling or chilling effect on the right to speak and to know by its very existence. This Judge Patel noted was:

… the more deleterious consequence of its retention in the Criminal Law Code, particularly in the present context of newspaper reportage.... This, in turn, may result in the citizenry remaining uninformed about matters of public significance and the unquestioned and unchecked continuation of unconscionable malpractices.[11]

The court also went on to observe that it is impossible to expect the media to perform its investigative and informative functions without defaming one person or the other

Proportionality of the Penalty

Also scrutinized, was the effect and proportionality of the maximum two year imprisonment sentence. On this, the court noted that the sentence only serves to exacerbate the chilling effect caused by criminalising defamation and further stressed that the sentence was "excessive and patently disproportionate" to the intended purpose of prohibiting the publication of statements that injure the rights and reputations of others.

Adequacy of Civil Remedies

Having declared that criminal measures and the accompanying term of imprisonment were excessive and disproportionate to the objective of protecting the rights and reputations of other persons, the court went on to hold that the offence is not reasonably justifiable in a democratic society and was inconsistent with the freedom of expression guaranteed by section 20(1) of the constitution at the time and therefore void. The court further noted that the country has in place "an appropriate and satisfactory alternative civil remedy ....to combat the mischief of defamation[12]." The essence, the constitutional court in this case emphasized and based its decision on a number of issues similarly observed in the aforementioned case of Chimakure and Kahiya which include that;

- Criminalising defamation results in harmful consequences such as the chilling possibility of arrest, detention as well as imprisonment and that these are excessive in effect.
- While the objective of the criminal defamation offence is to protect the reputations, rights and freedoms of other persons, criminalising defamation is a disproportionate remedy to the objective being pursued.
- The harmful and undesirable consequences of criminalising defamation such as the chilling possibilities of arrest, detention and two years imprisonment, are manifestly excessive in their effect
- The effect of criminal defamation extends to the public as well as it stifles and silences free-flow of information in the public domain resulting in an uninformed citizenry on matters of public significance.
- It is unnecessary to criminalise defamatory statements as the country's civil remedies for defamation afford ample compensatory redress for injury to one's reputation or dignity.

2016: Criminal Defamation Put to Rest

Media Institute of Southern Africa (Zimbabwe Chapter) and 4 Others v Minister of Justice, Legal and Parliamentary Affairs and 2 others CCZ07/15

In February 2015, MISA-Zimbabwe together with three journalists (2nd to 4th Applicants) and one citizen and independent publisher filed a constitutional court application seeking clarity on the status of the criminal defamation offence under the new Zimbabwe Constitution following the Madanhire judgement (CCZ 2/14).

The application was necessitated by the fact that the 2014 Madanhire v Attorney General Judgment indicated that the declaration of invalidity of criminal defamation was in respect of the right to freedom of expression under the previous Constitution of Zimbabwe. Further in that judgment, PATEL J had included a passage that suggested that as the formulation of the right to expression in the new Constitution was different, it was possible that the offence of criminal defamation would be constitutional in terms of the new constitution, thus creating uncertainty on whether the law was still alive or not under the current constitutional dispensation.

At the 3rd of February 2016 hearing MISA-Zimbabwe advanced the argument that by virtue of the declaration that criminal defamation was void, the Madanhire judgment had in effect removed the offence from Zimbabwean law. The State representatives eventually conceded this argument and an order to this effect was granted confirming that criminal defamation is no longer a part of Zimbabwean law.

Online Expression: State v Vikazi Mavhudzi

In 2011, Mavhudzi was charged with contravening section 22(2) of the Criminal Law (Codification and Reform) Act [Chapter 9:23] i.e. "subverting a constitutional government" for allegedly suggesting to the then Prime Minister Mr Morgan Tsvangirai to take over or attempt to take over the government by unconstitutional through a facebook post on the Prime Minister's facebook page. The facebook post in question allegedly read; "I am overwhelmed don't know what to say PM, what happened in Egypt is sending shock waves to all dictators around the world. Worth emulating hey." The charges against Mavhudzi were later discharged the same year for lack of evidence

State v Matsapa

Zimbabwean police arrested Ernest Matsapa in 2016 for circulating a video on social media to a Whatsapp group called Nyanga Free Range. The audio-visual clip was considered as "denigrating the person of" President Robert Mugabe hence Matsapa appeared in the Nyanga Magistrates court facing charges of criminal nuisance for alleging the president was too old and a burden to all Zimbabweans."The audio and video clip has the impression that the President Cde Robert Mugabe is incapacitated and has become a burden to the majority including his family due to diminishing responsibility." Matsapa could be jailed for potentially attempting to destabilize the country through publication of utterances that could cause Zimbabweans to lose trust and confidence in the presidency. Such criminal cases have inherent potential to cause riots, violence and instability.

THE SOUTH AFRICAN APPROACH

Hoho v The State [2008] ZASCA 98 -

In this case which involved a non-media person charged with criminal defamation, the South Africa's Supreme Court of Appeal held that the crime of defamation was consistent with the constitution of South Africa. The Court held that the crime of defamation still exists. In arriving at this decision, the court pointed presented several arguments, amongst which was the drawing of similarities between civil and criminal cases of physical assault before the courts, and that of defamation. The court pointed out that

… there is also a civil remedy available for common assault, yet nobody would suggest that there is for that reason no need for the crime of common assault. There is in my view no reason why the state should oblige and prosecute in the case of a complaint in respect of an injury to a person's physical integrity but not in the case of a complaint in respect of an injury to reputation, which may have more serious and lasting effects than a physical assault.[13]

Motsepe Ntele Cecil v the State [Case No: A816/2013]

In 2014, the South African High Court (Pretoria) delivered judgment in the case of the *Sowetan* journalist Motsepe who had been convicted for criminal defamation relating to a series of articles that he had

published in the paper. Upon his conviction, Motsepe had been fined and in lieu of that fine he would face a ten-month imprisonment term wholly suspended on specified conditions. Motsepe then challenged both the conviction and sentence and the appeal was joined by fifteen *amici curiae* that specifically appealed to the court on the negative effects of criminal defamation on the freedom of the media and on this basis challenged the constitutionality of criminal defamation laws.

From the inception, the court concluded that on analysis, the articles in question were defamatory and that what only needed to be determined was whether or not the requisite intention to defame was present and the unlawfulness of the action by the appellant. After analyzing the facts further, the court concluded that while the appellant may have been reckless in not verifying the facts as much as he should have, recklessness still does not equate to intention and as such, his conviction could not stand. In arriving at this conclusion, the court stressed that; "Once a person thinks that the published words are covered by one of the recognised defences to a claim for defamation, such person lacks the necessary intention required for a conviction on criminal".[14]

AMICI CURIAE APPLICATION

On the other hand, the Amici Curiae's application was to the effect that the common-law crime of defamation is inconsistent with the constitution of South Africa in that it is an unjustifiable limitation to the right to freedom of the media. The application was further to the effect that the crime should be limited to the publication of defamatory statements by other persons who are not members of the media as previous decisions in cases such as Hoho, had not dealt with the impact of criminal defamation on the media and that the impact of the law on the media and on non-media persons differed.

The Amici further contended that the civil remedy for defamation provides adequate means to cure and deter defamation by the media. The application was opposed by the state on the basis that a ruling to that effect would have adverse consequences

The Effect of Criminal Defamation on Freedom of the Media

After considering regional and international standards and case law on freedom of expression, the high court held that;

- The right to freedom of expression is not unrestrained and that it must yield to the individual's right not to be unlawfully defamed and to the individual's right to dignity.[15]
- The request to have criminal defamation declared unconstitutional "undermines the constitution and the promotion of Equality and Prevention of Unfair Discrimination Act.
- The court further noted that the case for repealing of criminal defamation laws at international level was in respect of "extreme" cases of governmental abuse of journalists which in the court's view did not apply in South Africa. Instead, the court relied on the founding of the South African Constitutional Court in Dikoko v Mokhatla 2007 (1) BCLR 1 (CC) at para 141-142 where the court held that the right to freedom of expression must at times be relegated in favour of the right to dignity.

The Need to Balance Freedom of Expression and Other Competing Interests

On this aspect, the court observed that the law of defamation still requires that a balance be struck between freedom of expression and the protection of reputations and while further conceding that criminal sanctions were a drastic remedy to the intended objective that civil remedies, the high court maintained that this was cured by the fact that criminal defamation came with an extensive burden of proof to which the court attributed the low number of prosecutions under that law.[16] Having considered thus the court held that;

- Criminal prosecution of the media for defamation in not inconsistent with the constitution of South Africa.
- Even though criminal defamation limits the right to freedom of expression, such limitation was justifiable in an open and democratic society.[17]

THE MOZAMBIQUE RULING

The ruling in a Mozambique Court is remarkably significant in that it involved publication of material alleged libelous material against a state President. The alleged offending material was originally published on a blogsite then found its way into mainstream newspapers. Prominent Mozambican economist Carlos Nuno Castel-Branco and journalist, Fernando Mbanze, editor of the independent newssheet "Mediafax", were in September 2015 acquitted by a Maputo court acquitted of libeling former President Armando Guebuza. The court action had emanated from a post Castel-Branco published on his Facebook page in November 2013, lambasting then President Guebuza's governance and calling on him to resign. Two papers, *Mediafax* and the weekly *Canal de Mocambique* republished Carlos-Branco's text. Libeling the head of state and other senior political figures is considered a security offence in Mozambique; hence the Public Prosecutor instituted charges against Castel-Branco under the law on crimes against state security. For republishing the article, Mbanze was charged under the vague offence of "abuse of press freedom" under the 1991 Press Law. Initially, the director of *Canal de Mocambique*, Fernando Veloso, was also accused, but since he was in Portugal for medical treatment he was not in the dock, nor was he tried in absentia.

Delivering the verdict a panel of three judges, Presiding Judge Joao Almeida Guilherme, observed that the court analysed in detail Castel-Branco's Facebook post and found nothing libelous in it. Judge Gulherme protected Castel-Branco's freedom of opinion in view of the latter's criticism of Guebuza's governance of the country. Other people could find such criticisms unpalatable, but that did not make them a crime. On the whole, according to the court, Castel-Branco's words fell within the confines of freedom of expression, and were protected by the Constitution. Some words were considered as just criticism notwithstanding that they could be exaggerated. The court was averse to thrust itself on the unsavory "list of the most undemocratic organizations", through convicting the accused, especially when some of the accusations made by Castel-Branco were factually true, such as reference to the appointment of a convicted criminal "to command one of the main police units in the centre of the country". This was a matter in the public domain, Guilherme noted, and Castel-Branco had made "a legitimate criticism and it's reasonable to expect the government to clarify this". The court acknowledged the language used by Castel-Branco might be regarded as "impertinent and vulgar", but the law did not deal with mere imper-

tinence and vulgarity. Since Castel-Branco was ultimately found not guilty, other parties involved in the republication of his text were similarly acquitted. Judge Guilherme concluded that, however tough some people might find the language used in the article, "it is perfectly acceptable in a democracy…. People have the right to give their opinions on how the President is governing the country". The prosecution did not appeal against the ruling. If found guilty Castel-Branco could have faced a jail sentence of up to two years, although international pressure groups such as Amnesty International were already lobbying that he be regarded "a prisoner of conscience". This case is significant because it heralded the first time in Mozambican history that anyone has been prosecuted for alleged libel published on Facebook.[18]

TANZANIAN CASES AND THE ILLUSION OF NORMALCY

Tanzania is typical of countries where the criminalisation of the use of new ICTs seems to have affected ordinary people and citizen journalists more than professional journalists. By professional journalists here, we refer to those persons working in conventional media houses and are recognised news reporters fitting the old definitions and identity of newspersons (Tuchman). A recent doctoral thesis from Tanzania observes that professional journalists work easily within a legislative context where there is a Cyber-Crime Act amongst other pieces of legislation that criminalise certain forms of expression (Hassani 2016). Tanzanian journalists revealed that the Cyber Crime Act has not directly affected them in the immediate present. It is arguable that professional journalists are general conscious and sensitive and cautious about all forms of defamation hence they conduct themselves with either due diligence or they self-censor. The editorial chain of news production can also ensure that potentially litigious publications are eliminated before they attract adverse responses from those who think their reputations have been unduly or maliciously harmed.

Previously Tanzania has used older laws to prosecute for alleged social media transgressions but recently they have on the statutes the Cyber Crime Act of 2015. This act criminalises certain forms of expression as it states,

Any person who publishes information or data presented in a picture, text, symbol or any other form in a computer system knowing that such information or data is false, deceptive, misleading or inaccurate, and *with intent to defame*, threaten, abuse, *insult*, or otherwise deceive or mislead the public or concealing commission of an offence, commits an offence, and shall on conviction be liable to a fine of not less than five million shillings or to imprisonment for a term of not less than three years or to both.

Tanzanian doctoral candidate Abbasi Hassani (2016) has listed social media and defamation related cases in his recent thesis. In spite of some cases having been filed before the enactment of the Cyber Crime Act, there are several recent cases that show that there are levels of criminalisation of publication of materials regarded as offensive in that country. The first case involved a university student and the state, and is referred to as "Mwamunyage case." Benedict Angelo Ngonyani was charged for publishing on 25 September 2016 on social media that Tanzanian Chief of Defence Forces (CDF), General Davis Mwamunyange had died from poisoning. If found guilty Ngonyani is liable to serve three years imprisonment or payment of a fine of TSh5 million or both sentences.

Another notable case with a verdict is that of Isaac Emery Hubakuki, a resident of Arusha in Tanzania. He was charged for insulting President of the United Republic of Tanzania, Dr. John Pombe Magufuli. Hubakuki was arrested and charged at the Arusha Magistrate Court for publishing defamatory materials contrary to section 16 of the Cybercrimes Act. He pleaded guilty as charged. The court sentenced

him to either pay a fine of TSh 7 million or to be imprisoned for three years. Hubakuku paid the fine. Several more young and naïve people have been arrested for insulting the President or spreading false and malicious statement either on internet or Whatsapp.

Some Tanzanian civil society groups have protested about the criminalisation of communications through the Cyber Crimes Act. They a allege the law is overly harsh and potentially incriminates well-intentioned whistle blowers who possess credible information that can be used to prosecute government officials involved in crime or corruption. However, journalists interviewed by Habassi seemed to be comfortable to work in a legal environment where the new act exists (Habbasi 2016). The cosy view Tanzanian journalists present is contradicted by harsh empirical realities presented elsewhere on the continent and throughout the world about how professional journalists using digital media are surviving. We have already noted how Tom Lowenthal (2015) has observed how journalists the world over are under siege and operate under constant surveillance forcing them to "to think and act like spies" especially when practicing investigative journalism using new ICTs. Another report shows the distressing fatality figures of journalists especially those using new media technologies. Writes Catherine Guchera (2016);

According to the Committee to Protect Journalists (CPJ), over the past two decades 780 journalists worldwide were murdered while reporting or investigating stories. Many used digital tools in their daily work, which exposed them to cyber threats as well. This trend is reflected in a recent CPJ report indicating that 109 out of the 199 journalists jailed (in 2015) worked online. Article 19 has also increasingly documented attacks against journalists who work online. In many African countries as elsewhere in the world, laws have been enacted to allow security agencies to intercept communications... The ubiquitous mobile phone with built-in geolocation software makes the user traceable anywhere and at all times. Merely making an appointment can expose both the journalist and his or her source to unwanted surveillance. What is disconcerting is that while state actors and corporate entities have become more and more adept at using surveillance tools, many journalists have yet to learn how to protect themselves online.

Such details are shocking when journalists are made to pay the ultimate prize when criminalisation alone is not deterrent enough.

CRIMINAL DEFAMATION FROM THE PERSPECTIVE OF THE AFRICAN COURT ON HUMAN AND PEOPL'S RIGHTS

Lohé Issa Konaté v Burkina Faso- Application No. 004/2013

The applicant a Burkinabe citizen was charged with defamation, public insult and contempt of court arising from an article he wrote and published in one of the country's newspapers relating to one of the country's prosecutors. He was subsequently convicted and sentenced to twelve (12) months imprisonment and also ordered to pay various amounts in fines and damages including an order suspending the operation of the publishing newspaper for six (6) months.

Konate appealed against both conviction and sentence at the African court on human and people's rights (the African Court) on the grounds that the jail term, huge fine, damages and costs of suit ordered against him violated his right to freedom of expression as protected under article 9 the African Charter

on Human and People's Rights (the Charter) and under Article 19 of the Covenant on Civil and Political Rights (the Covenant). It was further argued on Konate's behalf that criminalising the tarnishing of the image of a public figure was a disproportionate sanction which brought about a chilling effect to the public when discussing public interest issues.

Konate therefore sought the following relief from the African Court among other aspects;

1. A declaration that his conviction and sentence were in violation of the right to freedom of expression.
2. A declaration that Burkina Faso's laws on defamation and insult are in contravention of the right to freedom of expression OR ALTERNATIVELY that the jail term for defamation is a violation of the right to freedom of expression and that Burkina Faso be should amend its laws accordingly.

In arriving at its decision, the court considered a number of key issues including the following;

Justifiable Limitations to Freedom of Expression

The court stressed that while the right to freedom of expression can be limited, it must still be subjected to a lesser degree of interference and that a limitation to this right is not acceptable simply because it is provided by law but rather, reasons for limiting this right must be based on legitimate public interest and the limitation must be *proportionate* to and *necessary* for the intended objective. To this end, any criminal sentence must conform to the criteria of necessity and proportionality and any that do not conform are not in sync with the dictates of the Charter. Having considered all the facts at hand, the African Court held that;

1. Custodial sentences should not be used to remedy violations of the right to freedom of expression and of the media except in "serious and very exceptional circumstances" such as in international crimes among others.
2. All sentences that were imposed on Konate were disproportionate to the pursued aim in the law and were thus in contravention of article 9 and 19 of the Charter and of the Covenant respectively and of the revised ECOWAS treaty.
3. Particularly because of the existence of custodial sentences for defamation in the law.

CONCLUSION

Criminal libel is viewed as archaic and undemocratic but it still subsists even in countries that claim to be leading in espousing principles of democracy. The criminalisation of freedom of expression or freedom to disseminate information is also an ongoing challenge apparent in the US and other states that claim to be 'civilised' and tolerant. In the US it is still possible in a number of states for individuals to institute criminal libel charges. In the digital era both media houses and individuals who have the capacity to communicate on a mass scale ought to be wary of the possibilities of getting sued and prosecuted for different forms of libel or defamation, even in those countries that might claim to have dumped criminal defamation. The criminalisation of communication and publication remain, and at stake is the reputa-

tion of individuals or organisations or the state who claim their rights and interests have been injured. Whether verdicts which correspond with the plaintiff or complainants' alleged injury are issued in any courts of law or not is a matter of the jurisdictional decision and justification of such verdict. It is not always certain that courts will reject to hear and accept the prosecution of parties accused of criminal defamation/libel or any other communication that attracts the criminalisation of communication or publication. Internet users must also remain wary of the possibilities of litigation, and offenses rooted in publications and utterances as 'criminal' can be defined or classified variously in order to charge and penalize originators and distributors of such communication. The several examples cited in this chapter show that defamation and criminal defamation, and alternatively the criminalisation of communication in the public sphere are no longer exclusive to the traditional media, the so-called fourth estate. Individuals who now operate in the emergent 'fifth estate' and with the capacity to communicate and distribute messages and information at a mass scale due to the ubiquity of digital technologies are also prone to getting arrested and prosecuted for defamation and 'criminal defamation' or other criminalizing charges. New ICTs and their uses by both the fourth and fifth estate confirm that "When *anyone* can become a media producer, *everyone* should know something about media law – both to protect their own rights and to avoid violating the rights of others" (Packard, 2010). It remains the states prerogative to use terms such as 'criminal defamation' or "criminal nuisance" to conveniently reject them as archaic, but if the latter is the case, there is never outright assurance that freedom of expression and freedom of the media are not bludgeoned and compromised through other 'criminalising' torts or terminology that can be attended to in courts of law. Precedence might guide the determination of current and future cases on criminal defamation and the criminalisation of communication and publication, but it still remain the prerogative of each individual court attending to a particular case to determine whether defamation or any other offensive publication or utterance can be classified to be a crime.

Theoretical and political correctness posits that criminal defamation is archaic, undemocratic and unjustifiable in the contemporary world. However, in numerous countries practical exigencies make the 'crime' persist at best as a 'theoretical' possibility, and in extreme scenarios as a real punitive instrument or deterrent for possible excesses of the media against either private citizens or public officials. There are instances such as in Zimbabwe where criminal defamation has been categorically struck off the statutes. It remains to be seen if it will not be invoked for blatant and extreme cases of defamination that threaten public peace and stability, or those that 'serious' damage the reputation of complainants or public officials. South Africa, for instance, observes that while it is the standard and norm to repeal extreme cases of governments abusing criminal defamation laws against journalists throughout the world, it did not apply in the country. It is however reassuring those courts even in nation-states generally considered being strict and intolerant such as Zimbabwe criminal defamation has been struck of the statutes. Where it has possibility of reappearing as a suit other considerations also apply in mitigation for the journalists and non-professional communicators. For instance, a reckless journalist will not be heavily penalized if there is no proof of malice or intention in committing the crime, and punishments need also not be disproportionate in the severity to the offense committed. All this is in apparent consideration that communicators are not saints and may flout some legal and ethical tenets of communication even when they purport to serve the best interests of humanity through such actions as raising alarm of transgressions as has been shown in the considerable deterioration in the standards and performance of the new WikiLeaks exposures.

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Chapter 80
Reflecting Emerging Digital Technologies in Leadership Models

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ABSTRACT

In this chapter, Smith and Cockburn reaffirm the claim that they made in a previous book (Smith & Cockburn, 2013), namely that today's global business environments are characterized by volatility, uncertainty, complexity, and ambiguity, and that leaders must focus less on developing behavioral competencies and more on complex thinking abilities and mindsets. In so doing, leaders must be familiar with emerging digital technologies, their benefits and drawbacks, and utilize these technologies in their practice as appropriate. In their previous book (Smith & Cockburn, 2013), the authors defined flexible and dynamic leadership models that assure successful leadership in the above turbulent contexts, and also described learning related processes that are essential to mastering the ability to learn and adapt at rates consistent with the business complexity leaders face. In this chapter, the authors extend their previous research (Smith & Cockburn, 2013), review newly emerging elements of social digital connectivity that are contributing to global business complexity, and explain how these elements may be applied by leaders to augment the power of the recommended dynamic leadership models.

INTRODUCTION

According to Friedman (2007) the rate of change today is much different than in the past and this has created a new environment that strategic business leaders are increasingly calling a 'VUCA' environment (Lawrence, 2013). VUCA (Wikipedia, 2013) is an acronym used to describe or reflect on the volatility, uncertainty, complexity and ambiguity of general conditions and situations. The common usage of the term VUCA began in the late 1990s and derives from military vocabulary and has been applied in

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a wide range of organizational and business situations. In today's VUCA environment, organizations of all kinds are facing unprecedented economic demands that they be successful in their given niches whilst operating in increasingly dynamic business contexts, and under ever escalating ethical and sustainability constraints. The further impact of a host of newly emerging digital technologies may well be the straw that "breaks the camel's back" for many organizations. In any event, in face of these complex challenges, "business as usual" is not a viable option, and organizations must change since complacency equates with extinction.

In other words, leaders must develop new capabilities if they are to successfully steer their communities through the newly emerging era of social digital connectivity and global dynamic complexity. As Lawrence (2013) explains in regard to this new VUCA environment, "It is taxing even the most able of leaders who may find their skills growing obsolete as quickly as their organizations change in this volatile, unpredictable landscape. Leadership agility and adaptability are now required skills if organizations are to succeed in this VUCA world." or as Michael Marquardt (2000) foresaw: "Our new century demands new kinds of leadership with new skills. Leadership styles and skills that may have worked in a more stable, predictable environment of the 20th Century will be inadequate in this new era of uncertainty and rapid change, where we can hardly define the problem, much less engineer possible solutions".

In consequence, as organizations reinvent themselves to address constantly shifting opportunities and constraints, so must new relevant leadership models emerge to fit the changed landscape the leaders confront, bearing in mind that such leadership models must be culturally and economically sensitive, and thus country sensitive (Bersin, 2012). Clearly it is a matter of urgency that HR and talent management professionals reframe leadership development activities to accommodate the faster-paced VUCA world, and focus less on behavioral competencies and more on complex thinking abilities and mindsets. As Petrie (2011) asserts "Leadership development should be focused on learning agility, self-awareness, comfort with ambiguity, and strategic thinking" - this is exactly the approach to leadership-development that was described in the book "Dynamic Leadership Models For Global Business: Enhancing Digitally Connected Environments" authored by Smith and Cockburn (2013).

This new leadership development focus is itself made more complex since it is not a one-time event, and the business landscape and available technologies are constantly changing such that leaders may not know at any given moment what manner of organization or context they will have to deal with in the future. In other words, organizations, leaders, innovators, and all the other stakeholders are in a situation where they are co-evolving at an accelerating rate. Leadership is no longer a matter of sailing a calm sea, setting a direction and ensuring it is being followed by an obedient crew - leadership now and for the future is more like trying to survive a tsunami, and is all about having a vision with an uncertain path to its achievement that may only be attempted through flexibility, agility, and adaptability in the collaborative company of fellow stakeholders. In other words, as Cashman (2013) notes: "To succeed in our volatile, complex, ambiguous world, we have no choice but to master our ability to adapt and learn", or as Biro (2013) concluded: "The demands of a collaboration-based, talent-hungry, global, wired economy are evolving so quickly that success depends on nothing less than continuous learning. Fall behind and you may find yourself disqualified from the race." and Biro (2013) further asserted that "Companies of all sizes in all industries are trying to meet the new imperative. Learning and development spending was up 12 percent in 2013, the largest jump in almost a decade. The goal is to integrate learning into a company's culture and processes. There are also training sessions, workshops, conferences, and retreats, but the most successful strategies are those that make learning a continuous process, hardwired into a company's metabolism."

In their previous book (Smith & Cockburn, 2013), the authors defined flexible and dynamic leadership models that are consistent with development of the above capabilities, and also described learning related processes that are essential to mastering the ability to learn and adapt at rates consistent with the business complexity leaders face. The models provide simple, iterative, and reflective tools for leaders in any organization to better analyze their strategic situation, decisions, available options, resources and outcomes, and to enhance or construct flexible action plans. These models are based on the understanding that Smith and Cockburn (2013) have developed from their practice that a leader's ongoing experience represents a significant source for development, but that this is often an untapped resource In order to leverage this resource these authors (ibid) proposed a disciplined, deliberate and systematic process for learning from experience.

In their new book (Smith & Cockburn, 2014), of which this chapter is Chapter 2, these authors present an extension of their first book (Smith & Cockburn, 2013) that deals with further newly emerging elements of social digital connectivity that are contributing to global business complexity, and with which leaders must not only be familiar if they are to be successful, but must also incorporate into their leadership models. In this Chapter, descriptions of the original leadership models are updated consistent with these imperatives, and newly emerging digital technologies plus contributions from other authors in Chapters 3 through 11 are provided that further detail these emerging technologies and their impact on leadership.

In this Chapter 2, the authors first clearly recapitulate and elaborate on details of the proven, flexible, and highly practical leadership process that was detailed in their first book by Smith & Cockburn, (2013). They then show how these models may be augmented to include the impact of the various new and emerging digital technologies. Many of these technologies were not treated in the first book (Smith & Cockburn, 2013), and this new material indicates specifically how leaders may recognize, review, and react to these new factors. The new book is comprised of fifteen chapters, where Chapters 3 through 11 are authored by authorities in the subject matter of a particular chapter. As a whole, and as shown in Figure 1, the book proposes to change the mindset of leaders from command and control, based on the world as clockwork, to one of appreciation of successful leadership through influence, learning and agility based on a world characterized by digital networking, complexity, unpredictability and emergence.

This book will contribute significantly to organizational and management knowledge and participation in global affairs of all kinds, and help ensure successful outcomes in today's unpredictable contexts. The approach does not entail any assumptions as to skills or expertise of users, and is adaptable for all organizations, being comprehensible for both technical and non-technical readers, and so enabling all readers to readily apply the models to their own evolving situations. Further, this book treats current leadership challenges that are not amenable to leadership approaches of the past, and it does so in an accessible manner that effectively empowers the reader to enhance their leadership aptitudes and sustainably develop their organization and staff for the challenges they face now and in the future. The book is potentially appropriate for all classes of current and aspiring leaders, being gender-neutral, culture-neutral, and economy-neutral, and will aid in their day-to-day activities, their career progression, and in the development of emergent capabilities relevant to co-evolution with their environments.

Objectives for this Chapter:

- Review dynamic leadership models recommended in Smith and Cockburn (2013)
- Discuss how emerging digital technologies may be integrated into these models

- Present concluding remarks and explore related emerging trends
- Detail the relevant references

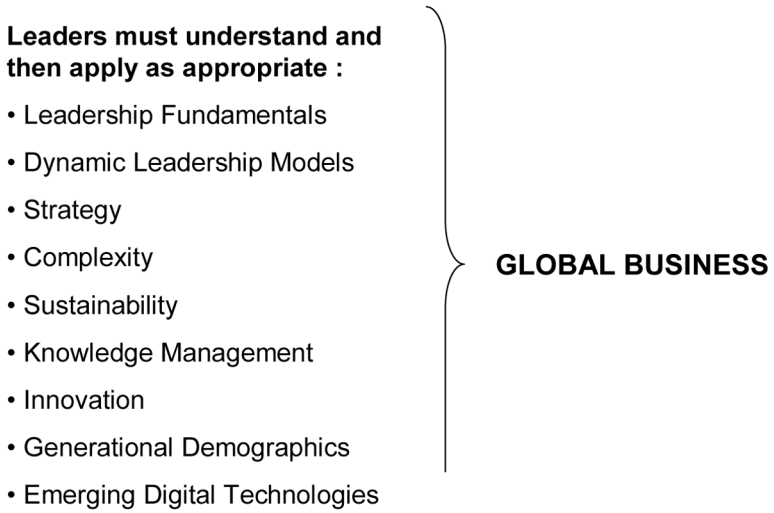
BACKGROUND

Smith and Cockburn (20113, p. 32) state that, in relation to their recommended dynamic leadership models: "To fully equip global leaders nowadays there is a need to build an *enabling* framework across all levels of the organization. We believe that a bold approach is necessary, and *Dynamic Leadership Models for Global Business: Enhancing Digitally Connected Environments* is the result. Like that great leader Alexander in ancient times, it's time to unravel the Gordian Knot (2011), and we propose a foundation for understanding and practicing leadership based on proven ways to deal with complexity. This foundation is particularly relevant to dynamic leadership in digitally connected environments where such leadership is critical to addressing the complexity typical of such situations. Please note that the foundation is also independent of whether one leads in engineering, IT, construction, banking, or a myriad of other disciplines, and is gender neutral." These authors go on to claim that complexity may be very successfully addressed if one's actions are based on "intuitive decisions that in turn are based on extensive experience" (ibid, p. 34), but add that if one does not have extensive experience, "another way to successfully make progress is by taking small steps in an experimental fashion and learning from what seems to get the results one wants and what doesn't." (ibid, p. 34). This is an 'emergent' approach that Snowden (2012) terms "probe, sense, respond" (ibid, p. 95).

In adopting this approach, all chapters in this new book (Smith and Cockburn (2014) add practical supportive detail to the approach illustrated in Figure 1 which summarizes the intent of the previous book (Smith & Cockburn, 2013) and of this book (Smith & Cockburn, 2014).

Smith and Cockburn (2013) devoted chapters to up-to-date research on leadership fundamentals such as strategy, complexity, sustainability, socio-digital technologies, knowledge management, innovation,

Figure 1. A leader's mindset for success in VUCA environments
(Adapted from Smith and Cockburn, 2013)



demographics, and digitally connected networked environments, with the proviso that these are subjects with which leaders must be familiar if they are to lead successfully in our complex global environment. These authors (ibid, 2013) also detailed integrated processes, termed "Dynamic Leadership Models", that facilitate this emergence, but they were not prescriptive regarding specific behaviors, competencies etc. In this way, these authors avoided the trap whereby leadership development is based on competency models derived for a past era, for as Myatt (2013) asserts: "When organizations hire, develop, and promote leaders using a competency-based model, they're unwittingly incubating failure." Rather Smith and Cockburn (2013) emphasized continuous learning, noting that the close links between leadership and learning were established long ago by scholars in organizational behavior (Schein, 1992; Argyris, 1993), and the links continue to be emphasized world-wide today (Grazier (2005). Further, they explained that the leadership processes they described (Smith and Cockburn, 2013; p. 39-55) were designed to take into account the existing knowledge of an individual and provide a framework to further develop this knowledge, or as appropriate, to relinquish previous knowledge and skills that the individual finds counterproductive e. This latter objective has come to be termed 'unlearning' (Becker et al., 2006).

Smith and Cockburn (2013) claim that the learning-based leadership approach they detail is effective and efficient for the complex environments leaders must safely navigate daily, and that their new system is free of the weaknesses of current leadership programs, delivering significant additional personal and organizational benefits at less cost. Smith and Cockburn (2013, p. 39) state thfrom

Although leadership learning has been covered in the past, we believe this is the first time that an overarching process has been fully described that successfully addresses the realities of everyday leadership, and at the same time facilitates many dynamic leadership models to be enacted depending on the digitally connected environments at hand.

Leadership Process Cycle

The four-step learning-based leadership approach advocated by Smith and Cockburn (2013) is described in this sub-section. Here is what this "learning-leadership by doing" might look like:

Follow the four-step incremental leadership process cycle recommended by Smith & Cockburn (2013, p. 39-55), and according to Smith and Cockburn (2013, p. 39-40) also:

- Face reality.
- Continuously reflect alone and with others.
- Recognize the strengths you have and build on them.
- Start from where you are.
- Learn by leading in your particular context.
- Learn from successes and failures.
- Continue to incrementally improve at your best pace.
- Organize in a people-centric way.
- Motivate stakeholder participation.
- Leverage the wisdom of your learning partners.

Step 1

According to Smith and Cockburn (2013, p. 40) "The first step is to understand your leadership role – what are you expected to achieve? In sporting terms, this is your scoreboard, and the win, lose, or draw of your leadership will be judged on its results." Your leadership role may be defined by a variety of people in any given organization but it is critical, according to Smith and Cockburn (2013) that you yourself are very clear on your current leadership role, and furthermore you must constantly review and attempt to change it to better meet your organization's mission, goals and objectives. These authors strongly encourage leaders to develop and have approved such a personal role if one does not exist.

A generic leadership role framework (ibid, p. 40) is said to describe the leader's involvement in:

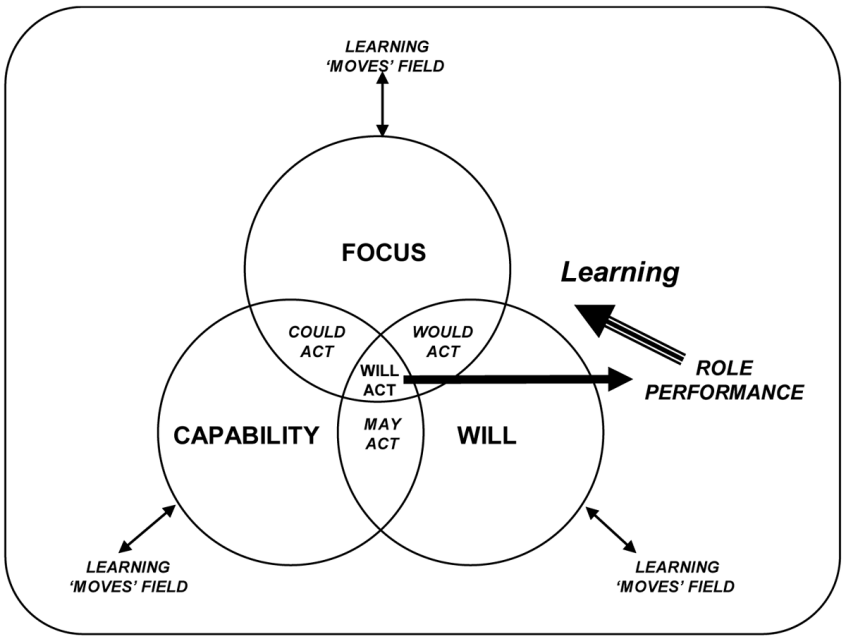
- Defining the organization's mission and identifying the means and outcomes for its achievement.
- Developing the plans to actualize the tasks and activities related to the means and outcomes desired.
- Leading implementation of the plans, sustaining commitment and ensuring cohesiveness.
- Supporting sustainability through openness to change and continuous improvement.

Step 2

The second step involves analyzing how to successfully perform your role. This is accomplished according to Smith and Cockburn (2013, p. 41) using the performance system model presented in Figure 2

In Figure 2, your leadership role performance is pictured as dependent on three fields (Wheatley, 1992, p. 47-57) termed Focus, Will and Capability. The three fields form a dynamic system, and the

Figure 2. Dynamic performance system (reproduced from Smith & Saint-Onge, 1996)



performance level you achieve depends on the interactions and interdependencies of the three fields. According to Smith and Cockburn (2013, p.41):

Focus represents a clear definition and understanding of your role performance to be achieved; Focus is associated with questions such as What ..?; How ..?; Who ..?; Where ..?; When ..?; Why ..? The element Will represents your strength of intent to achieve the performance defined in Focus; Will is associated with your attitudes, emotions, beliefs and mindsets. Capability represents the wherewithal to transform into reality the performance defined in Focus; Capability is associated with such diverse areas as your skills, infrastructure, budgets, tools, physical assets etc. A change in any one of these fields may effect a change in the state of one or both of the other fields.

As Figure 2 shows, current performance potential is represented by the degree of overlap of the circles; optimal performance potential is indicated when Focus, Will and Capability are all in balance and harmony, which would be demonstrated in the figure if all three circles completely overlapped. Imbalance leads to misdirected and wasted efforts as well as loss of performance. Figure 2, where only two model fields overlap and three fields overlap only slightly, is typical of real-life situations. For example, Smith and Cockburn (2013, p. 42) note thfrom

… it is not unusual for a leader to poorly discharge their role because although the leader has a relatively clear understanding of the role performance they are charged to action (strong Focus), the leader has somewhat inadequate interpersonal skills and resources to carry out the actions required (moderate Capability), and no belief in the role's value and so little incentive to carry out the role as given (low Will).

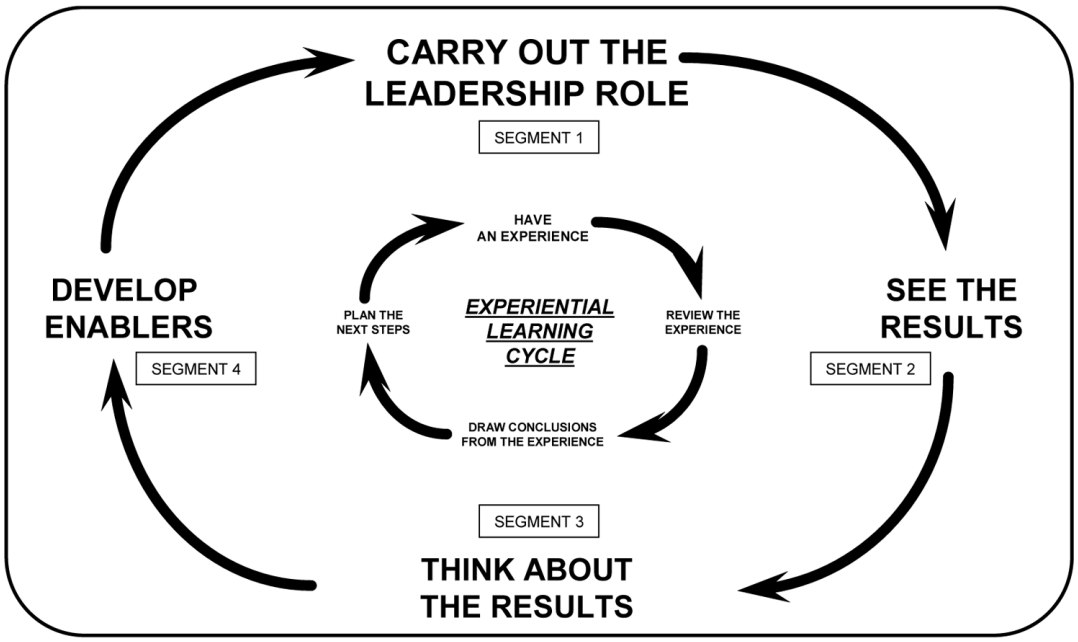
Performance optimization is based on the continual dynamic tuning of the degree of overlap of the three fields. As a leader reflects on the results of their workplace efforts, their learning provides them with the clues regarding how they need to alter their Focus, Will and Capability to attempt to maintain harmony and balance, and thus there optimum role performance; in other words learning and reflection are keys to optimum leadership performance. Smith and Cockburn (2013, p. 42) claim that the necessary learning, and reflection are fostered and greatly facilitated through the kind of collaborative learning associated with the Action Learning approach that these authors discuss in their book (Smith Cockburn, 2013). These authors further claim that a unique benefit of this performance model is its "systemic equivalence of Will versus Focus and Capability and its personal psychological nature." As Popper and Mayseless (2007) point out, this is in contrast to typical leadership instruction where the emphasis is on observable variables rather than on the intra-psychic psychological variables that are truly fundamental to the visible expression of leadership.

Step 3

Smith and Cockburn (2013) state that the third step involves a leader frequently working through a succession of activities in an experiential leadership learning cycle (Smith, 2000; Schewhart, 2012; Kolb (2012; Honey and Mumford, 1992; Deming, 2012); this experiential leadership learning cycle is shown in Figure 3.

In Figure 3, the first three cycle segments refer to any aspect of the leadership role being undertaken. "See the results" and "Think about the results" are segments in which the leader reviews role demands

Figure 3. Leadership learning cycle (reproduced from Smith, 1999)



and actual results versus relevant aspects of the elements Focus, Will and Capability described in Step 2. “Carry out the role”, “See the results”, “Think about the results” and “Develop *enablers*” correspond to “probing, sensing and responding” and are consistent with the ‘emergent’ approach described by Snowden (2012) and Smith and Cockburn (2013, p. 95). Reflection, particularly in segments three and four, facilitates the leader deciding on what s/he needs to do to correct the mismatch between role demands and leadership results. Smith and Cockburn (2013, p. 42) point out thfrom

When time is extremely short, decisions have to be rapid, and the scope for reflection is extremely limited. In these circumstances, reflection may be seen as a metacognitive process in which the practitioner is alerted to a problem, rapidly reads the situation, decides what to do and proceeds in a state of continuing alertness.

Smith and Cockburn (2013, p. 43) explain thfrom

Enablers are comprised of any understanding, knowledge, activity, capability, attitude, characteristic etc. which enables the leader to carry out his/her leadership role more effectively and better achieve intended results. For example an enabler might be as onerous as undertaking a skill training course or as simple as dropping into a colleague’s office to straighten out a misunderstanding.

Some typical enablers highlighted by Smith and Cockburn (2013, p. 43) are listed in Figure 4. Segment number one in Figure 2 then re-starts the cycle with the chosen enabler(s) as part of role execution, and so on repetitively, cycle by cycle.

Smith and Cockburn (2013, p. 44) claim that complexity by its nature must be addressed through experimentation, and that Steps 1 through 3 should be treated in this manner, where iteration of the steps provides the experimentation from which the leader must learn and build experience. Yeo (2010) notes that the intrinsic value of reflection is not simply to seek an immediate solution to a problem, but rather it creates new insights into broader and deeper issues that reflection brings into continued questioning. Smith and Cockburn (2013) also recommend that the leader capture these experimental episodes in a reflective journal that may be used in the future to help in selecting enablers and also maintains a database of events.

In Step 2 of the leadership process cycle it was noted that learning and reflection of the performance system model is fostered and greatly facilitated through the kind of collaborative learning associated with action learning (McGill & Brockbank, 2004). In this regard, Smith and Cockburn 2013, p. 45) recommended that from time to time segments three and four in Step 3 be carried out in the company of one or more (no more than five) trusted colleagues in "learning partnerships" as shown in Figure 5. Action learning in an informal setting is a very effective method for developing learning partnerships; the formal activities of an action learning group (set) need not be followed, but the general principles of questioning, reflection, conjecture and activity planning would be utilized in achieving these results. Action learning (McGill & Brockbank, 2004) was originated by Professor Reg Revans in the 1940's (Revans, 2012) and is used by many notable organizations (Smith, 2001, p. 35) Action learning according to Revans embodies an approach based on comrades in adversity learning from and with each other through discriminating questioning, fresh experience and reflective insight. This seemingly very simple methodology has demonstrated in innumerable cases that its practitioners can affect the complex and often inscrutable processes of natural learning through personal and collaborative reflection. The seven questions listed by Smyth (1991) are also helpful in reflection:

1. What do my practices say about my assumptions, values and beliefs?
2. Where did these ideas come from?
3. What social practices are expressed in these ideas?
4. What is it that causes me to maintain my theories?
5. What views of power do they embody?
6. Whose interests seem to be served by my practices?
7. What is it that acts to constrain my views of what is possible?

Smith and Cockburn (2013) note that simple personal assessment instruments related to the performance model shown in Figure 2 have been used for many years (Tosey & Smith, 1999). Such a personal assessment instrument relevant to the leadership performance discussed here is presented by these authors (ibid, p. 49). In interpreting the assessment results, Smith and Cockburn (2013) encourage leaders to add their own questions to the assessment to help track problem areas or to highlight important aspects of their leadership role. Further these authors caution that it is important to have balance between the three fields rather than have one field significantly better than others e.g. Capability is typically over-developed and Will is typically under-developed. Smith and Cockburn (2013, p. 47-52) provide further comprehensive research and recommendations regarding the tuning of Focus, Will and Capability

- Clearly understand and commit to implications of your role.
- Collaborate in revising your role as necessary.

Figure 4. Some typical enablers In general business situations (Smith & Cockburn, 2013)

- Clearly understand and commit to implications of your role.
- Collaborate in revising your role as necessary.
- Develop an understanding of systems thinking.
- Expand business experience and customer know-how.
- Build organizational savvy - how/who can get things done.
- Increase networking and extend your credibility.
- Widen cross-functional relationships.
- Value people.
- Enhance communication skills.
- Familiarize yourself with the chapter-contents of this book.

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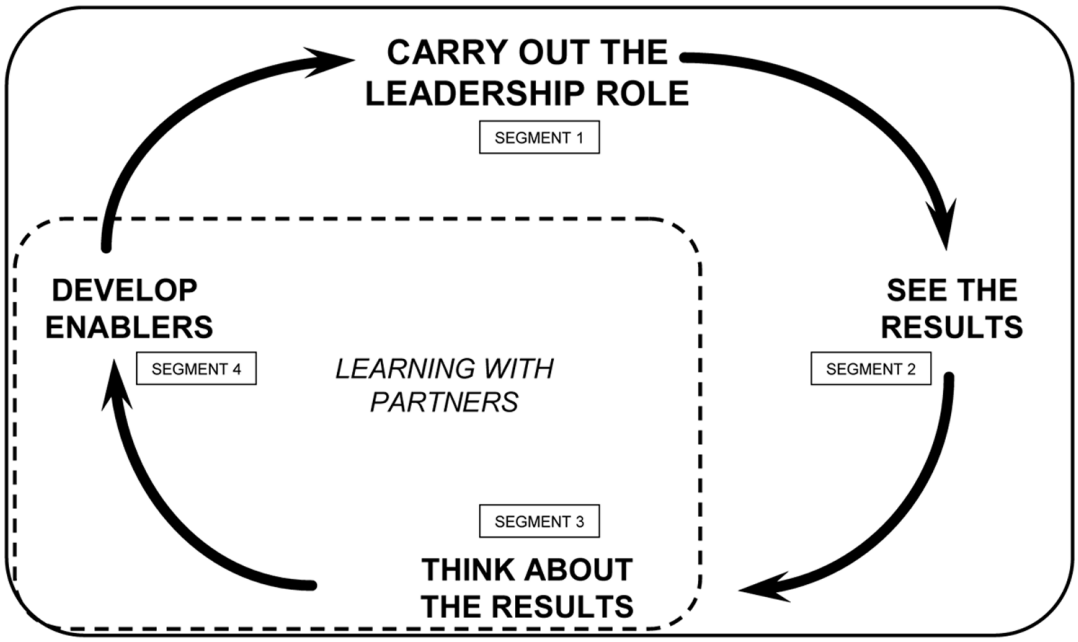
- Enhance communication skills.
- Familiarize yourself with the chapter-contents of this book.

Figure 5. Learning with partners (reproduced from Smith, 1999)



Step 4

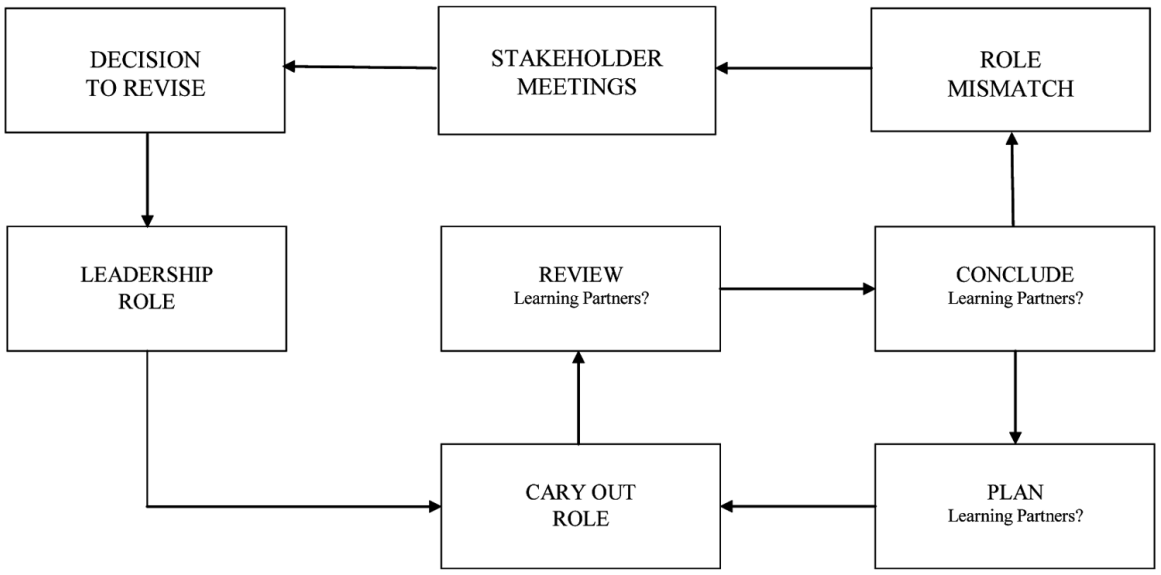
Smith and Cockburn (2013) assert that Step 4 is concerned with operationalizing Steps 1 through 3 to obtain the maximum value.

These authors cite Argyris and Schon (Argyris, 1991) who adopted the position that learning that involves the detection and correction of error is 'single-loop learning' based on a simple feedback loop, where outcomes cause adjustment of behaviors, like a thermostat. It is generally in operation when goals, beliefs, values, conceptual frameworks, and strategies are taken for granted without critical reflection. In other words it is the *uncritical* acceptance of a leader's role description in Steps 1 through 3 of the leadership process approach described so far.

Smith and Cockburn (2013, p. 52-53) claim that an higher order of learning is realized when a leader, upon detecting a mismatch between the target leadership role and reality, questions the goal-structures and rules embedded in his or her role description. This these authors assert, is exemplified when a leaders doubts and queries the relevance of his/her leadership role based on practical results and circumstances (s)he perceive in carrying out Steps 1 through 3 of the leadership process approach described previously. According to Argyris and Schon (Argyris, 1991), this is referred to as 'double-loop learning'. Double-loop learning is more creative, and may lead to alterations in the rules, plans, strategies, or consequences initially related to the problem at hand. Double-loop learning involves critical reflection upon goals, beliefs, values, conceptual frameworks, and strategies. Argyris believed that this way of learning is critical in organizations and particularly to individuals who find themselves in rapidly changing and uncertain contexts - that is in complex situations.

Pardey (2008) claims that there is little new in terms of leadership ideas, and the challenge of today and the future is to adapt leadership styles to fast changing business environments. Smith and Cockburn (2013) state that the more complex, dynamic, turbulent, and threatening the organization's environment,

Figure 6. Steps one through four of the leadership process
(Reproduced from Smith & Cockburn, 2013)



the more significant double-loop learning must be considered in relation to leadership capability (Van Grinsven & Visser, 2011; Smith, 2012), and since the notion of single- and double-loop learning has stood the test of time, application of this concept to Steps 1 through 3 of the work-based leadership process described previously is important and relevant as shown in Figure 6.

Unfortunately, practical experience described by Smith (2011) indicates that many organizations are operating as if they were involved in 'simple' or 'complicated' contexts, rather than the reality of their current highly complex environments. This has potential implication for leadership where the leaders delude themselves in regard to the complexity of the situation they are dealing with, and the understanding of others. Again this is a common problem with leaders (Smith & Saint Onge, 1996; Argyris, 1990; 1993). The latter delusion is particularly relevant in many emergency situations where teams must operate under constrained time horizons and with fluid 'experts' joining and leaving the teams at various points. Riley et al. (2008, p. 8), comment:

...in conventional teams it might be possible that implicit communication is sufficient for team members to effectively communicate with each other. However, in critical teams, our observations show that implicit communication can be ineffective and possibly dangerous for patient safety. For example, we observed many instances in leadership transfer where the leader made certain assumptions that were erroneous.

On the basis of this theory and their own experience, Smith and Cockburn (2013) emphasize the importance of a leader continually evaluating his/her role for relevance given their experience in Steps 1 through 3, and seeking to have it revised as appropriate.

MAIN FOCUS OF THE CHAPTER

Paul Barsch (2013) recounts a story that he attributes to Gillian Tett of the Financial Times who discusses how in western economies 85% of the dollars lent by banks go to supporting existing assets, and not innovation, with only 15% of financial flows going into 'productive investment'.

This is a phenomenon typical of human nature where for example only 15% of a community are natural avid learners of new subject matter with 80% being learners only when 'seriously encouraged' and 5% being 'couch potatoes'. Smith and Cockburn (2013) make the case that given the complexity inherent in today's business world, and the necessity for systemic thinking to address this complexity (Gharajedaghi, 2012), leaders in general are not familiar in any meaningful way with important business and technology topics outside of their own particular discipline. In their efforts to close this gap, these authors devote a chapter to each of the topics that they claim contribute to business complexity and with which leaders ought to be at least familiar; these topics are leadership fundamentals, strategy, complexity, sustainability, socio-digital technologies, knowledge management, innovation, demographics, and digitally connected and networked environments.

In this book Smith & Cockburn (2014) assert that the plethora of emerging digital technologies must be added to this list. These technologies include: information organization and representation;, information use and analysis; information preservation and access; information environments and socio-cultural concerns; social networking; enterprise social software; innovation/collaboration platforms; cloud computing; grid computing; big data; analytics; risk analysis; dashboards; eLearning; mobile technologies; Artificial Intelligence (AI); distributed AI systems and multi-agent systems; games; simulations; Social

Network Analysis and related software; information capture and storage; data mining; potential pitfalls of emerging digital technologies; information security; and information privacy issues. Clearly a daunting list, especially when combined with the topics detailed by Smith and Cockburn (2013). Smith and Cockburn (2014) assert that only very few domains in business or society have remained untouched by emerging digital technologies, and especially social media (Deiser & Newton, 2013). Wikis enable more efficient virtual collaboration in cross-functional projects; internal blogs, discussion boards, and YouTube channels all encourage global conversations and knowledge sharing. This radical change has created a dilemma for senior executives; while the potential for leveraging the power of social media seems immense, the inherent risks create uncertainty and unease. The security concerns raised with respect to this internal and often private privileged information are significant and well founded. In addition, as Deiser and Newton (2013) point out:

…there's a mismatch between the logic of participatory media and the still-reigning 20th-century model of management and organizations, with its emphasis on linear processes and control. Social media encourages horizontal collaboration and unscripted conversations that travel in random paths across management hierarchies. It thereby short-circuits established power dynamics and traditional lines of communication.

These authors in their article detail many aspects of a leader's role that have been redefined in this new digital environment.

Smith and Cockburn (2013) made it clear that they were only recommending 'familiarity' with the topics they covered in their 2013 book, and these authors feel that this proviso should apply to a leader's understanding of emerging digital technologies and their applications. They make the point that expert authorities in these various topics are typically readily available, and the purpose of 'familiarity' is to ensure meaningful dialog between the business leader and the topic expert. Too often in the past technical solutions to business problems have resulted in mismatched 'stitched together' solutions where each side blames the other for the failure of the initiative in practice. This is a particular problem in regard to emerging digital technologies that are rife with acronyms and where senior staff still show disregard for the benefits of the digital era. For example, Toomey (2013) in discussing a government case "Plain Language about Digital Leadership and Governance of Information Technology" states as follows:

The patterns are clear. When the IT agenda is controlled by the IT specialists, and the people who run the government agencies are not engaged, things often go wrong - sometimes horribly. None of the investigations that I have seen describe a significant government IT failure arising from a situation where the business leaders are firmly in control of the IT agenda.

Toomey cites numerous examples of IT-business mismatches, for example Gershon (2009); Reinecke (2009); National Audit Office (2012); Chesterman (2013); and Joyce (2013).

Smith and Cockburn (2014) emphasize that 'familiarity' with emerging digital technologies in the sense outlined above is the aim of their new book - leaders need to be 'broadly read' in these topics and take a learning approach to adoption of these technologies where their successes and failures both provide the learning. Research conducted by Korn/Ferry International, and reported by Cashman (2013) from assessment of nearly 1 million executives, demonstrates that as individuals mount the executive ladder, they need to become increasingly comfortable with uncertainty and sudden change, and as Cashman

states: "As leaders, they have to have the "integrative capability" to weave together and make sense of apparently unrelated pieces of information and ideas, crafting novel and innovative solutions from them".

The focus of this chapter so far has been on recapitulation and elaboration of details of the proven, flexible, and highly practical leadership process that were detailed in the book by Smith & Cockburn, (2013). In this section the authors will demonstrate how these models may be augmented to include the impact of the various new and emerging digital technologies. Although, in many cases the potential for a given digital technology to impact the particular leadership model is treated in isolation from other potentially promising digital technologies, the leader is cautioned that digital technologies often display the greatest synergy when used in combinations in holistic fashion, and digital technologies should not be segmented without situational consideration (Goldner, 2013). In addition, it should not be inferred that this section in any way represents an exhaustive application of emerging digital technologies to these models; each leader, in the spirit of learning and adaption, must reflect on the relevance of emerging digital technologies to application of the models in their environment, and augment the models as appropriate.

Leadership Process Cycle

The four-step learning-based leadership approach advocated by Smith and Cockburn (2013) was described previously in this chapter in the sub-section 'BACKGROUND'.

According to Primus (2013): "Driven by clear productivity and cost benefits, IT and business management are embracing and empowering a mobile, distributed workforce – a workforce that views communications and collaboration technology, rather than bricks-and-mortar offices, as their business infrastructure". This White Paper states that this movement is in response to the need to reduce costs, attract/retain top talent and recruit from around the world by offering the flexibility to work from any location, offer options to local employees who prioritize workplace flexibility, and the need to integrate "independent professionals" into their organizations. As Primus (2013) makes clear, the result is that productivity is significantly enhanced and costs significantly reduced. For example:

Research shows that employees tend to dedicate 60% of the time formerly lost to commuting to additional work activities, and another study shows that 35 per cent of technology professionals…said they would sacrifice up to 10 per cent of their salaries ($7,900 on average) for full-time telecommuting.

Clearly organizations leaders need to factor this trend into their leadership initiatives, and here is what the learning-leadership by doing recommended by Smith and Cockburn (2013) *additionally* might look like in a digitally-aware environment (based on Murray [2013]):

- Foster a culture of digital experimentation.
- Cultivate digital leadership.
- Utilize technology for improved communication, sharing and interaction.
- Communicate your own digital learning.
- Invigorate team meetings through technology (surveys, desk-sharing etc).
- Model 'powering down' to maintain sanity.
- Utilize technology by automating for improved efficiency.
- Encourage personal learning networks and COP.

Step 1

As emphasized earlier in this chapter in the sub-section on BACKGROUND **-** Leadership Process Cycle - Step 1, according to Smith and Cockburn (2013, p. 40) "The first step is to understand your leadership role – what are you expected to achieve? In sporting terms, this is your scoreboard, and the win, lose, or draw of your leadership will be judged on its results." This advice holds true as you attempt to introduce emerging digital technologies into your leadership and workplace practices. If your role does not specifically include introduction of emerging digital technologies into your business environment, great care must be exercised to demonstrate that such digital technology as you do introduce can be seen to be linked to achieving elements of your role that are listed. As stressed in the Step 4 sub-section of BACKGROUND **-** Leadership Process Cycle - Step 4, Smith and Cockburn (2013) emphasize the importance of a leader continually evaluating his/her role for relevance given their experience in Steps 1 through 3, and seeking to have it revised as appropriate, and this holds true particularly when the introduction of emerging digital technologies seems appropriate.

Step 2

As explained earlier, the second step involves continuously learning how to successfully perform your role using the performance system model presented in Figure 2.

In this step mobile phones and tablets have significant potential for enhancing learning and reflection. Maglajlic and Helic (2012) in their research identify a high correlation between communication intensity and learning outcomes. Insightful guidance provided by the Aberdeen Group (2012) includes the use of mobile devices in building leadership capability, plus widespread use of such devices for knowledge sharing and learning. Aberdeen Group's data showed significant increase in the use of mobile tools for internal learning and communication between 2009 and 2011 with further major growth anticipated. An enhanced learning experience was said to be one of the prime drivers for the use of mobile technology with improved learning administration also being identified according to these authors. As more mobile tools are targeted by organizations to their customers etc. the more an organization's leaders may learn with and from these important networks. Aberdeen Group (2012) claim that issues around how to stream content and address interactive activities are becoming more important as users become more sophisticated. As in other areas of complexity, mobile technology is coevolving with learners and their needs.

Analytics is another emerging digital technology that may have a place in Step 2 activities. Bersin (2013) defines the word "Analytics" as the systematic discovery of meaningful patterns in data to support decision-making. In practice (Forbes & Mckiney, 2012) Analytics is typically the process of turning *large quantities* of data into information that is digestible and actionable. It includes tools and processes that analyze large amounts of organizational data, related to finances, employees, transactions, customers, etc. The term includes reporting, Dashboarding (Levy, 2011; IBM, 2013; Dashboards, 2013), predictive analyses and scenario-modeling. Research shows that many companies which have included corporate analytics in their operations have seen a 5 percent to 6 percent increase in performance in comparison with their peers (Forbes & Mckinsey, 2012). Bersin (2013) found, in a study of 741 organizations, thfrom

75 percent of HR leaders agreed that analytics is an important element to their organizations, but 51 percent said they have no plans in place. Another 37 percent reported that they have insufficient resources. In fact, 56 percent said that they have poor skills and only 6 percent rated themselves as highly skilled.

Gaining immediate and appropriate feedback on performance is critical and Dashboards (2013) are becoming more and more highly prized for Business Intelligence (BI) with potential for Step 2 application, although development cost maybe a deterrent. Back in the 1980's, Executive Information Systems (EIS) performed a similar service but today's Dashboards are far more interactive and usable for today's dynamic business requirements. Modern dashboards have the capability to present data and information in summary which makes them very powerful tools for BI, although the question of how to calculate the return on a Dashboard investment can be tricky. However, many of the charts used in older EIS systems were very much like those in use in today's Dashboards since user needs and wants have not changed much over time. What has changed is the availability of more sophisticated technology and more sophistication in the user community. Modern Dashboards meet business needs in a practical and actionable way when they can give quick snapshots of the big picture on one hand while being capable of offering detail on the other. Dashboards are fundamentally intended to provide 'at-a-glance' views of key performance indicators relevant to a particular objective or business process. The most useful dashboards in Step 2 are those designed for analytical purposes that often include context, comparisons, and history, along with subtler performance evaluators.

The spreadsheet is an alternative to the dashboard for certain applications. Spreadsheets are typically used in the form of Microsoft Excel documents. Their advantage is that they are intuitively easy to use and learn, providing detailed numbers, which users can analyze adding their own calculations. Unfortunately, the spreadsheet is often too detailed to give a quick and comprehensive overview of business data, although given their ease of development, they may provide a useful tool to assist in Step 2 activity.

Scorecards may also be developed for use in this step based on the kind of appraisal set out in Smith and Cockburn (2013, p. 49 & p. 265). Such scorecards, for 'at a glance' visualization of the status of Focus, Will, and Capability, have been used in many practical situations (Tosey & Smith, 1999) and are based on transferring the numerical outcomes from an appraisal onto three vectors each scaled from 0 to 10. The use of scorecards implies the use of surveys for the appraisal. Also, surveys in their own right may be used very profitably in Step 2 to help ascertain how others view the manner in which your role is being discharged and to gauge the effect of enablers. Online surveys are now easy to assemble and may therefore be distributed, collected and analyzed very readily. A primer on survey-design for the Internet is provided at Survey (2013) and many commercial s/w 'do it yourself' systems are available.

Membership in relevant social networks also offers access to potentially useful data in Step 2 with respect to for example Enablers that others have found useful, availability of Focus and Capability enhancement opportunities, and also to gain organizational 'savvy' in all areas of practice. With respect to Capability enhancement in particular it is noteworthy, as Arinze (2012) claims that E-Collaboration has come of age in the last decade, with industry and academia using the latest web-based collaborative software to bring together groups of workers, including those in academia, to work on common tasks.

Step 3

The third step, as explained earlier, involves a leader very frequently cycling through a succession of activities in an experiential leadership learning cycle. This experiential leadership learning cycle is shown in Figure 3. The emphasis in this case is on personal learning and reflection, and comments regarding emerging digital technologies recommended in regard to step 1 above are appropriate in this step.

However, as Figure 4 illustrates, it is recommended from time to time that this learning and reflection be carried out in the company of learning partners. As Smith and Cockburn (2013, p. 35 & p.

46-47) explain at length, action-learning is very well suited to the type of learning and reflection that is fundamental to this step. The extent to which a leader wishes to apply digital technology to broaden the circle of their learning partners, or facilitate dialog where these partners are situated at a distance, is an individual matter that the leader must decide. The emergence of ubiquitous digital interconnectivity for social networks has provided a ready means by which public and private conversations may take place across an organization, including very importantly its customers and stakeholders. This is critical to the widespread sharing and generation of knowledge, and to learning and reflection in general. This widespread digital interconnectivity for social networks has already provided a means for action learning to be carried out at arm's length (VAL) between an action learning group's participants (IFAL, 2013).

Dickenson et al. (2010) report findings from their research exploring VAL as an emerging variety of action learning (AL). These authors note that VAL provides value by bringing together geographically dispersed individuals within and across organizations, and possibly across time, and therefore has potential in both education and commercial contexts. At the beginning of this research there appeared to be little evidence of VAL being used, although face to face was well known and practiced. Although there was considerable interest expressed by educationalists and practitioners in adapting AL to VAL, there was a lack of understanding of how to go about it. However the research findings revealed more practice than was anticipated and demonstrated that VAL is a distinct variety of AL, characterized by its virtual, non-f2f nature, and that it has its own strengths and weaknesses. Dickinson et al. (2010) provide a 6-form classification of VAL, consider some of the theoretical questions associated with its practice and explore its potential in the light of emerging technologies. These authors conclude that, like AL, VAL is not singular, but takes a variety of forms, each with distinct characteristics, advantages and shortcomings. It is further reported in a study by Plack et al. (2010) that most of the students engaged in VAL were able to demonstrate reflection on complex clinical issues. Some struggles were encountered and issues were exposed regarding a lack of voice and power that may lead to missed learning opportunities. VAL also facilitates social learning, meaning making, and social reflection in communities of practice [COP] or in broader organizational setting (Wenger, 2000).

Wenger (2000) asserts thfrom

A community of practice can be viewed as a social learning system. Arising out of learning, it exhibits many characteristics of systems more generally: emergent structure, complex relationships, self-organization, dynamic boundaries, ongoing negotiation of identity and cultural meaning, to mention a few. In a sense it is the simplest social unit that has the characteristics of a social learning system.

However, as Wenger (2001) explains, COP are "focused on a domain of knowledge and over time accumulate expertise in this domain. They develop their shared practice by interacting around problems, solutions, and insights, and building a common store of knowledge". That is CoP are typically concerned with the development of best practices through the sharing, and recycling of existing 'accepted' knowledge (Cavaleri & Seivert, 2005), whereas the kind of learning and reflection related to step three relates to expanding the leader's thinking, knowledge, and boundaries, and requires a different supporting mindset from that of sharing existing knowledge (Coakes et al., 2011). However Smith (2003, 2009) quotes Wenger (circa 2007) that COP are formed by people who engage in a process of collective learning in a shared domain of human endeavor: a tribe learning to survive, a band of artists seeking new forms of expression, a group of engineers working on similar problems, a clique of pupils defining their identity in the school, a network of surgeons exploring novel techniques, a gathering of first-time managers helping

each other cope. In a nutshell: Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. Clearly, Wenger's sense of COP is consistent with individual learning via social interaction and co-participation, and is ubiquitous in ongoing activity, though often unrecognized as such.

Communities of Innovation (CoInv) are a special case of the more general Communities of Practice (COP), and are proposed as places of safety to provide 'Ba' (Nonaka & Konno, 1998), and for challenging organizational norms and innovating; thus changing organizational practices long term. CoInv are a form of COP that leverage the appropriate capabilities of COP, but are very specifically dedicated to the support of innovation. CoInv are an important new social learning concept that was first introduced by Coakes et al. (2009).

Again, the leader must decide if COP or CoInv are appropriate vehicles for learning and reflection in this step. Some practical pointers may be gleaned from work addressing leadership in virtual team environments by Pauleen (2003).

Smith and Cockburn (2013) recommend keeping a personal reflective journal that may be used at a later date to help in selecting enablers or for resolving other performance issues. In the past, such a journal was laborious to compile by long-hand and very difficult to search when one wished to locate a particular incident; digitization has revolutionized the keeping of such a journal and also the capability to search it using keywords (tags). There are many commercial digitized "diary" products on the market; such a well known app is Day One (2013) which is usable via mobile devices and has key word search-ability. Such a digital journal may also be readily backed-up for security purposes by for example Dropbox (2013). Dropbox also facilitates sharing the journal and ensures that the journal is available on all a user's digital devices.

The question of whether a leader should be using Cloud Computing in relation to any of the dynamic leadership models described in this chapter to a large extent depends on (a) the ready availability of cloud computing to realize the capabilities of the emerging technology being applied to the model, or (b) the policies and capabilities of the IT department of the leader's organization, or both (a) and (b). There is no shortage of hype regarding cloud computing, but CNBC (2011) provides clarification that cuts through the rhetoric. For example this source claims that "cloud computing can be grasped on its basic level - anytime, anywhere computing - without the user ever having to know much about the technology" and "In simplest terms, cloud computing involves delivering hosted services over the Internet. The *service end* is where the data or software is stored and the *user end* is a single person or company network." The official definition from the National Institute of Standards and Technology is also provided and reads: "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services)that can be rapidly provisioned and released with minimal management effort or service provider interaction." Although cloud computing offers cost savings and enhanced use of use, as CNBC (2011) goes on to caution, safety is a bit of a touchy issue, and "By using cloud computing, a company opens a door into its data and that door is an attractive target for attacks."

CONCLUSION AND FUTURE TRENDS

Throughout this chapter, the authors have been discussing how a leader may learn to figure out and achieve his/her role in realizing their organization's vision and strategy, and utilize emerging digital

technologies as appropriate. Social media at leadership levels was once the exclusive domain of digital gurus; however, Twitter, Facebook, and other tools are gradually becoming everyone's responsibility and "We are seeing an increased demand for social savvy candidates across the business -- from human resources to product to customer service," (Holmes, 2013). It must be noted though, that digital technologies provide both credits and debits. The biggest debit associated with these technologies is digital fatigue (Kenyon, 2013). As Deiser and Newton (2013) point out "The Social media has created an ocean of information. We are drowning in a never-ending flood of e-mails, tweets, Facebook updates, RSS feeds, and more that's often hard to navigate." These authors propose that leaders must become proficient not only in the software itself, but also in using the settings that filter important from unimportant information. Unfortunately, this is only a partial solution, since fundamental to social-media is social interaction, and a leader must decide on whether and when to comment and or reply, and in what fashion to apply the information. This is more time consuming than it might appear, since most of such information requires assessment of its source, authenticity, and credibility. In addition, to remain a legitimate player in this social dialog, there is considerable pressure to respond immediately in this social process of creating meaning. Although leaders from the millennial-generation are more adept at handling such rapid digital-dialog, there remain questions regarding their ability to reflect and make meaning from such exchanges (Barry, 2013), and indeed their growing antagonism to digital media (Grensing-Pophal, 2013). This digital fatigue problem is likely only to grow worse in the future, and ultimately the answer lies with the leader developing appropriate discipline and working guidelines.

Good leaders not only demonstrate a clear Focus, and the required Capability, but they have the Will to follow through and persevere in meeting the challenges presented to them. Clearly this is asking a lot of a leader and the situation is further exacerbated by the significantly increasing and important impact of digitization on all business environments, particularly those related to global business. The emerging skill set and expected capabilities of leaders are both wide ranging and continually evolving at an ever-faster pace. Developing the global business perspective and business strategy for the global business phase of Figure 1 means that "one needs to enhance one's understanding of the social, political, technological and environmental forces that are shaping our existence and our children's' future, including an understanding of the links between us and others throughout the world." (Smith and Cockburn, 2013, p. 258-259). There was a time when this involved onerous undertakings to search for relevant information in books, journals, magazines, and newspapers through an organization's library or information service. Progress on the Internet has meant that much of the searching and indexing on given topics are now done for us by commercial organizations to which we can subscribe. In addition, search engine capability provides us with quick and easy access to ad hoc information searches as required, and 'clipping' s/w such as Evernote (2013) and 'sharing' s/w such as Dropbox (2013) facilitate our personalizing retention and sharing of information. Linkedin (2013) through its general postings, networks, and discussion groups also provides an excellent means for professionals to stay up to date on global topics and to pose questions as appropriate. It is reasonable to suppose that such services will become even more user friendly and search question focused in the future. The increasing use of mobile devices will certainly encourage this trend.

In the Main Focus Of This Chapter, the following list of emerging digital technologies was detailed: information organization and representation;, information use and analysis; information preservation and access; information environments and socio-cultural concerns; social networking; enterprise social software; innovation/collaboration platforms; cloud computing; grid computing; big data; analytics; risk analysis; dashboards; eLearning; mobile technologies; Artificial Intelligence (AI); distributed AI systems and multi-agent systems; games; simulations; Social Network Analysis and related software;

information capture and storage; data mining; potential pitfalls of emerging digital technologies; information security; and information privacy issues. The relevance of a number of these technologies to the dynamic leadership models proposed by Smith and Cockburn the (2013) were treated in the previous sections. Two topics in particular, that hold much promise for facilitating the development of agile leaders capable of functioning in VUCA environments, are games and simulations. The successful application of these technologies to leadership-development is not new (Smith, 1996), but their growing sophistication promises much for the future, and leaders are urged to follow emerging trends and products. Balance (2013) supports this recommendation, noting that corporations and other organizations around the world are recognizing that games promote cognitive reasoning and information retention, and that modern games are advanced, immersive and engaging. Another topic that has particular relevance to the broader topic of leadership learning and development is Elearning both in its synchronous and asynchronous forms. E-learning is a broadly inclusive term that describes educational technology that electronically or technologically supports learning and/or teaching. This again is a topic that has a long history, but it is one where enhancements continue to be made, particularly in regard to mobile delivery. Zhang (2003) provides a broad and detailed, if somewhat dated, overview of the subject, and. Wikipedia (Elearning, 2013) and Peacock (2012) provide comprehensive current accounts.

Effective and efficient networking and collaboration within and between organizations are Critical Success Factors for achieving global competitive business advantage, and today's business environments demand updated leadership tools and practices reflecting these factors, focusing on relevance particularly to globalized environments (Hypia & Pekkola, 2011). It is concluded that an understanding and adoption of the dynamic leadership models detailed in this chapter together with a broad familiarity with application of the emerging digital technologies highlighted in this book will satisfy the critical success factors criteria, and will be highly beneficial for both the leader and the organization.

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KEY TERMS AND DEFINITIONS

Digital Technologies: Are digital resources that are effectively used to find, analyze, create, communicate, and use information in a digital context. This encompasses the use of web 2.0 tools, digital media tools, programming tools and software applications.

Global Business: Consists of very many companies that operate in several (many) countries and that may use information technology to facilitate the control of operations and performance in each country.

Leadership: Is a process of social influence which sets direction toward a goal and maximizes the efforts of others towards the achievement of the goal.

Organizational Complexity: Is present when there are multiple systems dynamically interacting in unpredictable ways; the outputs of one system are the inputs for another and so on across various scales, from micro levels of individual actors upwards to the macro scale of global business, resulting in the final result being unpredictable and emergent.

Social Digital Connectivity: Refers to the situation in which individuals' professional and private lives are integrated with digital social media platforms like Facebook, YouTube, and Wikipedia, etc., that enable them to make connections by sharing expressive and communicative content in order to enjoy online social lives.

VUCA Environments: Are characterized by volatility, uncertainty, complexity and ambiguity of general conditions and situations.

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Section 6
Emerging Trends

Chapter 81
Trends in Managing Multimedia Semantics

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ABSTRACT

This paper reviews various efforts to define and capture the semantics of multimedia data. These efforts are particularly relevant to the problem of storing, managing and querying the semantic content of such data. Since there is not yet an accepted solution to the problem of how to represent, organize and manage multimedia data and the related semantics by means of a formal framework, this paper aims at providing some major research trends in this area. The focus is on ontologies, which allow the exchange of semantics of multimedia content between distributed information systems. This paper aims at reporting on recent trends in the development of multimedia ontologies.

INTRODUCTION

Audiovisual resources in the form of still pictures, graphical, 3D models, audio, speech, and video play an increasing pervasive role in our lives, and there will be a growing need to manage all these multimedia objects. This is a task of increasing importance for users who need to archive, organize, and search their multimedia collections in an appropriate fashion.

To cope with this situation, much effort has been put in developing standards both for multimedia data (natural and synthetic (e.g., photography, face animation), continuous and static (e.g., video, image)) and for data describing multimedia content (metadata). The aim is to describe open multimedia frameworks and achieve a reasonable and interoperable use of multimedia data in a distributed environment.

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The development and application of ontologies, as explicit formal knowledge bodies, in the multimedia domain aims at bridging the gap separating the available low-level multimedia descriptors and the noema of the information conveyed by multimedia objects.

The objective of this paper is to report on some recent trends in semantic technologies responding to the challenges of managing and accessing multimedia objects (images, audio, video, 3D material, etc.). After a brief introduction to the role of metadata in the multimedia domain, the need for a common understanding of the semantic relationships between metadata terms from different domains is stressed. The next section highlights the use of ontologies in the representation of the multimedia data, by giving an overview of the most well-known multimedia ontologies. Moreover, guidelines for multimedia ontologies construction are given. The works quoted are by no means exhaustive, but provide some indicative pointers in this direction. Finally, ontology matching is mentioned as "a new vision" of developing multimedia ontologies by reusing available multimedia knowledge resources, and of enabling interoperability between multimedia resources.

METADATA

Metadata are a representation of the administrative, descriptive, preservation, usage, and technical characteristics associated with multimedia objects; they can be extracted manually or automatically from multimedia documents. This value-added information helps bridge the semantic gap, described as: "The lack of coincidence between the information that one can extract from the visual data and the interpretation that the same data have for a user in a given situation" (Smeulders, Worring, Santini, Gupta, & Jain, 2000).

Because of the high cost and subjectivity associated with human-generated metadata, a large number of research initiatives are focusing on technologies that enable automatic classification and segmentation of digital resources. Many consortia are working on a number of projects to define multimedia metadata standards, in order to describe multimedia content in many different domains and to support sharing, exchanging, and interoperability across different platforms. They are distinguished in (Salvetti, Pieri, & Di Bono, 2004):

1. *Standardised description schemes* that are directly related to the representation of multimedia content for a specific domain (like METS, MPEG-7);
2. *Standardised metadata frameworks* that consider the possibility of integrating metadata standards mapped on different application domains, providing rich metadata models for media descriptions together with languages that allow one to define other description schemes for arbitrary domains (like PICS, RDF, MPEG-21).

For example, the vision of MPEG-21 is to define a multimedia framework that enables augmented and transparent use of multimedia resources across a wide range of networks and devices used by different communities. The intent is that this framework will cover the entire multimedia content delivery chain, including creation, production, delivery, personalization, presentation, and trade.

The development of metadata standards will increase the value of multimedia data, which are used by various applications. Nevertheless, there are disadvantages in current metadata representation schemes

(Smith & Schirling, 2006), such as cost, unreliability, subjectivity, lack of authentication, and interoperability with respect to syntax, semantics, vocabularies, and languages (Salvetti, Pieri, & Di Bono, 2004).

It is necessary to have a common understanding of the semantic relationships between metadata terms from different domains. Representation and semantic annotation of multimedia content have been identified as an important step toward more efficient manipulation and retrieval of multimedia. In order to achieve semantic analysis of multimedia content, ontologies are essential expressing semantics in a formal machine-processable representation (Staab & Studer, 2004).

Professional groups increasingly are building metadata vocabularies (or ontologies). A number of research and standardisation groups are working on the development of common conceptual models (or upper ontologies) to facilitate interoperability between metadata vocabularies and the integration of information from different domains.

MULTIMEDIA ONTOLOGIES

It is well known that the word "ontology" generates a lot of controversy in discussions about Artificial Intelligence, although it has a long history, in which it refers to the categorical framing of what is (Poli, 2001, 2002, 2007; Poli & Simons, 1996). Briefly it can be claimed that ontology deals with what can be rationally understood, at least partially. According to this interpretation, science in all of its branches is the most successful and powerful ally of ontology.

One may say that there are material things, plants and animals, as well as the products of the talents and activities of animals and humans in the world. This first almost trivial list already indicates that the world comprises not only things, animate or inanimate, but also activities and processes and the products that derive from them. It is likewise difficult to deny that there are thoughts, sensations, and decisions, and the entire spectrum of mental activities, just as one is compelled to admit that there are laws and rules, languages, societies, and customs. We can set about organizing this list of objects by saying that there are independent items that may be real (mountains, flowers, animals, and tables), or ideal (sets, propositions, values), and dependent items which in turn may be real (colors, kisses, handshakes, and falls) or ideal (formal properties and relations). All these are in various respects items that are.

Ontologies have been applied in many areas, including natural language translation, medicine, standardization of product knowledge, electronic commerce, and geographic information systems, among others. Many of these applications use or will use multimedia data in the immediate future, making the creation of multimedia ontologies a crucial component (Jaimes & Smith, 2003).

A multimedia ontology, informally, is a means for specifying the knowledge of the world through multimedia documents in a structured way such that users and applications can process the descriptions with reference to a common understanding.

Four different levels of information are represented in multimedia ontologies (Euzenat et al., 2004): *signal*, *featural*, *symbolic*, and *semantic* information.

Multimedia ontologies are used for different goals by different applications, including the following (Jaimes & Smith, 2003):

1. **Content Visualization:** They can be used to create tables of content and used for browsing;
2. **Content Indexing:** They can be used to improve indexing consistency in manual annotation systems (e.g., use the term apartment instead of flat), or in the propagation of labels in automatic indexing

systems (e.g., a fece detected imlies a person was detected) (Schreiber, Bubbeldam, Wielemaker, & Wielinga, 2001);
3. **Knowledge Sharing:** Annotated multimedia collections can be more easily shared if they use a common conceptual representation (Carsten & Ansgar, 2010);
4. **Learning:** Collections annotated by different individuals using common ontologies lead to annotation consistency which is of extreme importance in applying approaches based on learning techniques that use annotated collections for training (Fan, Gao, & Luo, 2008);
5. **Reasoning:** Information not explicit in the data may be obtained automatically with the help of ontology (Ouyang & Liu, 2013).

The plethora of the recently produced multimedia ontologies aims at improving search and retrieval, by enabling the semantic interpretation of multimedia data, as well as the interoperability between multimedia resources.

CREATING A MULTIMEDIA ONTOLOGY

The construction of multimedia ontologies is difficult because different correct specifications of the same domain or collection are possible and many decisions have to be made, which depend on the domain, the purpose of the multimedia ontology, the complexity of content and structure that characterizes the multimedia objects, and the user's knowledge.

One can build a multimedia ontology simultaneously for all media. For each concept, all media specific concepts are encoded into the nodes of the ontology simultaneously (essentially the ontology is built in one cycle). Alternatively, one can develop a separate ontology for different media and create a link between nodes for every cross reference.

Ontology construction is usually a manual, iterative process consisting of at least three steps: (1) selection of concepts to be included in the ontology; (2) establishment of properties for the concepts and relationships between concepts in the ontology; and (3) maintenance of the ontology. The ontology can be constructed using a *concept-driven* or a *data-driven* approach. The concept-driven approach does not require any data: the ontology is built from general or domain specific knowledge. In the data-driven approach the ontology is constructed primarily from data, but domain knowledge is also used in manually constructing it. In general, although, fully automatic construction of ontologies still remains a challenging task because automatically selecting *relevant* concepts and relationships is hard, a process useful to automatically build, for example, an image ontology, based on a data driven unsupervisioned approach is composed by the following steps: (1) definition of an initial taxonomy containing a hierarchy relevant concepts' instances of the considered domain, which is performed by experts; (2) information extraction from publicly available image repositories; (3) content based analysis of images and semantic processing of texts; and (4) ontology building (Chianese, Moscato, Persia, Picariello, & Sansone, 2012). An alternative is to use semiautomatic ontology construction techniques, which aim at facilitating each of the steps above.

In the data-driven approach, for example, a semiautomatic construction of a multimedia ontology uses a video collection, and models the concepts, their properties and their relationships. For each of the videos one applies the following steps: (1) automatic scene cut detection; (2) automatic speech recognition; (3) parsing of metadata; and (4) automatic concept analysis. Preprocessing consists of steps one

through three, after which an ontology can be constructed based on textual content alone. Step four forms the basis for manually adding multimedia components to the ontology (Smith, Tseng, & Jaimes, 2003).

Indicative approaches for constructing multimedia ontologies are the ones presented hereafter:

1. In Arndt, Troncy, Staab, and Hardman (2009), a core ontology for multimedia annotation has been built by *re-engineering the MPEG-7* standard for multimedia annotation and using DOLCE as its underlying foundational ontology;
2. In Li, Lu, Yu, and Liang (2011), a multimedia ontology modeling approach based on the MPEG-7 standard is proposed and the *produced ontology is extended to support spatial-temporal relation of multimedia data*;
3. In Martens, Verborgh, Poppe, and Walle (2011), guidelines on how an XML-based metadata format, such as DIG35 standard for digital images, can be *converted into an OWL ontology*, are provided;
4. In Jimenez, Suarez-Figueroa, Mateos, Fernandez-Lopez, and Gomez-Perez (2012), a new ontology in the multimedia domain is constructed by *reusing existing ontologies*;
5. In Mallik and Chaudhury (2012), an *ontology learning scheme* which combines standard multimedia analysis techniques with knowledge drawn from conceptual metadata to learn a domain-specific multimedia ontology from a set of annotated examples, is proposed;
6. In Bannour and Hudelot (2013), *fuzzy description logics are used* as a formalism to represent a multimedia ontology dedicated to image annotation and the inherent uncertainty and imprecision of this kind of information;
7. In Rinaldi (2013), a global approach to define and develop multimedia ontologies is presented, which *uses multimedia data and linguistic properties* to bridge the gap between the target semantic classes and the available low-level multimedia descriptors.

When building multimedia ontologies, one should address the requirements listed below:

1. Multimedia ontologies should be designed to serve one or more of these purposes, accurately and adequately: *Annotation* (e.g., summarization of multimedia content); *Analysis* (e.g., ontology driven semantic analysis of multimedia content, etc.); *Retrieval* (e.g., context-based retrieval and recommendations); *Reasoning* (e.g., application of reasoning techniques to multimedia content); *Personalized filtering* (e.g., delivery of multimedia content according to user preferences); *Meta-modeling* (e.g., ontologies used to model multimedia processes, procedures, etc.);
2. Multimedia ontologies need to describe and represent knowledge for either one or even more of the following top-level hierarchical types of multimedia documents: *Image*, *Video*, *3D Graphics*, *Audio*, *AudioVisual*, *Multimedia presentation*.

They also need to distinguish between annotations describing the information object and these concerning the multimedia document's content (e.g., semantic concepts depicted in an image):

3. Multimedia ontologies should be able to represent *the structure of a multimedia document itself, depending on the type of document and the relations between structural elements*.

Ontologically speaking, possibly the most striking aspect of semantic visual information is its multilayer structure. To provide but a feeling of the multilayered stratification of visual object, one may

consider the case of a portrait, where one may distinguish the following levels: the three-dimensional space in which the subject of the portrait and some elements of the setting appear; the movement of the subject's apparent corpo-reality; the subject's character; his or her individual idea, or the idea that the person portrayed has of him/herself; and the symbolic, or the universal content manifested by the portrait (Hartmann, 1950; Ingarden, 1962).

A *hierarchical structure of multimedia segments* is thus needed in order to capture all possible types of media decompositions and relations. The regions that correspond to semantic objects need to be described in terms of their *location* within the multimedia content.

Ontology should be capable of capturing the low-level descriptor information (in order to semantically express this kind of characteristics associated with a concept, several different audiovisual attributes (e.g., color, shape, texture, motion, localization, etc.) need to be represented, depending on the concept) and to allow for basic and complex data types. Hence, alignment with standards (MPEG-7, TV-Anytime, MPEG-21) is a safe approach in order for the ontology to be of practical interest:

1. Ontology should be rich enough to describe the spatiotemporal relationships between the entities depicted. *Spatial* relations are needed to describe how segments are placed and relate to each other in 2D space (e.g., right and above). *Topological* spatial relations are needed to describe how the spatial boundaries of the segments relate (e.g., touches and overlaps). *Temporal* relationships among segments or events, providing information about the sequence in time, need to be represented, especially when the multimedia object is of type video;
2. Details regarding the description of the multimedia object itself, such as the creation date, the creator, the purpose it was created for, or even its subsequent history, and so forth, should be represented in ontology, because *provenance information* provides rather important metadata of the multimedia document. A multimedia ontology framework should *support annotations* produced by different annotators (humans or not), thus *enabling their linking and further processing*;
3. Due to the large number and wide variety of Web access devices, it has become quite essential for a Web service to *know the required device capabilities* in order to support playback of a media object and other characteristics of the delivery context that influence their presentation;
4. Multimedia ontologies need to be *open* in order to be widely-adopted by multiple and heterogeneous communities;
5. Multimedia ontologies should be designed in a *modular way* in order to minimize the execution overhead when used for multimedia annotation;
6. Multimedia ontologies building require a design that can always be extended, without changing the underlying model and assumptions and without affecting legacy annotations;
7. Multimedia ontologies could be implemented in MOWL (Ghosh, Chaudhury, Kashyap, & Maiti, 2007), which has been proposed as an ontology language that enables the *perceptual modeling* of domain concepts with their media properties; essential for semantic processing of media data.

More requirements for designing a complete and comprehensive multimedia ontology are reported in Troncy, Huet, and Schenk (2011).

Development of multimedia ontologies is still quite an empirical process. Due to that reason research communities involved with ontology-driven analysis, while sharing the same knowledge do not share a mutual consensus. Harmonization approaches, therefore, need to be followed by all these ontology-driven based systems and applications, in order to pave the way toward the development of an integrated

knowledge infrastructure. Achieving ontology harmonization may be difficult and complex in practice. The most significant factors are the efficient modularization of ontologies, the easy linking to other ontologies, and the specification of a minimum set of ontologies to be used for arbitrary applications.

EXISTING MULTIMEDIA ONTOLOGIES

Multimedia ontologies are necessary because the concepts and categories defined in a traditional ontology are not rich enough to fully describe the plethora of events that can occur in multimedia objects. Existing multimedia ontologies are divided in groups, according to their domain of application or their framework (Eleftherohorinou, Zervaki, Gounaris, Papastathis, Kompatsiaris, & Hobson, 2006). Table 1 shows a list of existing multimedia ontologies, grouped according to their domain or framework; the groups of ontologies are:

1. **Content Structure Ontologies:** They focus on the description of multimedia content structure;
2. **Specific Domain Ontologies:** They have been created to serve a particular domain;
3. **Multimedia Upper Ontologies:** Upper level ontologies are intended for more general use and describe higher level concepts that can be refined by domain ontologies, in order to make multimedia-handling procedures more homogeneous;
4. **Multimedia Core Foundational Ontologies:** The role of core ontologies is to serve as starting point for the construction of new ontologies, to provide a reference point for comparisons among different ontological approaches and to serve as a bridge between existing ontologies. core ontologies are typically conceptualizations that contain specifications of domain independent concepts and relations based on formal principles derived from philosophy, mathematics, linguistics, and psychology.

An increasing number of multimedia ontologies are being used in various projects for multimedia processing; examples are given below.

The main goal of *MEPCO* (Kienast, Zeiner, Hofmair, Schlatte, Thallinger, Burger, et al., 2006) is the cross-relation of media campaigns over the media TV, press, and Internet and furthermore the ambitious goal to cross link media campaigns over different countries. What makes a media campaign unique from others is not completely straightforward; however, there are rules that a human uses to determine

Table 1. Existing ontologies, grouped by their domain or framework

Content Structure	Specific Domain	Multimedia Upper Ontology	Multimedia Core Ontology
aceMedia Framework	Medical Image Domain	SWeMPs	CIDOC CRM
AIM@SHAPE	NM2	ZyX	ABC
Music Information	MEPCO	Salero	DOLCE
INA	ImageStore	MPEG-7	WordNet
	Soccer Domain	Semantic User Preference	
	Formula 1 Domain	X3D	
		Modality	

whether a media campaign is new. These heuristic rules will be formally encoded as to describe media campaigns in a generic way. The MediaCampaignOntology (MEPCO) will be based on the upper-level ontology PROTON and will be aligned to media-related metadata standards, such as NewsML and News Codes from IPTC.

ACEMedia extends and enriches ontologies to include low level audiovisual features, descriptors and behavioral models in order to support automatic annotation; a core ontology was described based on extensions of the DOLCE core ontology and the multimedia-specific infrastructure components, the VisualDescriptorOntology, based on an RDFS representation of the MPEG-7 Visual Descriptors, and the multimedia Structure Ontology based on MPEG-7 MDS. Its main aims are the support of audiovisual content analysis and object/event recognition, the creation of knowledge beyond object and scene recognition through reasoning processes, and enabling user-friendly and intelligent search and retrieval.

The *ZyX* ontology provides an ontological description of an abstract multimedia presentation model and is based on the ZyX model by Boll et al. (2000). The ZyX model describes complete or fragments of multimedia documents by the means of a tree. The nodes of the tree are called presentation elements. Each presentation element has got a binding point associated with it. Such a binding point can be bound to one variable of another presentation element, thus creating the edges of the tree. The presentation elements are the generic elements of the model. They can represent atomic media elements (e.g., videos, images, and text) or operator elements which combine presentation elements with certain semantics. There are operator elements that allow for temporal synchronization, definition of interaction, adaptation, and for the spatial, audible, and visible layout (the so-called projector elements) of the document.

Another classification of multimedia ontologies, based on their scope, is represented in Suarez-Figueroa, Atemezing, and Corcho (2013). Table 2 shows a list of the well-known multimedia ontologies designed and implemented for describing multimedia objects, which are defined as combinations of different media objects (text, image, sound, video, animation), shapes and images, visual resource objects (painting works, cultural heritage), audio and music, and ontologies applied for more specific uses, such as athletic events and virtual representation of humans.

Some of these well-known multimedia ontologies are briefly described below:

The *Shape Acquisition and Processing Ontology* (SAP) (Albertoni, Papapleo, Robbiano, & Spagnuolo, 2006) intends to conceptualize the knowledge pertaining to the development, usage and sharing

Table 2. Well-known multimedia ontologies, grouped by their scope

Ontologies for Describing Multimedia Objects in General	Ontologies for Describing Shapes and Images	Ontologies for Describing Visual Resource Objects	Ontologies for Describing Audio and Music	Application Ontologies
COMM	DIG35	VRA Core 3	Music Ontology	MEPCO
M3O	MSO	VDO	Kanzaki's Audio Ontology	AEO
Media Resource Ontology	SAP		Music Recommendation Ontology	VHO
MPEG-7 Upper MDS	CSO			
MPEG-7 Rhizomik	MIRO			
SWintO	PDO			
LSCOM				

of hardware tools, software tools and shape data by researchers and experts in the field of shape acquisition and processing. The fundamental goal of this OWL Full ontology is to formalize the knowledge related to the acquisition and processing of a shape. Its main classes include "Acquisition Device", which represents a system of sensors connected to a storage device for acquiring data, "Acquisition Condition" used to acquire environmental and logistic data, "Shape Type" describing categories of shapes, "Shape Data" conceptualizing the concrete data associated to a shape, "Processing Session", which formalizes either the acquisition phase or the application of a processing procedure, etc. The creation of the SAP ontology was based on the consideration that a digital shape can be created either from a real object or it can be created synthetically.

The *Product Design Ontology* (PDO) (Catalano, Camossi, Ferrandes, Cheuter, & Sevilmis, 2008) aims at guiding researchers and experts in the development of tools and methods for supporting industrial product design and engineering analysis, and formalizing process, tool and shape know-how relevant to the free-form modeling and the engineering simulation phases for training purposes. Its key concepts are the tasks of the product development process and the shapes and tools adopted in the different tasks. For example the concept of "Task" is central to describe the workflow where the different shape representations are used and the different shape processing tools are applied, while the concept of "ShapeRole" of shapes along the product development process has been formalized to interpret the additional information related to the shape which intervenes in a specific task of the design workflow.

The *Virtual Human Ontology* (VH) (Gutierrez, Thalmann, Vexo, Moccozet, Magnenat-Thalmann, Mortana, & Spagnuolo, 2005) aims at organizing the knowledge and data related to research and applications in the field of virtual environments and humans, and especially, the modeling and analysis of virtual human body, and their animation and interaction with virtual objects. It describes complex 3D entities not only at the geometric level, but also at the structural and semantic level. "Virtual Human" is its main class, which has morphology descriptor, individual descriptor, skeleton, geometry, etc. The goal of this description is to simplify the composition of virtual humans by non-experts and to facilitate sharing of useful information by domain experts in order to promote reusability and scalability.

The *Multimedia Metadata Ontology* (M3O) (Saathoff & Scherp, 2009; Scherp, Saathoff & Scheglman, 2012) is a framework for integrating the central aspects of multimedia metadata, that is, the separation of the information conveyed by multimedia items and their realization, the annotation with both semantic and low-level metadata and the decomposition of multimedia content. It provides the means for rich semantic annotation using domain-specific ontologies.

MATCHING MULTIMEDIA ONTOLOGIES

Differences in the scope and purpose of existing multimedia ontologies as well as in their application context result in semantic heterogeneity. For managing semantic heterogeneity among these knowledge resources, that is, handling variations in meaning or ambiguity in multimedia entity interpretation, there is a need for the so-called ontology matching, which is achieved in two steps: (i) finding a set of correspondences between semantically related entities of distinct ontologies, that is, an alignment, and (ii) interpreting the generated alignment according to application needs, such as data translation, query answering, ontology merging (Shvaiko & Euzenat, 2013). To accomplish an ontology matching task one could rely on various types of knowledge used features, such as the instances contained in the ontologies (extensional or instance-based methods), use the relations that hold between concepts of each ontology

(structural methods), measure the similarities of the concept names and their lexical definitions (terminological methods), use background knowledge provided by a reference ontology (semantic methods), or address uncertainty of concepts (fuzzy ontology matching approaches).

Recently, some efforts have been made in the area of multimedia to solve the interoperability problem by applying ontology matching techniques in existing multimedia ontologies. In James, Todorov, and Hudelot (2010) the ontology matching process is proposed as a suitable approach to solve several interoperability issues that coexist in semantic image annotation and retrieval. In Todorov, James, and Hudelot (2013) an extensional matching method is proposed as the most suitable in the case of multimedia ontologies, which often come equipped with sets of annotated images. In Scherp, Eissing, and Saathoff (2012) a step-by-step alignment method is presented, which describes how to integrate existing multimedia metadata standards and metadata formats with the M3O in order to use them in a concrete application, where there is a need to combine and use more than one existing metadata standard or metadata format at the same time. In Castano, Ferrara, and Guillermo (2006) an ontology matching technique is used as a prerequisite step in a methodology for multimedia ontology evolution, in which the ontology needs to be enriched because it does not contain any concept that could be used to explain a new multimedia resource. The paper shows how ontology matching techniques can be used to enforce the discovery of new relevant concepts by probing external knowledge sources using both the information available in the multimedia resource and the knowledge contained in the current version of the multimedia ontology.

CONCLUSION

Multimedia ontologies enable the inclusion and exchange of multimedia content through a common understanding of the multimedia content description and semantic information. They model the domain of multimedia data, in terms of low-level features and media structure descriptions, thus increasing sharing capabilities of multimedia objects. Additionally, such an ontology could also be used as a translator, to integrate multiple, heterogeneous data sources. With the aid of multimedia ontologies the vision of querying and retrieving multimedia content from distributed databases has started to become more feasible.

As final conclusions, we can mention that during this last decade a lot of efforts have been done to deal with the challenging task of definition of ontologies within the multimedia domain, due to the complexity of multimedia data and the related knowledge and the automatic building of multimedia ontologies, since usually low-level features can be automatically extracted, while semantic concepts are manually provided. The trend in recent years is reusing knowledge resources and performing mappings when developing multimedia ontologies with the aims of reducing the time and costs associated to the ontology creation, increasing the overall quality of the produced multimedia ontologies, and enabling interoperability among heterogeneous multimedia knowledge bodies.

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Chapter 82
Next Steps in Multimedia Networking

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ABSTRACT

This chapter presents in brief background knowledge on multimedia communication: multimedia applications and services, network and user QoS requirements, bandwidth on demand, multicasting, media synchronization, adaptive media coding, multimedia streaming, and end-system support for multimedia communication. In the second part, it deals with content delivery networks (CDNs). In the third part, it concentrates on issues for achieving multimedia optimization over heterogeneous wireless and wired networks. In the fourth part, it presents the main approaches for QoS guarantees over the Internet. This part tries to include the important aspects that have significantly impacted the enhancements to the basic Internet architecture and its associated protocols. In the fifth part, the chapter presents future Internet architectures. This is followed by some future research directions in multimedia networking.

INTRODUCTION

Nowadays, industry is making considerable investments to deliver digital audio, image and video information to consumers and customers. Novel infrastructures are quickly being deployed for digital audio, image and video recorders and players, on-line services, and electronic commerce. Multimedia applications are emerging at a fast pace in various sectors such as medicine, education, travel, real estate, banking, insurance, administration and publishing. Such applications are characterized by large multimedia documents that must be communicated within very short delays. Multimedia denotes the integrated manipulation of at least some information represented as *continuous* media data (e.g., video, audio), as well as some information encoded as *discrete* media data (e.g., text and graphics). Multimedia communication refers to the representation, storage, retrieval and dissemination of machine-processable information represented in multiple media types (text, image, graphics, speech, audio, video, animation, handwriting, data files) (Lu, 2000). In particular, multimedia communication deals with the transfer, protocols, services, and mechanisms of discrete and continuous media data in/over digital networks. Such

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communication requires that all involved components be capable of handling a well-defined *Quality of Service* (QoS) (Kanellopoulos et al., 2009). The most important QoS parameters are required capacities of the involved resources, compliance to end-to-end delay and jitter as timing restrictions, and restriction of the loss characteristics. Precisely, multimedia traffic requires transfer of large volumes of data at very high speeds, even when the data is compressed. Especially for interactive multimedia communication, the network must provide low latency. Continuous media such as video and audio require guarantees of minimum bandwidth and maximum end-to-end delay. The variation in delay (jitter) and loss of data must also be bound. Most multimedia applications can tolerate some errors in transmission due to corruption or packet loss without retransmission or correction. In some cases, to meet real-time delivery requirements or to achieve media synchronization, some packets are even discarded. In general, traditional networks do not suit multimedia communication and are often used to provide error-free transmission. In particular, transmission characteristics of existing Ethernet and Internet Protocols (CSMA/CD, TCP/IP) do not support the low latency, high bandwidth requirements of the audio, video-based applications. Ethernet provides only a bandwidth of 10 Mbps. This is insufficient for most multimedia applications. Moreover, its access time is not bound and its latency and jitter are unpredictable.

From another perspective, different multimedia applications have different QoS requirements. For example, continuous media types such as audio and video require hard or soft bounds on the end-to-end delay, while discrete media such as text and images do not have any strict delay constrains. In addition, video applications require more bandwidth than audio applications. QoS requirements are specified by the following closely related parameters (Lu et al, 2000): (1) bandwidth on demand; (2) low end-to-end delay; (3) low delay variation (or delay jitter); (4) acceptable error or loss rate without retransmission, as the delay would be intolerable with retransmission.

With the advent of high capacity storage devices, powerful and yet economical computer workstations and high-speed integrated services digital networks, providing a variety of multimedia services and applications is becoming not only technically, but also economically feasible. Currently, multimedia networking applications benefit from the rapid development of encoding techniques of multimedia data sources, the effective quality of service (QoS) control mechanisms and the quality of experience (QoE) criteria for system optimization (Cerqueira et al., 2013). In the meantime, interoperability solutions are being proposed to integrate wired and wireless heterogeneous networking systems. Another challenge is ensuring that the multimedia-networked content is fully interoperable, with easy of management and standardized multimedia content adapted for interoperable delivery, as well as intellectual property management and protection (i.e., digital rights management), successfully incorporated in the system (Lian et al., 2009). Therefore, there is an inherent need to present frameworks, standards, techniques, QoS control mechanisms, QoE criteria for system optimization, and other tools that deal with such components in multimedia networking.

In this chapter, we present state of the art research in multimedia networking. In addition, we discuss challenging issues that must be addressed for achieving multimedia optimization over heterogeneous wireless and wired networks. The rest of the chapter is organized as follows. At first, we present background knowledge on multimedia communication: multimedia applications and services, network and user's QoS requirements, bandwidth on demand, multicasting, media synchronization, adaptive media coding, multimedia streaming, and end-system support for multimedia communication. In the second part, we deal with Content Delivery Networks. In the third part, we concentrate on issues for achieving multimedia optimization over heterogeneous wireless and wired networks. In the fourth part, we present

the main approaches for QoS guarantees over the Internet. This part tries to include the important aspects that have significantly impacted the enhancements to the basic Internet architecture and its associated protocols. In the fifth part, we present briefly future Internet architectures. This is followed by some future research directions in multimedia networking.

BACKGROUND

Multimedia Applications and Services

The increasing availability of optical fiber channels, as well as the rapid advancement in VLSI circuits and systems, has fostered a tremendous interest in developing sophisticated multimedia services and applications with an acceptable cost. Multimedia applications can be classified into the following three main categories:

- *Two-way conversational applications*, which are characterized by their stringent requirement on end-to-end delay that includes total time taken to capture, digitize, encode/compress audio/video data, transport them from the source to the destination, and decode and display them to the user.
- *Broadcasting services* where the source is live. The main dissimilarity from the conversational applications is that it is one-way communication and it can stand more delay.
- *On-demand applications* (e.g., video on demand) where the user requests some stored items and the server delivers them to the user. The consumer can select a video or any program on demand. The application consists of interactive features like forward, rewind and pause.

A multimedia network can provide various multimedia services such as:

- *News and reference services*: News on demand is similar to Video on Demand (VOD), but it provides sophisticated news retrieval. Reference services can combine live and achieved video, access to textual data and still photography from various sources. The information is delivered based on filtering criteria kept by the user.
- *Interactive shopping and electronic commerce*: Home shopping provides a customizable shopping environment. Customers are effectively and rapidly focus on the products and services that are of interest to them.
- *Entertainment and games*: Interactive entertainment may become a frequently used service. Games consist of simple applications that are downloaded to the set top device, thus not incurring the significant cost associated with the use of server and network facilities.
- *Distance learning*: Educational interactive programming and distance learning services are provided for e-learning purposes.
- *Video conferencing*: Video collaboration systems can facilitate high-quality video collaboration in a group setting. *Telepresence* is an evolving category of video conferencing that represents the highest end of the visual communications spectrum, providing an immersive communications experience. It is noteworthy that Wu et al. (2014) investigate the problem of packet transmissions in real-time video conferencing from a single source to multiple destinations.

QoS Requirements

In designing and implementing multimedia applications, the characteristics of the application types (discussed above) should be used to provide required QoS, but using network and system resources efficiently. Even though we say that QoS should be guaranteed, the end-user states the degree of guarantees. Usually, there are three levels of guarantees:

- *Hard guarantee*, where user-specified QoS should be met absolutely. Reserving network and system resources based on the peak-bit rate of a stream achieves hard guarantees.
- *Soft guarantee*, where user-specified QoS is supposed to be met to a certain precise percentage. This is suitable for continuous media, as they usually do not need 100% accuracy in playback. This type of guarantee uses system resources more efficiently.
- *Best effort,* where no guarantee is given and the multimedia application is executed with whatever resources are available. More networks operate in this mode.

Different levels of guarantee are used for different types of traffic, and user determines which type of guarantee to use. Besides, the charging policy is related to the level of guarantee and the most expensive is the hard guarantee, while the best-effort is the cheapest. At the source, multimedia data are either captured live or retrieved from storage devices. The transport module accepts these data, packetizes and passed them on to the Internet. At the destination (sink), multimedia data are reassembled and passed to the application for playback of audio/video. Packet processing time differences, network access time differences, and queuing delay difference can cause delay jitter, which has to be removed at the destination before data being played out.

Bandwidth on Demand

Bandwidth on demand refers to data rate measured in bit/s (channel capacity or throughput-bandwidth consumption), which is required in order to transfer continuous media data (e.g., video).The speed of network links and routers in the next generation Internet will be improved radically so that network congestion will be uncertain and QoS guarantees will be provided by design (Kanellopoulos et al., 2009). This endeavor will include optical wavelength-division multiplexing (WDM) technologies, being considered by Next Generation Internet (NGI) initiative (http://www.ccic.gov/ngi/).

Multicast Support

Multicasting is the capability of a network to transmit data simultaneously to many receivers with no need to replicate the data. It is a common requirement of multimedia communication to send data from one source to multiple destinations. Efficient multicasting protocols can reduce bandwidth requirements (Paul, 1998; Wittmann & Zitterbart, 2001). Given the multi-receiver nature of video programs, real-time video distribution has emerged as one of the most important IP multicast applications and it requires bandwidth adaptability. Real-time video multicast applications have to adapt to the dynamic network conditions, but still they offer reasonable playback quality to the receivers. Liu and Zhang (2003) pre-

sented a survey on adaptive video multicast solutions. Since video and shared data are essential to many distributed tasks, audio of sufficient quality is necessary condition for almost any successful real-time interaction.

Media Synchronization

Media synchronization among the streams is very important, but it may be disturbed owing to network delay, delay jitter, and packet loss. Continuous media are characterized by well-defined temporal relationship between subsequent presentation units to be played. A presentation unit is a logical data unit that is perceivable by the user. Media synchronization is the process of preserving the temporal order of one or more media streams. The problem of maintaining continuity within a single stream is referred as *intra-stream synchronization*; whereas the problem of maintaining continuity among the streams is called *inter-stream synchronization*. In multicast communication, it is necessary to output each stream simultaneously at different destinations, and thus *group* (or *inter-destination*) *synchronization control* is required. In this case, streams often fall into a master stream and slave streams. Only the intra-stream synchronization control is carried out over the master stream, and the inter-stream synchronization control is exerted for the slave streams after carrying out the intra-stream synchronization control over each slave stream. It is also possible to apply only inter-stream synchronization control over each slave stream. In general, there are three schemes for group synchronization control:

- The master-slave destination scheme.
- The synchronization maestro scheme.
- The distributed control scheme.

To conclude, all types of media synchronization are necessary for both live streams and for stored media streams presentations. Furthermore, if the media synchronization quality is deteriorated, the *Quality of Experience* (QoE) (ITU-T Rec. G.100/P.10, 2007) may seriously be damaged. To solve such a problem, we need to carry out media synchronization control, which adjusts the output timings of streams at each terminal to achieve high quality of media synchronization. It is noteworthy that Huang et al. (2013) presented a historical view of temporal synchronization studies focusing on continuous multimedia. They demonstrated how the development of multimedia systems has created new challenges for synchronization technologies.

Adaptive Media Coding

Multimedia data should be coded in a way such that acceptable audio/video playback quality is still achieved, when some data packets are delayed extremely or lost. Coding multimedia data into multiple layers is the basic suggestion. Some layers are assigned high priority and they contain essential data to generate basic acceptable basic play out audio/video quality. Extra layers contain data that add additional details (or quality) to the basic quality and are assigned low priority. In the case of system overloading, low priority data are dropped first, leading to little effect to play out quality. This effect is named *graceful quality degradation*, and it can be obtained by the use of error control techniques such as *forward error correction* (FEC).

Multimedia Streaming Protocol

Streaming media is a media format which can play on the Internet by adopting the streaming transmission way, such as audio, video or multimedia files. It can be used for online tutorials and news, online live, online advertising, distance learning, real-time teleconferences and so forth. The *Real-time Transport Protocol* (RTP) defines a standardized packet format for delivering audio and video over IP networks (Perkins, 2003). RTP (Schulzrinne et al., 1996) is used extensively in communication and entertainment systems that involve streaming media. Recently, the usage of RTP has been decreased because delivering data according to the RTP's small packet model is less efficient than using larger data frames. In particular, delivering multimedia content in larger HTTP segments is more effective and has several additional benefits. For example, HTTP packets are being well-conditioned for firewall configurations and outgoing connections. Besides, transport-level Web protocols do not manage any information about session state on the server and there is, therefore, not any additional management cost on content or resources. For these reasons, the popularity and usage of HTTP streaming has risen. Thus, the MPEG group reacted by introducing a new HTTP streaming protocol, named *Dynamic Adaptive Streaming over HTTP* (MPEG-DASH) (MPEG-DASH Part 1, 2012; Sodagar, 2011). This new standard is based on a combination of two components, namely, *media content* and *manifest file*. This combination identifies the stream for any player and destination by means of URL addressing. In the MPEG-DASH context, the media stream is called MP and defines a set of sequences of small HTTP segments. Each sequence corresponds to a short interval of playback time (i.e. periods) of original multimedia content. These periods contain one or several adaptation sets that describe one or more representations of a single stream. These representations define one or more audio or video streams with different parameters or encoding alternatives. For instance, an adaptation set might contain several representations with different bit rates of a same video or audio component. Each representation set is composed of a set of media information segments identified through URLs that correspond to chunks of data managed by the HTTP streaming protocols. These chunks may be discrete files or byte ranges in a single media file stored on a content HTTP server. The manifest file is named *Multimedia Presentation Description* (MPD), and is an XML file that contains the information describing and identifying the periods of a media stream. Precisely, MPD does not contain any media data, but describes the accessible segments and corresponding timing. According to this data model, DASH clients parse the MPD document and select the best adaptation set according to a device's capabilities and a user's profiles. Finally, MPEG-DASH also supports layered codecs such as *Scalable Video Coding* (SVC) (Muller et al., 2012) or *Multiview Video Coding* (MVC) (Vetro et al., 2011). In the case of SVC, each layer is described by a different representation. The SVC layers are structured as one base layer and several enhancement layers that depend on lower layers, down to the base layer. This dependency can be described in MPD, allows an advanced and efficient usage of network resources and supports dynamic adaptation according to network status. It is noteworthy that DASH specification does not prescribe how source coding can be best performed. To this direction, Adzic et at. (2012) proposed an interesting form of video streaming, called *content-aware video encoding*, which takes into account scene changes and content type. Issues worthy of further investigation are: the duration of each video chunk, and the number of video streams to include.

End System Support

End systems must offer mechanisms to handle multimedia data efficiently and effectively such as to provide end-to-end QoS guarantees (Lu, 2000). The end-system support for multimedia communications is required for two reasons. First, the communications protocol stack is implemented mainly in software and it has thousand instructions executed by the end-system. If, for these instructions, the end-system cannot guarantee the execution time, there will be no real-time communications system regardless of how well networking support is offered. Second, if the media data need to be compressed and decompressed before presentation, the processing time should be predictable. If not, a meaningful presentation is not obtained.

Multimedia applications impose the following requirements on the hardware architecture:

- Digital audio and video are very data intensive, and therefore the hardware must have high data transfer throughput and high processing power.
- Parallel hardware architectures are preferred as a lot of multimedia applications have to access several input/output devices simultaneously. In addition, multimedia host computers have usually I/O buses, which support lower transfer rates than of those of high-speed networks (Kanellopoulos, 2009). This situation leads to the problem called "*mismatch in bandwidth*". For the solution of this problem, various network interface units must be implemented.
- The hardware architecture must be scalable to accommodate new input/output devices and applications.
- To support different types of data and applications, the architecture should be versatile and programmable.

Multimedia operating systems should meet the following requirements (Steinmetz, 1995).

- They should use the hardware resources efficiently so that use of these resources is maximized.
- QoS requirements of multimedia applications should be guaranteed by using proper resource management and process scheduling. At the operating system level, one of the main QoS requirements is the guaranteed processing time for each task. It is noteworthy that Lakshman et al. (1998) proposed an integrated QoS management system to manage CPU, network and I/O resources. This cooperative model and architecture, called AQUA (*Adaptive QUality of service Architecture*), enables multimedia end-systems and operating system to cooperate dynamically for adaptively sharing end-system resources. In AQUA, the operating system allocates initial resources such as CPU time according to the user QoS specification. As the multimedia application executes, the operating system and the application cooperate to estimate the resource requirements and QoS received.
- The operating system should execute multimedia applications as well as conventional applications. This has two implications. First, the conventional application-programming interface (API) should be maintained. Second, the conventional applications should not be starved of resources, while QoS requirements of multimedia applications are guaranteed.

User terminal: Because of the large size of multimedia objects and real-time requirements, multimedia terminal or the network should include large data buffers. To restore the temporal relationship of a data stream, stream handlers should be connected to data buffers. To synchronize the possible multiple data streams and to control the stream handlers, synchronization and streaming manager are required. Since multimedia data objects are large, the terminal should also include compression and decompression hardware.

Multimedia Server: The majority of current personal computers, workstations and servers do not perform well for multimedia data, requiring fast data retrieval and guaranteed real-time capabilities. The I/O capacity is usually a severe bottleneck. The main requirements imposed to the multimedia server are the following:

- *Minimal response time*: A crucial factor for the success of multimedia services is the response time seen by the client. The server must be able to minimize response time to live unto the expectations of the user.
- *Fast processing capability*: To guarantee fast response time, clients should be processed fast, while data access rates should be minimized.
- *Reliability and availability*: Multimedia server must be reliable. In particular, the larger the number of users and volume of data handled by the server, the more difficult is to guarantee reliability. To provide fault tolerance, special hardware and software mechanisms must be employed. Since client requests may arrive at any time, the time the server is unavailable should be minimized.
- *Ability to sustain guaranteed number of streams*: Another important factor is the maximum number of data streams that the server can simultaneously handle. This affects the total number of clients the server can serve.
- *Real-time delivery:* To deliver multimedia data, the server should support real-time delivery. This poses profound requirements on the resource scheduling at the operating system level. The server should be able to guarantee real-time delivery for individual streams, as well as for all the streams combined together. For this goal, accurate real-time (multimedia) operating systems have to be developed (Steinmetz, 1995).
- *High storage capacity*: To store multimedia data and a large variety of information, the server must have a large storage capacity. To sustain the delivery requirements of multimedia data, the server may be required to compress and encode video and image data prior to transport or storage. The performance of compression and signal processing should be optimized. This might require special hardware.
- *Exploit user access patterns*: The server should also be able to trap and exploit dynamic user's behavior, minimizing system load and network traffic. For example, by analyzing data access rates and times, popular data could be distributed closer to users in periods of low network load.
- *Ability to handle different types of traffic*: A multimedia server should be able to serve multiple real-time data streams simultaneously, but it must also be able to provide satisfactory service to non-real-time data. It should be able to handle control data encountered, when loading new data from other servers or storage repositories, billing and accounting data and communication between intelligent personal software agents. Agents are autonomous programs selecting and managing data according to user preferences.
- *Cost effectiveness*: A very important requirement that governs the future of a multimedia server is its cost effectiveness. The server must be affordable.

- *QoS requirements*: QoS is a set of parameters describing the tolerable end-to-end delay, throughput, and the level of reliability in multimedia communication and presentation. QoS requirements of clients are an important factor that affects the usage of the server. The server should be able to provide and adapt itself to different QoS requirements, according to the characteristics of the client's terminal, the network connection, and the requested data type.

CONTENT DELIVERY NETWORKS (CDNs)

Content Delivery Networks (CDNs) are playing an important role in future multimedia networking. A CDN serves content to end-users with high availability and high performance. In particular, CDNs provide services that improve network performance by maximizing bandwidth, improving accessibility and maintaining correctness through content replication. They offer fast and reliable applications and services by distributing content to cache or edge servers located close to users. A CDN has some combination of content-delivery, request-routing, distribution and accounting infrastructure. The content-delivery infrastructure consists of a set of *edge servers* (also called *surrogates*) that deliver copies of content to end-users. The request-routing infrastructure is responsible to directing client request to appropriate edge servers. It also interacts with the distribution infrastructure to keep an up-to-date view of the content stored in the CDN caches. The distribution infrastructure moves content from the origin server to the CDN edge servers and ensures consistency of content in the caches. The accounting infrastructure maintains logs of client accesses and records the usage of the CDN servers. This information is used for traffic reporting and usage-based billing. In practice, CDNs typically host static content including images, video, media clips, advertisements, and other embedded objects for dynamic web content. Nowadays, CDNs serve a large fraction of the Internet content, including web objects (text, graphics and scripts), downloadable objects (media files, software, documents), applications (e-commerce, portals), live streaming media, on-demand streaming media, and social networks. CDNs augment the end-to-end transport network by distributing on it a variety of intelligent applications employing techniques designed to optimize content delivery. The resulting closely integrated overlay uses web caching, server-load balancing, request routing, and content services. Below, we describe in brief these techniques.

- *Web caches* store popular content on servers that have the greatest demand for the content requested. These shared network appliances reduce bandwidth requirements, reduce server load, and improve the client response times for content stored in the cache.
- *Server-load balancing* uses one or more techniques including service-based (global load balancing) or hardware-based, i.e. layer 4–7 switches, also known as a web switch, content switch, or multilayer switch to share traffic among a number of servers or web caches. In this case, the switch is assigned a single virtual IP address. Then, traffic arriving at the switch is directed to one of the real web servers attached to the switch. This has the advantage of balancing load, increasing total capacity, improving scalability, and providing increased reliability by redistributing the load of a failed web server and providing server health checks. A content cluster or service node can be formed using a layer 4–7 switch to balance load across a number of servers or a number of web caches within the network.
- *Request routing* directs client requests to the content source best able to serve the request. This may involve directing a client request to the service node that is closest to the client, or to the

one with the most capacity. A variety of algorithms are used to route the request. These include: *Global Server Load Balancing*, *DNS-based request routing*, *Dynamic metafile generation*, *HTML rewriting*, and *anycasting*. Proximity (viz., the capability of choosing the closest service node) is estimated using a variety of techniques including reactive probing, proactive probing, and connection monitoring (Plagemann et al., 2006).

Actually, users are often interested in content, and they have very little (or no) interest in where it comes from. This has led to the research in the area of *Content-Centric Networking*. The content-centric paradigm puts content at the heart of a network's operation and allows hosts to interact with it using a content request/reply model. Therefore, instead of having packets routed to specific hosts, requested are routed to optimal content sources using unique content identifiers. One of the first systems built around this paradigm was *Data-Oriented Networking Architecture* (DONA) (Koponen et al., 2007). First and second generation CDNs have mainly concentrated on improving content availability through network caching and replication, but more recent content network research has looked into providing content support at the same time as still been able to integrate existing systems (Cerqueira et al., 2011). It is noteworthy that Pathan and Buyya (2006) provided a comprehensive taxonomy with a broad coverage of CDNs in terms of organizational structure, content distribution mechanisms, request redirection techniques, and performance measurement methodologies. They studied the existing CDNs in terms of their infrastructure, request-routing mechanisms, content replication techniques, load balancing, and cache management. They also provided an in depth analysis and state-of-the-art survey of CDNs. From another perspective, Almeida and Calistru (2012) discussed the role of CDNs in helping content providers to deliver text, pictures, audio, video, applications and related services to users. They presented the architectural design of a CDN and discussed the main future challenges in terms of coordination, content replication, service and policy management.

MULTIMEDIA OPTIMIZATION OVER HETEROGENEOUS WIRELESS AND WIRED NETWORKS

Multimedia Content Adaptation

The Internet is a heterogeneous and constantly evolving environment in which end-users are making use of different types of client devices like notebooks, desktop PCs, workstations, set-top boxes, TV sets, and mobile devices such as PDAs, cell phones, and hand held devices. All those devices have different capabilities in terms of computational power, memory size, display size, or network capabilities. At the same time, there is a large number of possible media formats for multimedia content. As a result, current end-user devices cannot display all kind of multimedia data. Nevertheless, this does not be conventional to the vision of *Universal Multimedia Access* (UMA) (Mohan et al., 1999; Pereira and Burnett, 2003). According to the UMA vision, any user/device can consume any multimedia content, anytime and anywhere. Displaying multimedia content on heterogeneous client devices is a task of manageable complexity because users have different content/presentation preferences and intend to consume the content at different locations, times, and under altering circumstances, i.e., within a variety of different contexts. Generally, end-users can specify explicit personal preferences, which should be taken into account when servicing the client. The MPEG-21 standard (Burnet et al., 2003) provides mechanisms

that allow end-users to specify explicit, personal preferences on the multimedia content. The MPEG-21 is the ISO/IEC standard which defines an open framework for multimedia delivery and consumption involving all parties in the delivery and consumption chain. Rendering multimedia content in the Internet remains challenging because the content available on the multimedia server can be heterogeneous, e.g. in terms of encoding. For example, a video can be encoded in different formats such as MPEG-1, MPEG-2, MPEG-4, or H.264, using different encoder settings such as spatial and temporal resolution, color depth, or bit rate. Actually, there is a large number of file and encoding formats in which media resources are stored at the multimedia server. A multimedia server must adapt the multimedia resource correspondingly before sending it to the client for the following two reasons:

- The capabilities of the client's device of transforming the resource by itself may be limited.
- Preferences and personalization requirements of the end-users must be taken into account. New opportunities for personalization on the content level are emerged by the new possibilities of annotating the multimedia resources. For example, research efforts based on the MPEG-7 standard (Martinez et al., 2002) allow enriching media content with semantic content annotations, which in turn facilitate new forms of multimedia experience such as semantic-based content selection and filtering. There are some projects (Steiger et al., 2003) that have exploited the extended metadata annotation possibilities available with the new MPEG standards. The *Video Tool Kit* (ViTooKi) project is a representative example (Böszörmenyi et al., 2003).

Conclusively, multimedia content adaptation involves the execution of one or more transformation operations on the content. It uses descriptive information about the content, user preferences, and usage context to provide the variant of content more adequate to the usage scenario (Kanellopoulos, 2010).

QoE for Multimedia Users

Quality of Experience (QoE) is an important indicator for network operators and service providers to help them assessing the user acceptability towards a particular multimedia service or application. As the paradigm is shifting towards user-centric evaluation of service or application performance, the real time estimation of QoE is becoming a necessity for network operators and service providers in order to attract and bind users to their service. In order to support more accurate control and measurement of multimedia quality, novel user-aware and multimedia-aware approaches are required to increase the customer's satisfaction, while simultaneously improving the usage of network resources. In the light of this evidence, Latre et al. (2009) and Takahashi et al. (2008) have introduced *Quality of Experience (QoE) schemes* to overcome the limitations of current QoS-aware solutions regarding multimedia coding unawareness, human perception, and subjective-related aspects. Romaniak et al. (2008) proposed QoE assessment mechanisms and techniques to show how a networking environment can meet the viewer's specific requirements. In addition, Romaniak et al. (2008) presented several studies in video assessment models for future multimedia systems that have focused on Standard-Definition (SD) and especially in High-Definition (HD) content. It is noteworthy that the results of video assessment schemes for multimedia applications are very important and can be used for different proposals, such as: pricing, medium adaptation, and user-based optimizations. From another perspective, Mu et al. (2009) discussed how QoE control schemes can optimize network resources and improve the user perception simultaneously. Currently, the most influential working group in the video quality area is the *Video Quality of Experts*

Group (VQEG) (VQEG, 2014). This group runs test plans that aim at selecting the best quality models that could then be turned into ITU Recommendations. VQEG has recently started to turn its attention to 3DTV video quality metrics and models.

APPROACHES FOR QoS GUARANTEES OVER THE INTERNET

According to Servetto and Nahrstedt (2001), the problem of sending video over IP has essentially two main components: (1) video data compression and (2) design of communication protocols. One approach consists of designing a low bit rate coder, protecting the resulting bit stream with channel codes and using one of the standard Internet transport protocols to transmit the resulting data stream. If the source bit rate is low enough and the channel is not too congested, then it is possible to use TCP, in which case no errors occur and therefore there is no need for channel codes. Otherwise, user datagram protocol (UDP) is used with a constant packet injection rate, and low-redundancy channel codes are used to protect against infrequent lost packets. But this approach is to naive.

Speaking more precisely, supporting multimedia communications over the Internet introduces two major problems: *Fairness* and *Useless Packet Transmission* (UPT). In current Internet, a single FIFO-based queue is used to multiplex both adaptive and non-adaptive traffic at routers. When multimedia applications cross the same router, this may cause fairness problem. UTP is based on the fact that for packetised audio and video, packet loss rate must be preserved under a given threshold for any meaningful communication. Wu and Hassan (2004) have proposed two different management policies for UPT. ITU-T has developed a series of recommendations together comprising the H.323 system (Toga & Ott, 1999) that provides for multimedia communications in packet-based (inter)networks. The H.323 series of recommendations explain systems, logical components, messages and procedures that enable real-time, multimedia calls to be established between two or more parties on a packet network.

In the last decade, Giordano et al. (2003) described the evolution of QoS architectures, mechanisms, and protocols in the Internet, as it was ongoing in the framework of the European Union funded research projects (AQUILA, CADENUS, TEQUILA) on premium IP networks. Bhargava et al. (2005) developed an adaptable network architecture (ADNET) which allows different QoS provision schemes such as active networks, integrated services and differentiated services to co-exist.

In general, the Internet provides the best-effort service to multimedia applications and thus cannot meet the QoS requirements of multimedia communications. However, many research efforts have been made towards providing QoS guarantees. Communication architecture of the Internet is altered or improved to provide QoS guarantees (Kanellopoulos et al., 2009). Three main architectures have been proposed:

- *Integrated service model (IntServ).*
- *Differentiated service model (DiffServ).*
- *Multiprotocol label switching (MPLS).*

Integrated Service Model

The integrated service model (IntServ) is based on resource reservation (Braden et al., 1994). An appropriate amount of resources is reserved for each flow to meet its requirements. Resources including

bandwidth and memory are reserved to meet QoS requirements of an application or communication session (Braden et al., 1997). The following fundamentals are needed to provide QoS guarantees:

- A *QoS specification mechanism* for applications to specify their requirements.
- *Admission control* to determine whether the new application should be admitted without affecting the QoS of other ongoing applications.
- A *QoS negotiation process* so that as many applications as possible can be served. During the QoS negotiation phase, each peer computer must determine whether it can support the desired QoS. If so, certain resources are reserved for this session. If the user is satisfied with the suggested QoS, the session is established. Otherwise, the session is rejected.
- *Resource allocation and scheduling* to meet the QoS requirement of accepted applications.
- *Traffic policing* to make sure that applications generate the correct amount of data within the agreed specification.

In addition, *a QoS re-negotiation mechanism* is required so that applications can request changes in their initial QoS specifications. The actual QoS provided to the ongoing sessions should be monitored, so that suitable actions can be taken in case of any problem in providing specified QoS guarantees. Media scalability and graceful quality degradation techniques should be used together with the above mechanisms to provide satisfactory services to multimedia applications.

Traffic-shaping schemes. Traffic shaping regulates a stream's traffic so that it is simple to describe and police. Traffic-shaping schemes are used, when the traffic pattern is too complicated to describe directly or the traffic is not appropriate for networks to support directly. For example, when video is variable bit rate coded, it may be hard to characterize the coded bit stream.

Admission control, QoS negotiation and renegotiation. When a connection with specified QoS is established, QoS parameters are translated and negotiated among all relevant subsystems. Only when all subsystems are in agreement with and guarantee the specified QoS parameters, the end-to-end QoS requirements can be met.

Resource reservation protocols. A vital part of the IntServ model is the resource reservation protocol at the network layer. A resource reservation protocol transfers information about resource requirements and negotiates the QoS values that users desire for their end-to-end applications. In current IntServ model, only RSVP (Braden et al., 1997) is used as the reservation protocol.

IntServ uses RSVP to make per-flow reservations at routers along a network path. While this allows the network to provide service guarantees at the flow level, it suffers from scalability issues. RSVP is a soft-state protocol, which means that the router's state has to be refreshed at regular intervals, and this adds to traffic overhead. The service classes offered by IntServ are: (1) guaranteed service class, (2) controlled load service, and (3) best-effort service.

Differentiated Services

The main problem of the currently best-effort model on the Internet is that all packets are treated the same although different types of service can be determined in the IPv4 header. The main problem of the IntServ is that there are potentially infinite number of different types of traffic so each router has to store essential information to provide QoS guarantees to each type of traffic. Differentiated services (Black, 1998) take a middle ground between the best-effort service and IntServ. It defines a fixed number of

packet classes. All traffic types/packets are aggregated into these classes and the network/routers provide different services to different packet classes.

Service classification. IPv4 has an underused type-of-service byte in its header. The newer IPv6 has a header byte called traffic class. In DiffServ, the type-of-service (traffic class) byte is re-defined as a differentiated service (DS) field. The first six bits of the DS field is called DS CodePoint, which indicates the behavior each router is required to apply to the individual packet. Packets with the DS CodePoint set to zero receive the same service as they get in the best effort service. Values between one and seven are defined to be backward compatible with the original IP precedence mechanism, to ensure that DiffServ technology can be deployed in the operational Internet progressively. The DS filed can be assigned by the customer (the transmitter process) to indicate the desired service. Alternatively, the ingress router marks the DS field based on multifield (MF) classification. MF classification classifies packets based on the contents of multiple fields such as source address, destination address, type-of-service byte, protocols ID, source port number and destination port number. As a packet moves from one Internet Service Provider (domain) to another, it may be re-classified. Many service classes can be defined. The Internet Engineering Task Force (IETF) working group has defined the following two new services.

- *Expedited or premium service:* to provide virtual leased line service to applications requiring low-delay and low delay jitter.
- *Assured service:* to provide better-than-best-effort services to applications.

In the past decade, Hou et al. (2000) proposed a Diffserv architecture for multimedia streaming applications in next generation Internet.

Multiprotocol Label Switching (MPLS)

In an IP network, each router analyzes the packet's header and runs a network layer routing algorithm. Each router separately chooses a next hop for the packet, based on its analysis of the packet's header and the results of running the routing algorithm. This process introduces some latency, as the routing tables are very big and table lookups take time. Choosing the next hop consists of two steps. The first step classifies the entire set of possible packets into a set of forwarding equivalence classes (FECs). The second step maps each FEC to a next hop. As far as the forwarding decision is concerned, different packets, which are mapped into the same FEC are indistinguishable and travel in the same path. In MPLS, the assignment of a particular FEC is done just once at the ingress router (Armitage, 2000). The FEC to which the packet is assigned is encoded as a short fixed length value known as a label. This label is inserted into the packet by the ingress router. At subsequent hops, there is no further analysis of the packet's network layer header. Instead, the label is used as an index into a table that specifies the next hop and a new label. The old label is replaced with the new label and the packet is forwarded to its next hop. The path taken by the packet is specified by a sequence of labels and is called a label switched path (LSP). The routers that support MPLS are called label-switching routers (LSRs). MPSL is a forwarding scheme and is much faster than IP routing. The label can represent a combination of a FEC and a precedence or class of service. Routers to provide differentiated QoS to different types of traffic can treat packets with different labels differently.

In the next section, we briefly present some of the current research progress on the future Internet architecture.

FUTURE INTERNET ARCHITECTURES

Pan et al. (2011) investigated the key research topics in the area of future Internet architecture. In particular, they discussed many ongoing research projects from United States, the European Union, Japan, China, and other places. Hereafter, we present some of the current research progress on the future Internet architecture.

Future Internet Architecture (FIA) Program: The National Science Foundation (NSF) directorate for Computer and Information Science and Engineering (CISE) administrates Research programs on future Internet architecture in the United States. The FIA program (Future Internet Architecture – N.S.F, 2013) of the NSF is a research umbrella, built on the previous program, called Future Internet Design (FIND). It is noteworthy that FIND funded about 50 research projects on all kinds of design aspects of the future Internet. FIA is the next phase to pull together the ideas into groups of overall architecture proposals.

Named Data Networking (NDN): The initial idea of the Named Data Networking (NDN) project can be traced to the concept of *content-centric networks* (CCNs) by Ted Nelson in the 1970s. The basic argument of the NDN project (Named Data Networking Project, 2014) is that the primary usage of the current Internet has changed from end-to-end packet delivery to a *content-centric model* (discussed previously). The current Internet, which is a "client-server" model, is facing challenges in supporting secure content-oriented functionality. In this information dissemination model, the network is "transparent" and just forwarding data (i.e., it is "content-unaware"). Due to this unawareness, multiple copies of the same data are sent between endpoints on the network again and again without any traffic optimization on the network's part. The NDN uses a different model that enables the network to focus on "what" (contents) rather than "where" (addresses). The data are named instead of their location (IP addresses). Data become the first-class entities in NDN. Instead of trying to secure the transmission channel or data path through encryption, NDN tries to secure the content by naming the data through a security-enhanced method. This approach allows separating trust in data from trust between hosts and servers, which can potentially enable content caching on the network side to optimize traffic.

Mobility First: The Mobility First (Mobility First Future Internet Architecture Project, 2014) project is led by Rutgers University with seven other universities. The basic motivation of Mobility First is that the current Internet is designed for interconnecting fixed endpoints. It fails to address the trend of dramatically increasing demands of mobile devices and services. The Internet usage and demand change is also a key driver for providing mobility from the architectural level for the future Internet. Mobility First aims to address the cellular convergence trend. It also provides mobile peer-to-peer (P2P) and info station (delay-tolerant network) application services, which offer robustness in case of link/network disconnection. In the future, Mobility First has the ambition of connecting millions of cars via vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) modes, which involve capabilities such as location services, geo routing, and reliable multicast. Ultimately, it will introduce pervasive system to interface human beings with the physical world, and build a future Internet around people. The challenges addressed by Mobility First include stronger security and trust requirements due to open wireless access, dynamic association, privacy concerns, and greater chance of network failure.

NEBULA: NEBULA (NEBULA Project, 2013) is another FIA project focused on building cloud-computing-centric network architecture. It is led by the University of Pennsylvania with 11 other universities. NEBULA envisions the future Internet consisting of a highly available and extensible core network interconnecting data centers to provide utility-like services. Multiple cloud providers can use replication by themselves. Clouds comply with the agreement for mobile "roaming" users to connect to

the nearest data center with a variety of access mechanisms such as wired and wireless links. NEBULA aims to design the cloud service embedded with security and trustworthiness, high service availability and reliability, integration of data centers and routers, evolvability, and economic and regulatory viability. NEBULA design principles include, reliable and high-speed core interconnecting data centers, parallel paths between data centers and core routers, secure in access and transit, policy-based path selection mechanism, authentication enforced during connection establishment. With these design principles in mind, the NEBULA future Internet architecture consists of the following key parts:

- The *NEBULA data plane*, which establishes policy-compliant paths with flexible access control and defense mechanisms against availability attacks.
- *NEBULA virtual and extensible networking techniques*, which is a *control plane* providing access to application selectable service and network abstractions such as redundancy, consistency, and policy routing.
- The *NEBULA core* (NCore), which redundantly interconnects data centers with ultrahigh-availability routers.

4WARD: It is an EU FP7 project (The FP7 4WARD Project, 2014) on designing a future Internet architecture led primarily by an industry consortium. The funding is over 45 million dollars for a 2-year period. 4WARD promotes the innovations needed to improve single network architecture. It also enables multiple specialized network architectures to work together in an overall framework. In particular, the key 4WARD design goals are:

- To create a new "network of information" paradigm in which information objects have their own identity and do not need to be bound to hosts.
- To design the network path to be an active unit that can control itself and provide resilience and failover, mobility, and secure data transmission.
- To devise "default-on" management capability that is an intrinsic part of the network itself.
- To provide dependable instantiation and interoperation of different networks on a single infrastructure.

AKARI: The AKARI project (AKARI, 2015) is supposed to assemble five sub-architecture models:

- An integrated sub-architecture based on a layered model with cross-layer collaboration. That means that we have a logical identity separation from the data plane.
- A sub-architecture that simplifies the layered model by reducing duplicated functions in lower layers.
- A sub-architecture for QoS guarantee and multicast.
- A sub-architecture to connect heterogeneous networks through virtualization.
- A mobile access sub-architecture for sensor information distribution and regional adaptive services.

Through systematic test-bed construction and experimentations, AKARI project aims to establish a new architecture ready for public deployment by 2016.

Future Internet Research and Experimentation (FIRE): FIRE (FIRE, 2014) is one of the European Union's research projects on test beds. FIRE involves efforts from both industry and academia. The FIRE project's research is built on the previous work on the GEANT2 (Gigabit European Academic Networking Technology) project (GEANT2 Project, 2014). GEANT2 is the infrastructure test bed connecting over 3000 research organizations in Europe. FIRE also expects not only to change the Internet in technical aspects but also in socio-economic terms by treating socio-economic requirements in parallel with technical requirements.

FUTURE RESEARCH DIRECTIONS

In the future, a high-speed multimedia network will be mainly wireless at the edges, with access to a high-speed optical backbone infrastructure, including optical switches. One can imagine a network that consists only of wireless access to an optical backbone. Fourth-generation mobile wireless networks offer capacities up to 150 Mb/s to fully mobile users in various environments. In such environments, resource management remains an important issue. Efficient resource management is a hot issue due to: (1) the rapid increase in size of the wireless mobile community; (2) its demand for high-speed multimedia communications; and (3) the limited resources. Additional crucial issues that need to be addressed in future multimedia systems are:

Ubiquitous and seamless mobility support: Multimedia systems can provide ubiquitous support by using intelligent multimedia content adaptation and context awareness techniques. Wireless and cellular networks have improved multimedia applications with mobility. Mobility aspect has added another dimension of complexity to multimedia networks. It opens up questions on a host of complex issues like routing to mobile terminals, maintaining the QoS when the host is in motion, interworking between wireless and wired networks. In addition, the ability of wireless devices to satisfy many of the emerging multimedia applications and user requirements remains an important challenge for designers and manufactures because these portable wireless devices have limited resources (CPU, memory, battery power).

Transport and network levels optimization mechanisms: Novel routing mechanisms and intelligent inter-intra session adaptation are still needed. Cross-layer design methodologies provide great promises for addressing these challenges and achieving reliable and high-quality end-to-end performance in wireless multimedia communications (Foukalas et al., 2008).

Cross-layer optimized wireless multimedia communications: Supporting multimedia applications and services over wireless networks is challenging due to constraints and heterogeneities such as limited battery power, limited bandwidth, random time-varying fading effect, different protocols and standards, and stringent QoS requirements. Cross-layer design methodologies proposals can address these challenges and achieve reliable and high-quality end-to-end performance in wireless multimedia communications. The cross-layer approach transports feedback dynamically via the layer boundaries to enable the compensation for e.g. overload, latency or other mismatch of requirements and resources by any control input to another layer but that layer directly affected by the detected deficiency. Cross-layer optimization removes strict boundaries (enforced between layers of the OSI communication model) to allow communication between layers by permitting one layer to access the data of another layer to exchange information and enable interaction. For example, having knowledge of the current physical state will help a channel allocation scheme in optimizing tradeoffs and achieving throughput maximization. Cross-layer optimization can contribute to an improvement of quality of services under various opera-

tional conditions. Such adaptive quality of service management can be based on a cross-layer control mechanism that will provide a feedback on concurrent quality information for the adaptive setting of control parameters. The developments of the new schemes, mechanisms, and systems associated with the cross-layer designs and protocols will have a significant impact on the next generation of wireless communications and networks.

Highly heterogeneous networking infrastructures and devices: Regarding heterogeneity, multimedia standards can play a major role in the multimedia revolution, because they provide interoperability between hardware and software provided by multiple vendors. However, the production of standards for multimedia communications is beset by the problem that the involved industries have radically different approaches to standardization.

New QoE-based applications: Narrative video assessment schemes for such multimedia applications can be used for different proposal, such as user-based optimizations, pricing, medium content adaptation etc.

Use of Network Coding (NC) to multimedia content distribution: NC is an innovative technique that can achieve the maximum information flow in a network by allowing nodes to combine received packets before retransmission (Ahlswede et al., 2000). Nemoianu and P. Popescu (2013) provided an overview of the joint use of NC and a set of current multimedia techniques. The applications of NC can range from distributed storage, multimedia content distribution with scalable coding, multiple description coding in Peer-to-Peer (P2P) networks, to the applications in wireless networks and the recent trends in cross-layer optimization.

Video coding: In the field of audio/video coding, a large variety of innovative coding algorithms exists, but the most algorithms of them are too complex for implementation.

CONCLUSION

In this chapter, we presented background knowledge on multimedia communication: multimedia applications and services, network and user QoS requirements, bandwidth on demand, multicasting, media synchronization, adaptive media coding, multimedia streaming, and end-system support for multimedia communication. We also discussed content delivery networks (CDNs) and concentrated on issues for achieving multimedia optimization over heterogeneous wireless and wired networks. We provided an overview of technologies required to support end-to-end QoS guarantees over the Internet. In particular, we presented the main approaches for QoS guarantees over the Internet. We outline, that besides the network layer architectures, proper transport protocols such as RTP and application dependent protocols such as *Session Initiation Protocol* (SIP) (Johnston, 2000) are required for multimedia communications. To achieve end-to-end QoS guarantees special efforts are required from all subsystems including end systems and all networking components involved. The communication architectures IntServ, DiffServ and MPLS will inter-operate with each other in the Internet environment. IntServ will be implemented in edge networks where the number of flows is small, while DiffServ will be putted into practice in core of the Internet where the number of flow is high. MPLS together with DiffServ will provide differentiated services and QoS guarantees. Finally, in this chapter we presented in brief future Internet architectures and some future research directions in multimedia networking.

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KEY TERMS AND DEFINITIONS

Content Delivery (or Distribution) Networks (CDNs): In the last years, these networks are evolved from infrastructures for Web documents to systems that support multimedia content and different forms of delivery such as streaming and Video on Demand (VoD).

Delay Variation (Jitter): It is a term used for the variation of end-to-end delay from one packet to the next packet within the same packet stream (connection/flow).

End-to-End Delay: It is an important parameter affecting the user's satisfaction with the multimedia communication application. It includes capturing, digitizing, encoding/compressing media data, transmitting them from the source to the destination, and decoding and displaying/presenting them to the user.

Future Internet: Current Internet protocol suite architecture has many shortcomings such as "semantic overload" (viz. an IP address denotes both the identifier as well as the locator of an end-system). Future Internet is a general term for research activities on new architectures for the Internet. Approaches towards a future Internet range from small, incremental evolutionary steps to complete redesigns (clean slate)

and architecture principles, where the applied technologies shall not be limited by existing standards or paradigms such as client server networking. Technical examples for evolutionary approaches include supplements to existing Internet technology, such as Differentiated services.

IP Multimedia Subsystem (IMS): It is an architectural framework for delivering IP multimedia services. In particular, it is a standardized *Next Generation Networking* (NGN) *architecture* for telecom operators that want to provide mobile and fixed multimedia services. IMS runs over the standard IP and uses a Voice-over-IP (VoIP) implementation that is based on a 3GPP standardized implementation of SIP.

Media Streaming: It is a technique for transferring data so that it can be processed as a steady and continuous stream. Streaming technologies are important because most users do not have fast enough access to download large multimedia files quickly in the Internet. With streaming, the client browser (or plug-in) can start displaying the data before the entire file has been transmitted.

Multimedia Content Adaptation: It is the modification/adaptation of multimedia content in order to meet various quality of service (QoS) requirements or different criteria such as the user/viewer's personal preferences, the resolution capability of a mobile device, a geographic target, etc.

Quality of Experience (QoE): A subjective measure of quality perceived by the user in some services types such as video transmission, voice transmission, web browsing, games etc. QoE evaluates the acceptability of a service from the client.

Quality of Service (QoS): QoS functionality enables service providers to guarantee and enforce transmission quality parameters (e.g., bandwidth, jitter, delay, packet loss ratio) according to a specified service-level agreement (SLA) with the customer.

Real-Time Streaming Protocol (RTSP): It is a network control protocol, which is used to establish and control media sessions between end-points. Networked multimedia computers use RTP to control streaming media servers. Clients of media servers issue commands, such as play and pause, to facilitate real-time control of playback of media files from the server.

Real-Time Transport Protocol (RTP): It defines a standardized packet format for delivering audio and video over the Internet. It transfers media streams controlled by H.323, MGCP, Megaco, SCCP, or Session Initiation Protocol (SIP) signaling protocols, enabling it one of the technical foundations of the voice over IP industry.

Resource ReSerVation Protocol (RSVP): RSVP is the network control protocol that allows data receiver to request a special end-to-end quality of service for its data flows. RSVP is a main component of future Integrated Services Internet (viz. Integrated Service Model) and can provide both best-effort and real-time service. RSVP is used by real-time applications to reserve necessary resources at routers along the transmission paths so that the requested bandwidth can be available, when the transmission actually takes place.

RTP Control Protocol (RTCP): It is a sister protocol of the RTP and is used to monitor transmission statistics and QoS information. RTCP provides feedback on the QoS in media distribution by periodically sending statistics information to participants in a streaming multimedia session.

Session Initiation Protocol (SIP): It is a signaling protocol defined by IETF. The SIP protocol is widely used for controlling communication sessions such as video and voice calls over IP. SIP can be used for creating, modifying, and terminating two-party (unicast) or multiparty (multicast) sessions. These sessions may consist of one or several media streams.

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Chapter 83
Media Synchronization Control in Multimedia Communication

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ABSTRACT

In this chapter, first, we explain media synchronization control. Next, we make a survey of media synchronization control techniques and classify the techniques. Also, we compare group synchronization control schemes. Then, we propose new control called the dynamic local lag control in joint musical performance which has severe requirements on high quality of media synchronization and high interactivity. In the performance, multiple users play their respective same or different types of musical instruments together. However, the media synchronization quality and interactivity may seriously be deteriorated owing to the network delay. By Quality of Experience (QoE) assessment, we demonstrate that the new control can achieve high quality of media synchronization and keep the interactivity high. Finally, we discuss the future directions of media synchronization control.

INTRODUCTION

In this chapter, we explain the state-of-the-art work on media synchronization control in multimedia communication and discuss its future work. In our daily lives, we communicate with each other over a network for various purposes by using multiple media streams such as voice, video, haptic media, and olfactory media (Natarajan, 2003). In multimedia communication, media synchronization among the streams is very important (Blalowski & Steinmetz, 1995). However, the media synchronization may be disturbed owing to network delay, delay jitter, and packet loss. If the media synchronization quality is deteriorated, the quality of experience (QoE) (ITU-T Rec. G.100/P.10, 2007) may seriously be damaged. To solve such a problem, we need to carry out media synchronization control, which adjusts the output timings of streams at each terminal to achieve high quality of media synchronization. A number

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of researchers have been studying media synchronization control so far (Blalowski & Steinmetz, 1995; Ehley et al., 1994; Ishibashi & Tasaka, 2000; Huang et al., 2013; Boronat et al., 2009).

A survey of media synchronization control was made, and techniques used in the algorithms for the control were classified into four categories (Ishibashi & Tasaka, 2000). However, a number of researches about media synchronization control have been done since the survey (Huang et al., 2013). Therefore, it is time to redo a survey of new media synchronization control techniques including the conventional ones as in (Ishibashi & Tasaka, 2000).

In this chapter, first, we explain media synchronization control. Next, we make a survey of media synchronization control techniques and classify the techniques. Also, we compare group synchronization control schemes. Then, we propose new control called the *Dynamic local lag control* in joint musical performance, which has severe requirements on high quality of media synchronization and high interactivity. In the performance, multiple users play their respective same or different types of musical instruments together. However, the media synchronization quality and interactivity may seriously be deteriorated owing to the network delay. By QoE assessment, we demonstrate that the new control can achieve high quality of media synchronization and keep the interactivity high. Finally, we discuss future research directions of media synchronization control.

MEDIA SYNCHRONIZATION CONTROL

Media synchronization may be disturbed owing to network delays and skews, which are caused by many reasons such as the difference of time in capturing media among terminals, the difference of time in protocol processing, media interleaving, network delay jitter, packet loss, the difference of decoding time at the playout process, and clock difference. Media synchronization control is carried out to compensate for the network delay jitter. We can identify two types of media synchronization control: *Object* (or *event-driven*) and *continuous* synchronization control (Campbell et al., 1992). Object synchronization control means synchronization control among multimedia objects. The control adjusts the beginning output timings of media according to a scenario. Under continuous synchronization control, the output timings (e.g., output times and speeds) among media streams can be synchronized with each other. In this chapter, we focus on continuous synchronization control. Media synchronization control is categorized into three types:

- *Intra-stream*
- *Inter-stream* (Blalowski & Steinmetz, 1995; Ehley et al., 1994; Ishibashi & Tasaka, 1995, 2000; Huang et al., 2013; Boronat et al., 2009, Ishibashi et al., 2003), and
- *Group* (or *inter-destination*) *synchronization control* (Ishibashi et al., 1997; Ishibashi & Tasaka, 1997, 1999).

The intra-stream synchronization control is necessary for preservation of the timing relation in a single stream. The inter-stream synchronization control is required for keeping the temporal relation among media streams. Media streams generally fall into a master stream and slave streams. Only the intra-stream synchronization control is carried out over the master stream, and the inter-stream synchronization control is exerted for the slave streams after carrying out the intra-stream synchronization control over each slave stream (Ishibashi & Tasaka, 1995). It is also possible to apply only inter-stream synchronization

control over each slave stream (Ishibashi et al., 2003). The group synchronization control is necessary to output each stream simultaneously at different destinations in multicast communication. There are three schemes for group synchronization control:

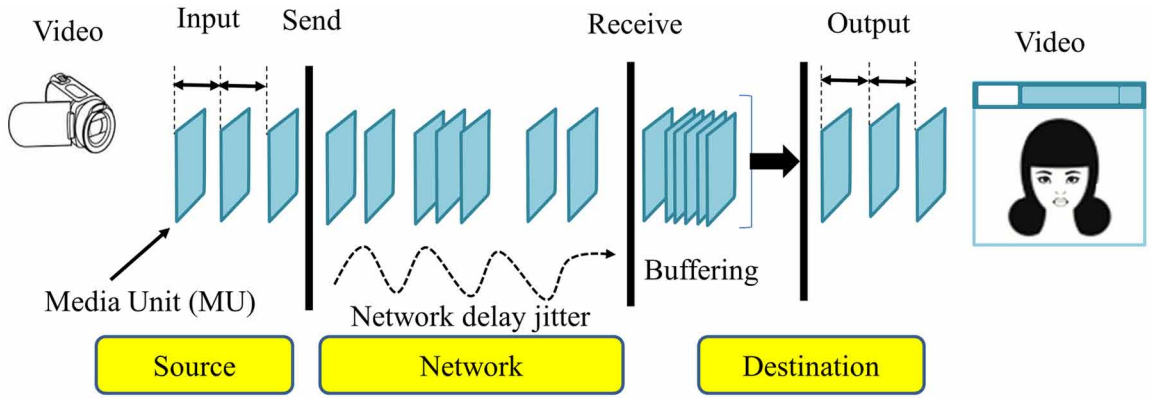
- The master-slave destination scheme (Ishibashi et al., 1997).
- The synchronization maestro scheme (Ishibashi & Tasaka, 1997).
- The distributed control scheme (Ishibashi & Tasaka, 1999).

Intra-Stream Synchronization Control

The intra-stream synchronization control is necessary for preservation of the timing relation between *media units* (*MUs*), each of which is an information unit for media synchronization, such as video frames and voice packets in a single media stream. The input intervals between MUs are disturbed owing to network delay jitter. The intra-stream synchronization control recovers the intervals when the destination outputs the MUs as shown in Figure 1, where the destination outputs MUs after buffering. To recover from asynchrony (i.e., out of synchronization), the *graceful* and *quick recovery schemes* (Ishibashi & Tasaka, 1995) can be used. The graceful recovery scheme recovers from asynchrony gradually so that users hardly perceive any degradation of output quality, and the quick recovery scheme tries to recover as soon as possible. Performance evaluation is carried out for the schemes in (Ishibashi et al., 1995; Ishibashi et al., 1996). The schemes can also be used in inter-stream synchronization control.

There are several types of intra-stream synchronization control such as *Skipping* (Ishibashi et al., 2002), *Buffering* (Ishibashi et al., 2002*), Adaptive Buffer Control* (ABC) (Wongwirat & Ohara, 2006), *Queue Monitoring* (QM) (Hikichi et al., 2002), *Virtual-Time Rendering* (VTR) (Ishibashi et al., 2002), and *media adaptive buffering* (Isomura et al., 2011). In Skipping, the destination outputs only the latest MUs on receiving them. When the sequence number of a received MU is smaller than that of the last-output MU, the destination discards the received MU. In Buffering, the MUs are saved in the destination's buffer for a constant time. When an MU arrives late, the destination outputs the MU on receiving it. QM deletes the oldest MU in the receiving buffer if the value of counter (a counter is set for each MU in the buffer, and the counter is incremented by one whenever an MU is output) exceeds a threshold value, and then the value of counter is reset to zero. In VTR, the *virtual-time* expands or contracts according

Figure 1. MU output under intra-stream synchronization control



to network delay jitters observed at the destination, and media are rendered along the virtual-time axis. ABC dynamically extends the buffering time of MUs according to the network delay under the adaptive buffer approach, which determines the buffering time by observing the network delay, and the time adjustment mechanism, which decides the output time of each MU by adding the buffering time to the generation time of the MU.

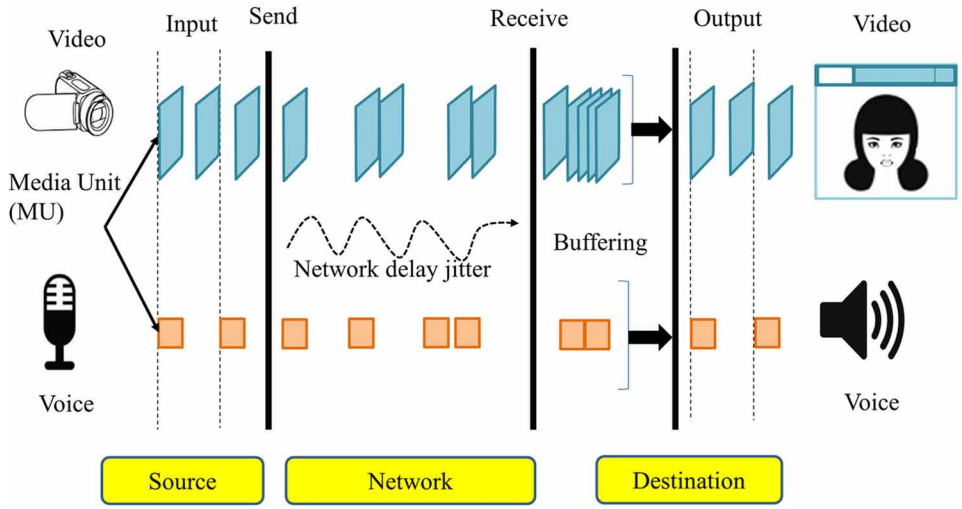
Inter-Stream Synchronization Control

Inter-stream synchronization control is required for keeping the temporal relationship among media streams. Lip-sync is a representative of the inter-stream synchronization, and it means the synchronization between spoken voice and the movement of the speaker's lips. As described earlier, media streams generally fall into a master stream and slave streams. The slave streams are synchronized with the master stream as shown in Figure 2. In lip-sync, the voice is generally selected as the master stream because voice is more sensitive to intra-stream synchronization error than video. Under the inter-stream synchronization control, each slave stream is output in synchronization with the master stream. Therefore, the intra-stream synchronization quality of the slave stream may largely be degraded by the inter-stream synchronization control. To solve this problem, in (Sannomiya et al., 2013), the group synchronization control is used for inter-stream synchronization control by handling all the streams as master streams.

In (Ishibashi & Tasaka, 1995), the inter-stream synchronization control is used for *tightly-coupled media streams* and *loosely-coupled media streams*. As for tightly-coupled media streams, each MU in a media stream is coupled with an MU in another media stream, and the coupled MUs should be output together. To handle the media streams, we need information which relates the MUs to each other as well as timestamps; for example, each slave MU has the sequence number of the corresponding master MU. For loosely-coupled media streams, each slave MU does not need to have the sequence number of the corresponding master MU, and temporal relationship is gotten from timestamps.

VTR and the control in (Ishibashi et al., 2004) are two examples of inter-stream synchronization control. They select one media stream as the master stream and the others as slave streams. VTR carries

Figure 2. MU output under inter-stream synchronization control



out only the intra-stream synchronization control for the master stream. For each slave stream, it exerts the inter-stream synchronization control after carrying out the intra-stream synchronization control. The output time of an MU is determined by using the *target output time* (an instant at which the destination should output the MU under the intra-stream synchronization control when there exists the network delay jitter) determined under the intra-stream synchronization control and the *scheduled output time* (an instant recommended for inter-stream synchronization control) determined from the output time of the corresponding master MU.

Under the inter-stream synchronization control in (Ishibashi et al., 2004), if the synchronization error is outside the *allowable range*, in which users feel that the error is allowable, the error is reduced gradually by advancing or delaying the output timing of media streams until the error enters the *imperceptible range*, in which users cannot perceive the error.

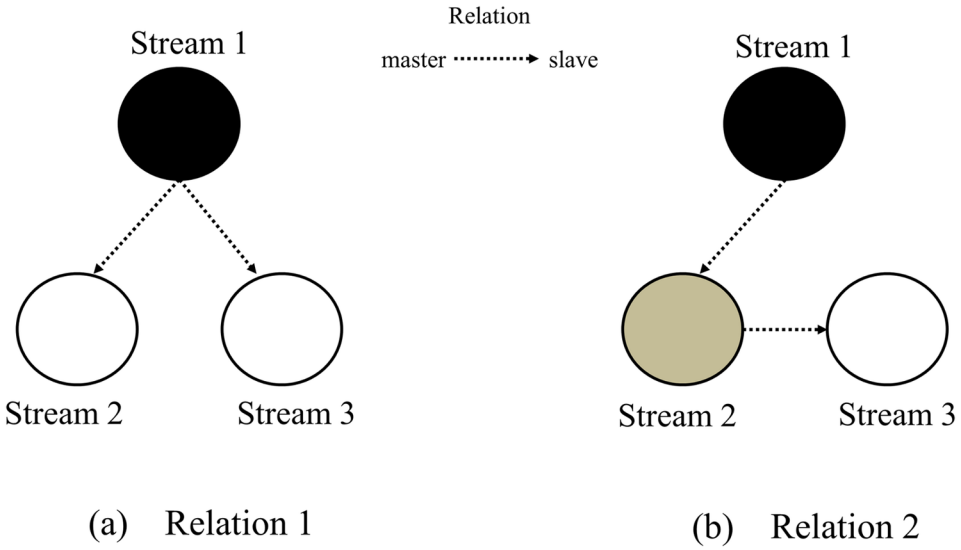
In the above descriptions, all the slave streams stand on an equal footing as shown in Figure 3 (a), where there are *streams 1*, *2*, and *3*; that is, a master stream and two slave streams (called *relation 1* here).

In Figure 3 (a), stream 1 is a master stream, and streams 2 and 3 are slave streams. Other relations such as the relation shown in Figure 3 (b) (called *relation 2 here)* as well as relation 1 are handled in (Takeo et al., 1997). In Figure 3 (b), two slave streams (streams 2 and 3) have a master-slave relation; stream 2 is a sub-master stream of stream 3. A performance comparison of the relations is carried out in (Takeo et al., 1997), where streams 1, 2, and 3 are voice, video, and drawing, respectively. According to experimental results, relation 1 is better than relation 2 for synchronization of voice and drawing; on the other hand, relation 2 is superior to relation 1 for synchronization of video and drawing. In what follows, relation 1 is used.

Group Synchronization Control

Group synchronization control outputs each MU simultaneously at different destinations in multicast communication as shown in Figure 4. The control is required in a number of networked multimedia ap-

Figure 3. Relations between master and slave streams



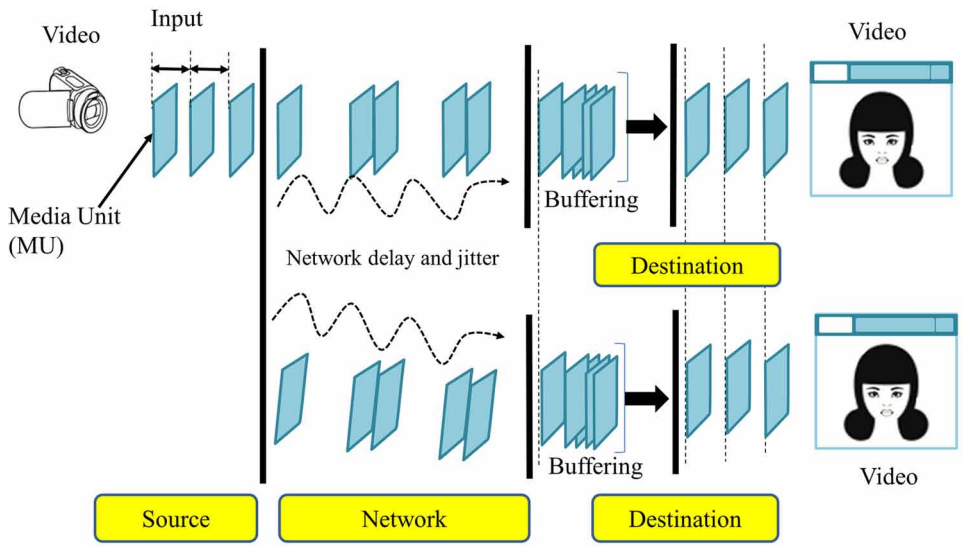
plications. In distance learning, for example, we suppose that a teacher distributes a movie (i.e., stored media) to students, and he/she sometimes makes some comments (i.e., live media) on the movie. In this case, it is necessary to output the stored and live media streams simultaneously at all the destinations. Even if only the stored media is output, each MU of the stream should be output simultaneously at different destinations. This is because the teacher may make some comments on the stream and the students may discuss the content of the stream. If each MU of media streams cannot be output simultaneously at different destinations owing to the differences in network delay and in delay jitter among the destinations, the causality of conversation and the fairness among the students may be damaged. As described earlier, there are the master-slave destination scheme (Ishibashi et al., 1997), the synchronization maestro scheme (Ishibashi & Tasaka, 1997), and the distributed control scheme (Ishibashi & Tasaka, 1999) for group synchronization control.

In the above studies of the Section titled "Media Synchronization Control", live and stored media streams are handled separately. However, we sometimes need to handle both live and stored media streams together. The *joint synchronization scheme* is proposed for inter-stream synchronization between stored video with interactive control and live media (live voice and video) in (Ishibashi et al., 2002). In the scheme, live voice is selected as the master stream, and live video and stored video are selected as slave streams, which are synchronized with the master stream by using VTR. The scheme enables visual search (e.g., fast-forward, reverse, and jump) of the stored video simultaneously at different destinations and adjusts the timing of changing the visual search mode among the destinations by using the synchronization maestro scheme.

MEDIA SYNCHRONIZATION CONTROL TECHNIQUES

A number of media synchronization algorithms have been proposed to meet diverse requirements so far. In this section, we redo a survey of media synchronization control techniques used in the algorithms, and we group the techniques into the following four categories as in (Ishibashi & Tasaka, 2000):

Figure 4. MU output under group synchronization control



- The *basic control techniques*
- The *preventive control techniques* (Minezawa et al., 2007)
- The *reactive control techniques* (Ishibashi et al., 2003)
- The *common control techniques*.

The basic control techniques are needed in almost all the algorithms, and they are indispensable to preserve temporal relationships among media streams. The preventive control techniques are required to try to avoid asynchrony. Thus, the techniques are used before asynchrony occurs. The reactive control techniques are employed to recover from asynchrony after it has occurred. We can employ some techniques as both preventive and reactive control techniques. Such techniques are referred to as the common control.

In order to achieve media synchronization, the four control techniques can be applied either alone or together depending on the type of application at sources or destinations. We focus our classification on techniques used for intra-stream and inter-stream synchronization control. In each of the four categories, the techniques are further classified into two groups by location at which they are employed (called the *source* or *destination control* here). As the other location, the network is used (called the *network control*) as well as the source or destination in (Zimmermann & Liang, 2008) and (Huang et al., 2011). However, in this chapter, we focus on the source and destination control because techniques used for the network control are very few.

Basic Control

Source Control

(a) Attachment of Synchronization Information to MUs

In the basic control, synchronization information such as timestamps, sequence numbers, and synchronization markers (Shepherd & Salmony, 1990) is attached to MUs. The timestamp contained in each MU indicates the generation time of the MU. However, timestamps are not necessarily needed when the generation of MUs is periodic; in this case, the sequence numbers are used instead of the timestamps (Ishibashi & Tasaka, 1995). On the other hand, the synchronization markers are inserted into each media stream at the source for inter-stream synchronization. The markers can be used for tightly-coupled media streams. The destination buffers MUs of streams whose synchronization markers have arrived until all the synchronization markers are collected. Therefore, the quality of media synchronization may seriously be deteriorated if one or more MU with the same synchronization marker is arrived largely late.

Destination Control

(a) Buffering of MUs

When the destination receives MUs, it stores the MUs in the destination buffer to compensate for network delay jitters (Santoso et al., 1993). Then, it outputs them according to the synchronization information. Therefore, each MU waits for output from the buffer when it arrives earlier than the time at which the MU should be output. If we could know the maximum and minimum network delays in advance, we can perfectly absorb the network delay jitter by setting the buffering time to the maximum network

delay minus the minimum one (Santoso et al., 1993). However, we cannot actually know the maximum network delay beforehand in networks like the Internet. Even if we could know the maximum network delay, we may not be able to set the buffering time to such a value because the value is too large and the interactivity is seriously damaged.

Preventive Control

Source Control

(a) Transmission of MUs According to Synchronization Information

For stored media, the source transmits MUs according to synchronization information such as timestamps. This technique is also considered as a kind of traffic control. The technique is employed in the great majority of studies which handle stored media (for example, in (Ishibashi et al., 1995)). For live media, the source transmits each MU with its timestamp on capturing the MU.

This technique is compared with other two transmission schemes in (Nunome et al., 1999), where the technique is called the timestamp scheme. The other two schemes are the file transfer scheme and the switching scheme. In the file transfer scheme, media streams are transmitted as a file. The switching scheme dynamically switches the timestamp scheme and the file transfer scheme according to the network load.

(b) Deadline-Based Transmission Scheduling

The source schedules MU transmission according to their deadline requirements (Ali et al., 2000; Boukerche & Owens, 2005; Lamont et al., 1996; Baqai et al., 1996). If the source knows the MU size, the output deadline, and delay bounds (or delay probability distribution) for each MU, it can schedule MU transmission based on the requirements. Thus, the technique can be employed for only stored media.

(c) Interleaving of MUs

The source interleaves MUs from different media streams to make a single transport stream (ISO/IEC 11172- 1, ISO/IEC 13818-1, 1993, 1994; ITU-T Rec. H.223, 1996). The technique in (Tasaka et al., 1997, Tasaka & Ishibashi, 1997, 1998) improves the quality of inter-stream synchronization, but it may degrade the intra-stream synchronization quality of media streams which are sensitive to the network delay jitter (Tasaka & Ishibashi, 1998). In the real-time transport protocol (RTP) (Schulzrinne, 2003), media streams are transmitted in separate RTP sessions; thus, the interleaving technique is not used. For example, in a teleconference where video and audio are employed, video and audio media streams are transmitted in two RTP sessions.

Destination Control

(a) Preventive Skipping (Discarding) and Preventive Pausing (Repeating or Inserting)

The destination skips (discards) MUs or pauses (repeats) output of MUs depending on the length of the output queue (Little & Kao, 1992; Daami & Georganas, 1997; Kohler & Muller, 1994). It is also possible to insert dummy (noise) data instead of pausing. In (Dammi & Georganas, 1997), when the

buffer occupancy at the destination exceeds a threshold value, the destination discards an MU every two MUs; when the occupancy becomes less than another threshold value, the destination repeats each MU once. For MPEG video, the destination discards some MUs with low priority out of MUs stored in the destination buffer according to the buffer occupancy (Lamont et al., 1996).

(b) Change of Buffering Time With Network Delay Estimation

By estimating the network delays, the destination changes the buffering time of MUs according to the estimated delays (Ramjee et al., 1994; Ishibashi & Tasaka, 1998; Cuevas et al., 1993). This idea is based on that the intra-stream synchronization can be achieved by choosing the buffering time so as to be larger than or equal to the maximum network delay minus the minimum network delay (Santoso et al., 1993). In (Ramjee et al., 1994), where only voice is handled, the buffering time is changed on a talkspurt-by-talkspurt basis; thus, the silence period between the two succeeding talkspurts may be artificially elongated or compressed.

The preventive control techniques are compared for media synchronization of voice and video in (Minezawa et al., 2007); transmission of MUs according to synchronization information (preventive control - source control (a)), preventive pausing (preventive control - destination control (a)), preventive shortening of output duration (common control - destination control (c)), and change of buffering time with network delay estimation (preventive control - destination control (b)) are handled.

Reactive Control

Source Control

(a) Adjustment of Transmission Timing

The source can change the transmission timing of MUs by changing the MU transmission time or by skipping or pausing MUs if the source knows the amount of skews among media streams (Correia & Pinto, 1995; Zhang et al., 2002). When the destination detects a skew, it sends feedback information to the source to change the transmission timing. The source performs this action by changing the transmission period.

(b) Decrease of Number of Media Streams Transmitted

The source decreases the number of media streams transmitted when the source detects that it is difficult for the destination to recover from asynchrony (Ishibashi & Tasaka, 1995; Ravindran & Bansal, 1993). For instance, in lip-sync, the source can stop the transmission of the video temporarily; when the source detects that the destination has recovered from asynchrony, the source restarts the transmission of the video.

Destination Control

(a) Reactive Skipping (Discarding) and Reactive Pausing (Repeating)

When the output timing of the current MU is late, the destination skips some succeeding MUs if the MUs arrives earlier (Ishibashi & Tasaka, 1995, 1998; Tasaka et al., 1996, 1997; Tasaka & Ishibashi,

1997, 1998a, 1998b; Correia & Pinto, 1995; Ravindran & Bansal, 1993; Anderson & Homsy, 1991; Li et al., 1992; Xie et al., 1996; La Corte, 1995; Taniguchi et al., 1996; Fadiga et al., 1998; Kato et al., 1997, 1998; Liu et al., 1996; Courtiat et al., 1996; Yoo, 1998; Yuang et al., 1999). We can also discard late MUs (Ramjee et al., 1994; Chen & Wu, 1996; Cen et al., 1995); however, discarding late MUs makes the average MU rate, which is defined as the average number of MUs output per second at the destination, decrease.

For MPEG video, the condition of picture skipping is changed depending on the picture type in (Tasaka et al., 1997). When the buffer starvation occurs, the destination pauses output of video MUs. This means that for video, the destination continues outputting the previous MU until the next MU becomes available. It is also possible to output other data at this time. These techniques are the most popular because their implementation is easy.

In (Yang, 2002), MUs with the same timestamp from different streams are regarded as a synchronous group. The output time of an MU of a stream is delayed until all the other MUs with the same timestamp from other streams as that of the MU have arrived. If MUs with the same timestamp from other streams do not arrive within the maximum allowable delay bound, the MUs are discarded.

(b) Virtual Time-Contraction and Time-Expansion

In (Ishibashi & Tasaka, 1995, 1998; Ishibashi et al., 1995, 1996; Tasaka et al., 1996, 1997; Tasaka & Ishibashi, 1997, 1998a, 1998b; Fadiga et al., 1998; Kato et al., 1997, 1998), the virtual time-contraction and time-expansion are realized in a form of modification of the target output time. In (Kato et al., 1997), the *slide control scheme*, which changes the amount of the modification of the target output time according to the extent of asynchrony, is proposed and applied to PHS (Personal Handy Phone System) (Kato et al., 1997, 1998). In (Anderson & Homsy, 1991), the Logical Time System (LTS) corresponds to the virtual-time. Only the virtual time-expansion is performed by stopping the LTS temporarily. The virtual time-expansion is also exploited in (Lamont et al., 1996) and (Jha & Fry, 1996). The set-back and advance operations of the PlayOut Clock in (Xie et al., 1996) correspond to the virtual time-expansion and time-contraction, respectively.

This technique differs from shortening and extension of output duration (common control - destination control (c)) in that the former indirectly changes the output timing by modifying the virtual-time (equivalently, resetting the origin of the time axis), while the latter directly does (that is, the origin of the time axis is kept the same).

(c) Master-Slave Switching

The roles of the master and slave streams can be changed dynamically under inter-stream synchronization control (Xie et al., 1996). When the amount of asynchrony for a slave stream becomes large, the destination switches the stream from slave to master and performs the appropriate adaptation. In (Ishibashi et al., 2003b), where voices and videos are output in a 3D virtual space, the master role is switched between media objects, each of which includes a voice and a video, according to the *global importance* of each media object. The global importance is determined by the positional relations among media objects, and it represents how strongly each object attracts observers' attention in a 3D virtual space.

The reactive control techniques are quantitatively compared in (Ishibashi et al., 2003a), where reactive discarding (Ishibashi et al., 2003a), reactive skipping (Ishibashi et al., 2003a), shortening and

extension of output duration (common control - destination control (c)), and virtual time-contraction and time-expansion (reactive control - destination control (b)) are handled. In (Ishibashi et al., 2003a), reactive discarding is different from reactive skipping in that the former deletes all late MUs, but the latter outputs even a late MU if there exists no MU which should be output.

Common Control

Source Control

(a) Source Skipping and Source Pausing

The source skips MUs or pauses output of MUs according to feedback information from the destination (Ishibashi & Tasaka, 1995; Ishibashi et al., 1996; Correia & Pinto, 1995; Ramanathan & Rangan, 1993; Zarros et al., 1996; Biersack et al., 1996; Rangan et al., 1996). It is also possible for the source to insert dummy (noise) data instead of skipping of the destination when the input rate is smaller than the output rate (Zarros et al., 1996). Note that the insertion of dummy data delays the output timing at the destination.

(b) Advancement of Transmission Timing with Network Delay Estimation

Either the source or destination estimates the network delay, and the source advances the transmission timing of MUs according to the estimates (La Corte et al., 1995; Ichikawa et al., 1996; Yamaoka et al., 1995). In order to advance the timing largely, the source may skip multiple MUs at a time. Thus, this technique can be used only for stored media. In the technique, high accuracy of delay estimation is required for high quality of synchronization.

The technique differs from deadline-based transmission scheduling (preventive control - source control (b)) in the following point: It dynamically schedules the transmission of MUs, while deadline-based transmission scheduling statically does. It is also different from adjustment of transmission timing (reactive control - source control (a)); the former schedules the MU transmission according to the network delay estimates, but the latter adjusts transmission of MUs according to the amount of skews.

(c) Adjustment of Input Rate

The source adjusts the clock frequency of input device (i.e., hardware input rate) according to the synchronization quality (Anderson & Homsy, 1991).

(d) Interpolation of Data

We can interpolate data to adjust the effective input rate (Anderson & Homsy, 1991) without changing the actual input rate.

(e) Media Scaling

Media scaling (Delgrossi et al., 1994), which is a type of traffic control, such as dynamic resolution control (Tasaka et al., 1997; Tasaka & Ishibashi, 1998; Fadiga et al., 1998; Katsumoto et al., 1996) of video is carried out depending on network loads. In the dynamic resolution control, the temporal, spatial,

and/or SNR (Signal to Noise Ratio) resolution of video (Wakamiya et al., 1996) is changed according to the network loads. The temporal resolution control can be considered as a kind of source skipping (common control - source control (a)). The technique may be able to include decrease of the number of media streams transmitted (reactive control - source control (b)). In this chapter, the word 'media scaling' is used in the case where the number of sub-streams in a single media stream is changed.

(f) Dynamic Local Lag

Dynamic local lag (Sithu et al., 2013) can be used to synchronize local information with received information at each terminal. The technique dynamically changes the value of local lag according to the network delay from the other terminal to the local terminal.

(g) Selection of Adequate Path

The source selects an adequate path to transmit media streams by taking account of the bandwidth requirements and synchronization requirements. In (Zimmermann & Liang, 2008) and (Huang et al., 2011), the technique is classified as the network control.

Destination Control

(a) Adjustment of Output Rate

The clock frequency of output device (i.e., hardware output rate) is adjusted according to the synchronization quality (Anderson & Homsy, 1991). In (Yuang et al., 1999) and (Liang et al., 1998), the destination dynamically changes the output rate depending on the length of the queue waiting for output.

(b) Interpolation of Data

We can interpolate data to adjust the effective output rate (Anderson & Homsy, 1991) without changing the actual output rate.

(c) Shortening and Extension of Output Duration

In the reactive shortening and extension, the destination shortens or extends the output duration of each MU until the recovery from asynchrony (Ishibashi & Tasaka, 1995, 1998; Ishibashi et al., 1995, 1996; Tasaka et al., 1996, 1997; Tasaka & Ishibashi, 1997; 1998a, 1998b; Cuevas et al., 1993; Correia & Pinto, 1995; Fadiga et al., 1998; Kato et al., 1997, 1998; Yoo, 1998; Kouvelas et al., 1996; Moon et al., 1998). The purpose is to recover from asynchrony gradually without large degradation of the output quality (that is, the graceful recovery scheme). The preventive shortening shortens the buffering time which has been extended by the preventive extension (Minezawa et al., 2007). The output duration of each MU is shortened or extended according to the number of MUs in the buffer. Preventive and reactive extension leads to pausing output of MUs, and shortening of the output duration of MUs includes fast-forwarding (without skipping) of MUs.

This technique can also be used to adjust the output timing of a media stream to that of another stream. For voice, we can make use of the silence period of voice to shorten or extend the output duration of MUs.

Comparison Among Algorithms

In Tables 1, and 2, we make a comparison among the algorithms for intra-stream and/or inter-stream synchronization control in (Ishibashi & Tasaka, 1995, 1998; Ishibashi et al., 1995, 1996; Zimmermann & Liang, 2008; Huang et al., 2011; Ali et al., 2000; Boukerche & Owens, 2005; Lamont et al., 1996; Baqai et al., 1996; Tasaka et al., 1996, 1997; Tasaka & Ishibashi, 1997, 1998a, 1998b; Little & Kao, 1992; Daami & Georganas, 1997; Kohler & Muller, 1994; Ramjee et al., 1994; Cuevas et al., 1993; Correia & Pinto, 1995; Zhang et al., 2002; Ravindran & Bansal, 1993; Anderson & Homsy, 1991; Li et al., 1992; Xie et al., 1996; La Corte et al., 1995; Taniguchi et al., 1996; Fadiga et al., 1998; Kato et al., 1997, 1998; Liu et al., 1996; Courtiat et al., 1996; Yoo, 1998; Yuang et al., 1999; Chen & Wu, 1996; Cen et al., 1995; Yang, 2002; Ramanathan & Rangan, 1993; Zarros et al., 1996; Biersack et al., 1996; Rangan et al., 1996; Ichikawa et al., 1996; Yamaoka et al., 1995; Katsumoto et al., 1996; Sithu et al., 2013, 2014a, 2014b, 2014c; Liang et al., 1998; Kouvelas et al., 1996; Moon et al., 1998), as in (Ishibashi & Tasaka, 2000) in terms of the following six factors; clocks, stored or live media, intra-stream and/or inter-stream synchronization control, master-slave relation, source or destination (location), and synchronization control techniques. Note that the algorithms in (Zimmermann & Liang, 2008; Huang et al., 2011; Ali et al., 2000; Boukerche & Owens, 2005; Zhang et al., 2002; Yang, 2002; Sithu et al., 2013, 2014a, 2014b, 2014c) are newly included in this chapter; that is, they are not handled in (Ishibashi & Tasaka, 2000).

1. **Clocks:** This factor denotes whether clocks are *globally synchronized clocks* or not. If the current local times have the same value and if the clock ticks have the same advancement, they are called globally synchronized clocks, which make synchronization algorithms simpler. If the advance of the clock tick at each source or destination is different from that of the others, or if the current local times are different from each other, we refer to the clocks as *locally available clocks*. To adjust the clocks, we need some protocol such as the Network Time Protocol (NTP) (Mills, 1991). Using NTP, we can adjust the clocks to each other within a few milliseconds. We can further improve the accuracy by using the Global Positioning System (GPS) (Mcneff, 2002).
2. **Stored or live media:** This factor denotes which of stored or live media are dealt with in each algorithm. Stored media are saved in storage devices in advance. Thus, we can tolerate network delays to some extent for stored media. On the other hand, live media have severe time constraints from the generation time of an MU to the output time of the MU. The joint synchronization scheme, which is described in Subsection titled "Group synchronization control", handles both stored and live media.
3. **Intra-stream and/or inter-stream synchronization control:** By this factor, we show if each algorithm performs only intra-stream synchronization control, or both intra-stream and inter-stream synchronization control.
4. **Master-slave relation:** This shows whether there are the master-slave relations among media streams.
5. **Source or destination (location):** The location at which the media synchronization control is carried out is denoted by this factor.
6. **Synchronization control techniques:** This factor denotes which kinds of techniques are used in each algorithm. Since the basic control techniques are employed in almost all the algorithms, we here focus on the preventive, reactive, and common control techniques.

Table 1. Comparison among media synchronization algorithms (1/3)

Algorithm	Clocks	Stored/ Live	Intra/Inter	Master-Slave	Source/ Destination	Techniques
ACME (Anderson & Homsy, 1991)	global	Stored, live	intra, inter	master-slave, no relation		reactive skipping, reactive pausing, virtual time-expansion, adjustment of input/output rate, interpolation of data
SCC (Li et al., 1992)	local		intra, inter	no relation	destination	Reactive skipping (discarding), reactive pausing
Little and Kao (1992)	local	stored	inter	no relation	destination	preventive skipping, preventive pausing
Delay compensation protocols (Ravindran & Bansal, 1993)	global	live		no relation	source / destination	decrease of no. of media streams, reactive skipping, reactive pausing
Ramanathan and Rangan (1993)	lcoal	stored	intra, inter	master-slave	source	source skipping, source pausing
Zarros et al. (1996)	local			no relation	source	source skipping (noise insertion), source pausing
Xie et al. (1996)	local	live	intra, inter	master-slave	destination	reactive skipping, reactive pausing, virtual time-contraction, virtual time-expansion, master-slave switching
MultiSynch (Chen & Wu, 1996)			intra, inter	no relation	destination	reactive skipping (discarding), reactive pausing
Biersack et al. (1996)	local	stored	intra, inter	no relation	source	source skipping (preventive), source pausing (preventive)
Rangan et al. (1996)	global	stored	intra, inter	master-slave, no relation	source, destination	source skipping, source pausing
SSP (Lamont et al., 1996)	local	stored			source, destination	deadline-based transmission scheduling, preventive skipping (selective discarding), virtual time-expansion
LLPS (La Corte et al., 1995)	global	stored	intra, inter	master-slave	source, destination	reactive skipping, reactive pausing, advancement of transmission timing with delay estimation
Ichikawa et al. (1996)		stored	intra		source	advancement of transmission timing with delay estimation, skipping
Yamaoka et al. (1995)	global	stored	intra		source	advancement of transmission timing with delay estimation
Katsumoto et al. (1996)		stored	intra, inter		source, destination	media scaling
Taniguchi et al. (1996)	global	stored	intra, inter	no relation	destination	reactive skipping (discarding), reactive pausing

Table 2. Comparison among media synchronization algorithms (2/3)

Algorithm	Clocks	Stored/ Live	Intra/Inter	Master-Slave	Source/ Destination	Techniques
VTR (Ishibashi & Tasaka, 1995, 1998; Ishibashi et al., 1995, 1996; Tasaka et al., 1996, 1997; Tasaka & Ishibashi, 1997; 1998a, 1998b; Fadiga et al., 1998; Kato et al., 1997, 1998)	global, local	stored, live	intra, inter	master-slave	source, destination	change of buffering time with delay estimation, decrease of the no. of media streams, preventive pausing, reactive skipping, reactive pausing, source skipping, shortening and extension of output duration, virtual time-contraction, virtual time-expansion, media scaling
Liu et al. (1996)	local	without distinction	intra, inter	no relation	destination	reactive skipping (discarding), reactive pausing
Kouvelas et al. (1996)	global	live	intra, inter	no relation	destination	shortening and extension of output duration
Corriea and Pinto (1995)	local	stored, live	intra, inter	master-slave	source, destination	adjustment of transmission timing, source skipping, source pausing, reactive skipping, reactive pausing, shortening and extension of output duration
BKWKSG (Baqai et al., 1996)		stored		no relation	source	deadline-based transmission scheduling
Moon et al. (1998)	local	without distinction	intra (only voice)		destination	shortening and extension of output duration
Cuevas et al. (1993)		live	intra (only voice)		destination	change of buffering time with delay estimation, shortening and extension of output duration
Courtiat et al. (1996)	global	without distinction	intra, inter	master-slave		reactive skipping (discarding), reactive pausing
Liang et al. (1998)			intra		destination	adjustment of output rate
Daami and Georganas (1997)			intra, inter		destination	preventive skipping (selective discarding), preventive pausing

GROUP SYNCHRONIZATION CONTROL SCHEMES

Hereafter, we explain three schemes for group synchronization control: The master-slave destination scheme (Ishibashi et al., 1997), the synchronization maestro scheme (Ishibashi & Tasaka, 1997), and the distributed control scheme (Ishibashi & Tasaka, 1999). The three schemes are based on the Virtual-Time Rendering (VTR) media synchronization algorithm to determine the output timing of each MU so that the timing can be the same at all the destinations. We also discuss the merits and demerits of the three schemes as in (Ishibashi & Tasaka, 1999). In this section and in section titled "Media synchronization in joint musical performance", we assume that clocks at sources and destinations are globally synchronized.

Master-Slave Destination Scheme

In the synchronization model of the master-slave destination scheme, there are M (≥ 1) sources and N (≥ 2) destinations which are connected through a network as shown in Figure 5, where relation 1 in Figure

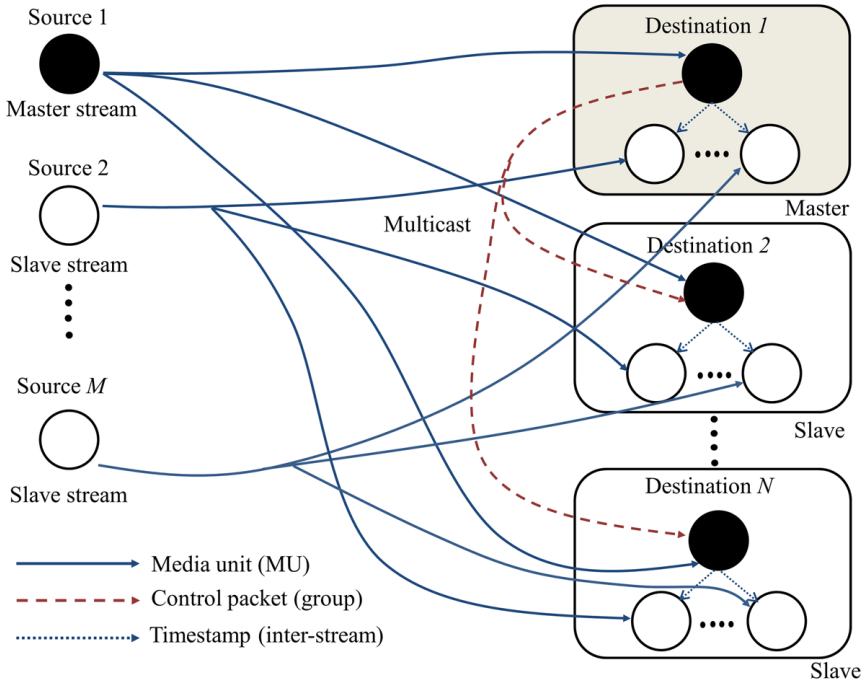
Table 3. Comparison among media synchronization algorithms (3/3)

Algorithm	Clocks	Stored/ Live	Intra/ Inter	Master/ Slave	Source/ Destination	Techniques
Yoo (1998)		without distinction	intra, inter	master-slave	destination	shortening and extension of output duration, reactive skipping (discarding), reactive pausing (repeating)
Ramjee et al. (1994)	local	live	intra (only voice)		destination	change of buffering time with network delay estimation, reactive skipping (discarding)
Kohler and Muller (1994)	local		intra		destination	preventive skipping (discarding) preventive pausing (inserting)
Cen et al. (1995)	local	stored	intra, inter		destination	reactive skipping (discarding)
Yuang et al. (1999)			intra, inter	master-slave	destination	reactive skipping, reactive pausing, adjustment of output rate
Zimmermann et al. (2008)		live	intra	no relation	source	transmission of MUs according to synchronization information, election of adequate path*1
Huang et al. (2011)	local	live	intra, inter	no relation	source	transmission of MUs according to synchronization information, deadline-based transmission scheduling, election of adequate path*1
Ali (2000)		stored	intra, inter		source	deadline-based transmission scheduling, adjustment of transmission timing, preventive skipping (selective discarding)
MoSync (Boukerche & Owens, 2005)	local	stored, live	intra, inter	no relation	source, destination	transmission of MUs according to synchronization information, deadline-based transmission scheduling, adjustment of output rate
Zhang et al. (2002)	global	stored	intra, inter	no relation	source, destination	transmission (or playout) rate adjustments, preventive skipping (discarding), reactive skipping (discarding), adjustment of output rate
ALPSMS (Yang, 2002)	global	stored, live	inter	no relation	destination	change of the buffering time according to the delay estimation, reactive skipping (discarding)
Sithu et al. (2013, 2014a, 2014b, 2014c)	global			no relation	source	dynamic local lag control

*1 This technique is employed at an intermediate network between the source and destination.

3 (a) is used. Source i ($i = 1, 2, \ldots, M$) distributes MUs of stream i to all the destinations by multicasting. Each MU includes the timestamp, which indicates the generation time of the MU. The streams can be classified into two types; a master stream and slave streams. At destination j ($j = 1, 2, \ldots, N$), the slave streams are synchronized with the master stream according to the timestamps. The destinations are also grouped into a master destination and slave destinations. The master destination may be supposed to be a chairperson's terminal in multimedia conferencing or a teacher's one in distance learning. The slave destinations need to output MUs at the same timing as the master destination in order to get synchronization among the destinations; that is, the slave destinations have to advance the MU output timing as well as to delay it according to the status of the master destination. Group synchronization can be achieved by adjusting the output timing of the master MUs at the slave destinations to that at the master destination. The master destination multicasts a control packet that includes the output time of

Figure 5. Model of master-slave destination scheme



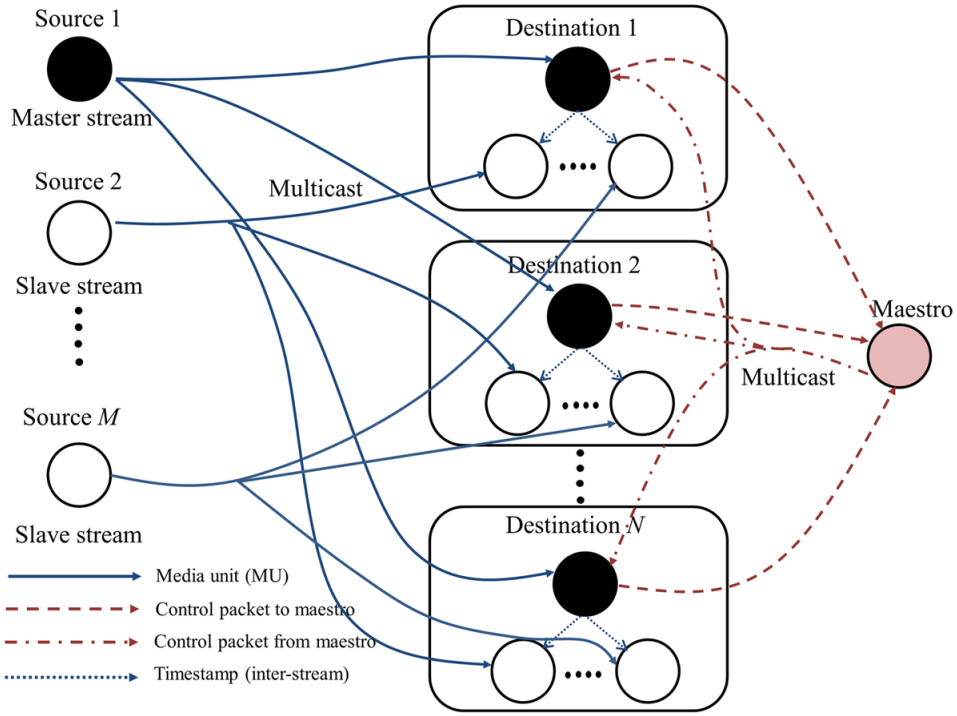
its first MUs to the slave destinations. In addition, when the target output time of the master destination is modified, the master destination notifies all the slave destinations of the modification by distributing a control packet which has the amount of time which has been modified and the sequence number of the MU at which the target output time has been changed. Using received control packets, each slave destination gradually adjusts its output timing of MUs.

If a terminal is a source as well as a destination in the master-slave destination scheme, we can use the local lag control (Mauve et al., 2004; Irie et al., 2009) to get the synchronization among the destinations. In this case, the local lag control can also be used in the synchronization maestro scheme and the distributed control scheme. Local lag control buffers local information for a constant time called the local lag (≥0 ms). We will explain details about the local lag control later.

Synchronization Maestro Scheme

In the synchronization maestro scheme, there are a synchronization maestro as well as *M* sources and *N* destinations, which are connected through a network as shown in Figure 6. The synchronization maestro can be chosen from among the sources and destinations. Each destination notifies the synchronization maestro of the information about its output timing. When the synchronization maestro receives the information about the output timing from each destination, it determines the *reference output timing* (that is, the reference value of the start time or modification time) and multicasts the information about the reference output timing to all the destinations. Each destination gradually adjusts its output timing to the reference output timing. This scheme is used for work in (Ishibashi et al., 2003, 2004; Ishibashi & Kaneoka, 2006; Hashimoto & Ishibashi, 2006; Huang et al., 2012). Two methods (*methods 1* and *2*)

Figure 6. Model of synchronization maestro scheme

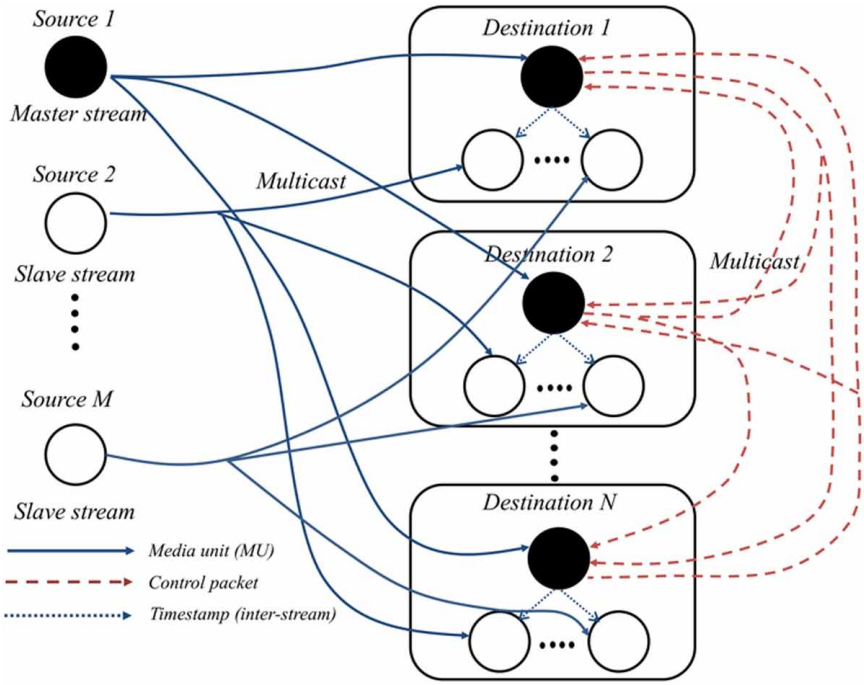


are used for determining the reference output timing in (Ishibashi et al., 2004). In method 1, the latest output timing is used (Ishibashi et al., 2003), and the earliest output timing is employed in method 2 (Ishibashi et al., 2004).

Distributed Control Scheme

The distributed control scheme does not need a centralized control terminal such as the master destination and the synchronization maestro in the master-slave destination scheme and synchronization maestro scheme, respectively (see Figure 7). All the destinations in a multicast group are treated equally. When each destination starts to output the first MUs or modifies the target output time, the destination notifies all the other destinations of the start time or the modification time by multicasting a control packet. Thus, each destination can know the output timing of all the other destinations. The destination determines the reference output timing of MUs from among the notifications. Then, it gradually adjusts its output timing to the reference one. This scheme is employed for work in (Huang et al., 2012; Kurokawa et al., 2007). The adaptive Δ-causality control (Ishibashi et al., 2007), which employs the local lag control and is usually used in networked real-time games, is similar to the distributed control scheme; the control can also be employed for group synchronization. There is at least the following difference between the distributed control scheme and the adaptive Δ-causality control; the former gradually adjusts the output timing at each destination to the reference output timing, but the latter changes the output timing at a time. When the network delays are different between the terminals, the control sets the local lag to the maximum network delay among the terminals (Ishibashi et al., 2007).

Figure 7. Model of distributed control scheme



Comparison of Group Synchronization Control Schemes

The control of the master-slave destination and synchronization maestro schemes is centralized in the master destination and the synchronization maestro, respectively. In such centralized control schemes, if the master destination or synchronization maestro becomes impossible of communications owing to some troubles, no destination is able to carry out the group synchronization control. On the other hand, in the distributed control scheme, even if some of the destinations break down, the other destinations can perform the group synchronization control. Thus, the distribution control scheme has higher reliability than the other two schemes.

The master-slave destination scheme lacks flexibility since the scheme always adjusts the output timing of the slave destinations to that of the master destination. It is suitable for applications in which a single destination has priority over the others. The synchronization maestro and distributed control schemes are more flexible than the master-slave destination scheme since the former two schemes can change how to determine the reference output timing. For instance, the schemes can behave like the master-slave destination scheme by selecting the reference output timing appropriately.

The control speed of group synchronization in the synchronization maestro scheme is slower than those in the other two schemes. The reason is that the former scheme transfers control packets among the destinations via the synchronization maestro, while the latter schemes directly transmits them among the destinations. Therefore, when the network delay is large, the synchronization maestro scheme is inferior to the other two schemes.

Regarding the control overhead, the number of control packets transmitted in the master-slave destination scheme is the smallest among the three schemes, and that in the distributed control scheme is the

largest. In the distributed control scheme, as the number of destinations in a multicast group becomes larger, the number of control packets largely increases. Thus, the scheme is not suitable for the case where the size of a multicast group is large.

The above comparison among the three schemes is qualitative. A quantitative comparison of the schemes is carried out in (Nunome & Tasaka, 2002). Simulation results show that the distributed control scheme provides the highest quality of group synchronization among the three schemes in heavily-loaded networks, while the other schemes can have almost the same quality as that of the distributed control scheme in lightly-loaded networks.

MEDIA SYNCHRONIZATION IN JOINT MUSICAL PERFORMANCE

In this section, we explain media synchronization control for joint musical performance. In joint musical performance, multiple users play their same or different types of musical instruments together. The joint musical performance can be classified into no-interactive performance and interactive performance. In the no-interactive performance, sounds which come from multiple sources are needed to be synchronized at each destination. In the interactive performance, each terminal needs to synchronize local sound with sounds received from the other terminals. We here propose new media synchronization control for the interactive performance, and we demonstrate the effectiveness of the control in a joint haptic drum system (Sithu & Ishibashi, 2013), where multiple users at different places play a drum set in a 3D virtual space by using their independent haptic interface devices.

No-Interactive Performance

Here, we introduce two types of media synchronization control. The first control was used at the opening ceremony of the Nagano Olympics (Yamakita et al., 1998). The second control was applied for a networked chorus to solve problems of the first control (Miyashita et al., 2011).

At the opening ceremony, a networked chorus "Ode to Joy" was carried out at five cities (New York, Beijing, Sydney, Berlin, and Cape Town) via satellites. In this case, there were a conductor, an orchestra, and a chorus group in Nagano, from which voices and video were sent to the five cities. Then, a chorus group in each city sang according to the standard timing shown by video and voice of the conductor. Finally, the voices and video of the conductor, orchestra, and chorus group of each point were received and output at Minami Nagano Stadium in Nagano, where the opening ceremony was held. Before the ceremony, the network delay between Nagano and each city was measured. Then, the largest network delay was chosen as the standard output timing of voice and video, and voices and videos generated at all the cities were output according to the standard output timing at Nagano. In this way, the synchronization of choruses was achieved. However, the method which determines the standard output timing in advance lacks flexibility for variation or jitter of the network delay. This means that when the arrival timing of media is later than the standard output timing, it is impossible to achieve synchronization of chorus; on the other hand, when the standard output timing is much later than the arrival timing of media, the real-time property is damaged.

To solve this problem, the group synchronization control can be applied to chorus with voice and video among multiple terminals. In (Miyashita et al., 2011), the group synchronization control is used to chorus with voice and video among multiple points. There are a terminal used by a conductor, who

shows the standard timing and sings a song, multiple terminals used by singers, who sing the song according to the standard timing, and a terminal used by a listener, who listens to the chorus. The synchronization among voices is achieved at the listener terminal. Voice is treated as a master stream, and video as a slave stream. The intra-stream synchronization control is carried out over voice and video, and the inter-stream synchronization control is carried out over video. At the listener terminal, the group synchronization control is carried out over voices. Virtual-Time Rendering (VTR) (Ishibashi et al., 2002) is used for the intra-stream and inter-stream synchronization control. At the listener terminal, the group synchronization control adjusts the output timing of MUs which are generated at the conductor and singer terminals. The synchronization maestro scheme is adopted for the group synchronization control. Assessment results show that the group synchronization control is effective for sound synchronization in no-interactive performance.

Interactive Performance

In order to get high quality of sound synchronization, we can use the local lag control (Mauve et al., 2004; Irie et al., 2009) in interactive performance. The control buffers local information for a constant time called the local lag in order to be synchronized with received information; thus, it degrades the interactivity. We here explain the conventional local lag control (Irie et al., 2009) and our new control called the dynamic local lag control (Sithu et al., 2013). We also present the dynamic local lag control for two or more terminals. It should be noted that each terminal behaves as a source and destination (see Subsection titled "Master-slave destination scheme"). Then, we illustrate the effect of the dynamic local lag control in joint haptic drum performance.

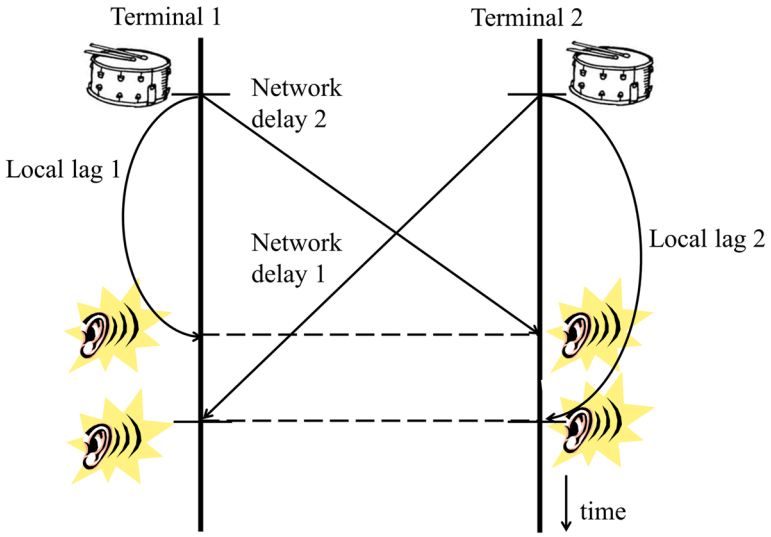
Conventional Local Lag Control

Under the conventional control between two terminals (*terminals 1* and *2*) (Irie et al., 2009), the local lag denoted by Δ ($\geq$0) ms is set to the same value as the network delay from the local terminal to the other terminal. Therefore, the interactivity is degraded when the network delay is large. High quality of sound synchronization can be achieved when the network delay from the local terminal to the other terminal is equal to that in the opposite direction (called the *symmetric delay case* here). In a network like the Internet, the network delay from the local terminal to the other terminal is usually different from that in the opposite direction (the *asymmetric delay case*). In this case, the quality of sound synchronization may be damaged (see Figure 8). In Figure 8, a user at terminal 1 hits a drum at the same time as a user at terminal 2. We call the network delay from terminal 2 to terminal 1 *network delay 1* and that from terminal 1 to terminal 2 *network delay 2*. Also, we call the local lag at terminal 1 *local lag 1* and that at terminal 2 *local lag 2*. Local lag 1 is set to the same value as network delay 2, and local lag 2 is equal to network delay 1. From Figure 8, we see that when network delay 1 is not equal to network delay 2, sound synchronization cannot be achieved at each terminal; that is, each user hears sound twice.

Dynamic Local Lag Control

To solve the problems of the local lag control, we propose the dynamic local lag control (Sithu et al., 2013). The dynamic local lag control dynamically changes the value of Δ according to the network delay from the other terminal to the local terminal. It should be noted that the direction of network delay is

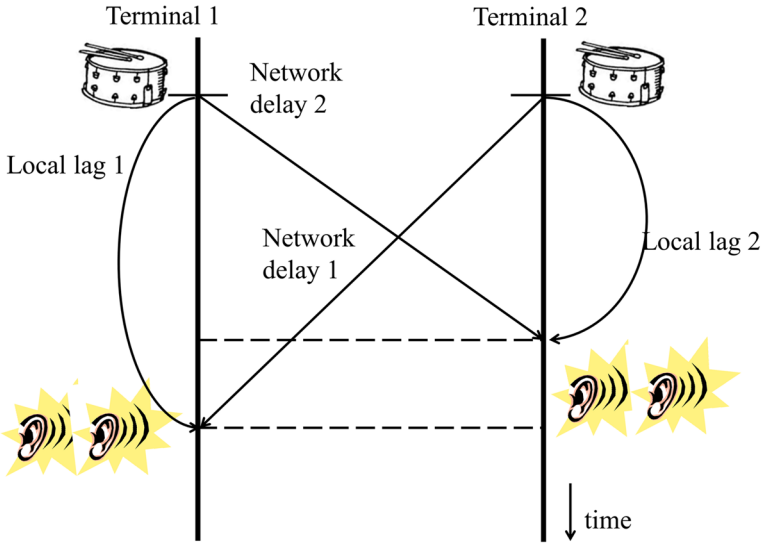
Figure 8. Asynchronization of sound under conventional local lag control



different from that in the conventional local lag control. In Figure 9, where local lag i ($i = 1$ or 2) is set to the same value as network delay i, we see that sound synchronization can be achieved at each terminal; that is, each user hears sound only once. Networks delays 1 and 2 are equal to those in Figure 8. In the dynamic local lag control, the value of Δ is set to the optimum value of local lag from the following equation (Sithu & Ishibashi, 2013):

$$\Delta = 0.637\, D + 6.578, \tag{1}$$

Figure 9. Synchronization of sound under dynamic local lag control



where D is the time interval (called the *MU delay* here) from the moment an MU is generated at the other terminal until the instant the MU is output at the local terminal.

The dynamic local lag control can be used for two or more terminals. The reader is referred to (Sithu et al., 2013) for the dynamic local lag control for two terminals. We here explain the key idea of the dynamic local lag control for three terminals (see Figure 10). We denote the MU delay from terminals i to j ($i, j = 1, 2,$ or 3) by Δ_{ij}. Also, we denote the local lag at terminal i by Δ_{ii}. For simplicity, let us focus on terminal 1. At terminal 1, Δ_{11} is set to the larger value of Δ_{21} and Δ_{31} according to the following equation: $\Delta_{11} = \max(\Delta_{21}, \Delta_{31})$. To synchronize the output time between received MUs, the additional buffering time is added to Δ_{j1} by $\Delta_{j1} - \Delta_{11}$ ($j = 2$ or 3); note that the additional buffering time of the larger one of Δ_{21} and Δ_{31} is zero. It is easy to obtain the control for more than three terminals.

We investigate the effect of the dynamic local lag control with prediction in the joint performance of the networked haptic drum system. As a result, we demonstrate that there exits the optimum value of prediction time according to the network delay. Based on this result, we propose the dynamic local lag control with dynamic control of prediction time, which dynamically changes the local lag and prediction time according to the network delay in the joint performance of the networked haptic drum system (Sithu et al., 2014a).

QoE Assessment of Dynamic Local Lag Control

In order to clarify effects of the dynamic local lag control, we make a comparison between the dynamic local lag control and the conventional local lag control, which has fixed values of local lag, by carrying out subjective QoE assessment on the quality of sound synchronization, interactivity, and comprehensive quality. The synchronization quality means how much simultaneously the sound of one user and that of the other user are outputted. The interactivity is the time difference from the moment a user hits a drum component until the instant the user hears a sound of the component. The comprehensive quality is the weighted sum of the synchronization quality of sound and interactivity; thus, the comprehensive quality is the most important. In the assessment, we use the networked haptic drum system for joint musical performance.

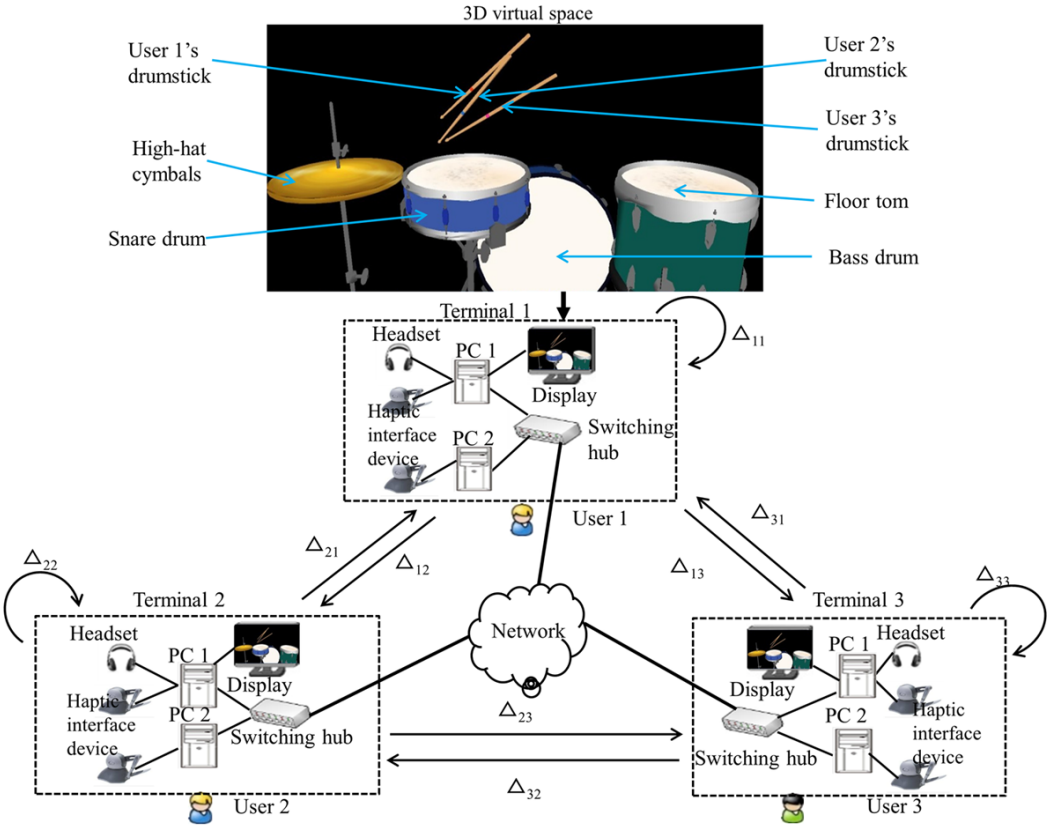
Networked Haptic Drum System

In the networked haptic drum system, users share a drum set which consists of high-hat cymbals, a snare drum, a bass drum, and a floor tom in a 3D virtual space as shown in Figure 10. We explain the networked haptic drum system for three terminals as shown in Figure 10. The system consists of three terminals (*terminals 1, 2,* and *3*), each of which has two PCs (*PCs 1* and *2*) connected to each other through an Ethernet switching hub (100 Mbps). Each PC has a haptic interface device (Geomagic Touch (Geomagic_ Touch, n.d.)). The two haptic interface devices at each terminal are used to move a pair of drumsticks in the virtual space. Also, a display and a headset are connected to PC 1 at each terminal. When each drumstick hits a drum component, the reaction force is perceived through the haptic interface device, and a sound depending on the drum component is generated (Sithu & Ishibashi, 2013).

Assessment Environment

In this subsection, we explain the assessment system of the dynamic local lag control between two terminals (see (Sithu et al., 2014c) for assessment among three terminals). In our assessment system, two

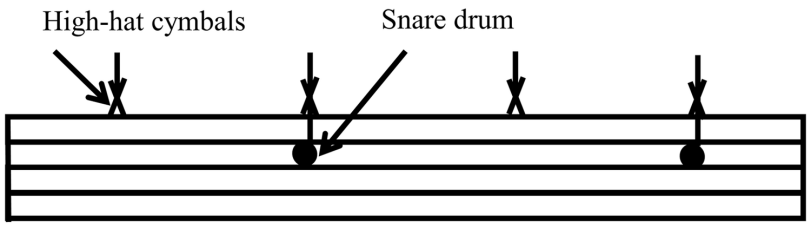
Figure 10. Configuration of networked haptic drum system



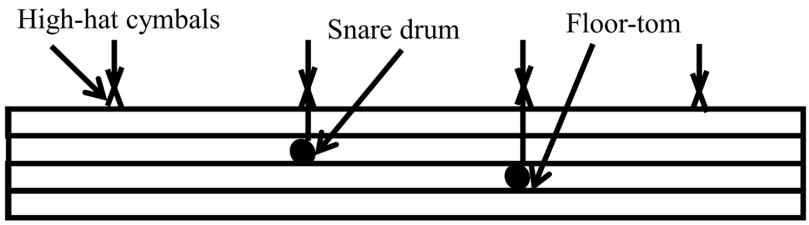
terminals (*terminals 1* and *2*) are connected to each other via a network emulator (NIST Net (Carson & Santay, 2003)) absorbed by buffering under media synchronization control, such as VTR (Ishibashi et al., 2002); we here take account of the jitter by including the buffering time in the constant delay. We handle the symmetric and asymmetric delay cases in the assessment. In the symmetric delay case, we set the constant delay (called *constant delay 1* here) from terminal 2 to terminal 1 to the same value as that (*constant delay 2*) in the opposite direction. In the asymmetric delay case, constant delay 1 is not equal to constant delay 2.

We carried out subjective QoE assessment with 16 subjects (males and females) whose ages were between 20 and 28. We employed two rhythms (*rhythms 1* and *2*) at two tempos (slow and fast) to investigate the influence of drumstick movements. In rhythm 1, each subject hits the high-hat cymbals by his/her left drumstick and the snare drum by his/her right one repeatedly (see Figure 11 (a)). The high-hat cymbals are hit at all the four beats, and the snare drum is done at the second and fourth beats. In rhythm 2, the subject plays the snare drum and floor tom by his/her right drumstick at the second and third beats, respectively, while hitting the high-hat cymbals by his/her left drumstick at all the times (see Figure 11 (b)). In rhythm 1, because the subject hits the same drum components repeatedly, he/she does not need to move their drumsticks to the other drum components. On the other hand, in rhythm 2, he/she needs to move the right drumstick between the snare drum and the floor tom. Rhythm 2 is more difficult than rhythm 1 since each subject needs to move one of his/her drumsticks between the two dif-

Figure 11. Two rhythms



(a) Rhythm 1



(b) Rhythm 2

ferent drum components. The rhythms are used in 8 beats or 4 beats rhythms and popular in jazz and rock music (Music_Tempos, n.d.). As for the slow and fast tempos, each subject hits the drum set at 60 beats per minute (bpm) and 100 bpm, which are often used in fast ballads and slow rock music, respectively (Music_Tempos, n.d.). In the assessment, constant delays 1 and 2, local lags 1 and 2, and the two types of control (i.e., the dynamic local lag control and the conventional local lag control) were selected in random order for each pair of subjects. In the symmetric delay case, we changed constant delays 1 and 2 from 0ms to 150ms at intervals of 50ms in both types of control. In the conventional local lag control, we set local lag 1 to the same value as local lag 2, and the values were set to 0ms, 50ms, 75ms, 100ms, and 150ms. In the dynamic local lag control, the value of local lag was dynamically changed according to Eq. (1). In the asymmetric delay case, we carried out the assessment for several combinations of constant delays 1 and 2 (50ms and 0ms, 100ms and 0ms, 150ms and 0ms, and 100ms and 50ms).

It took 30 seconds for each stimulus. After each stimulus, the pair of subjects were asked to base their judgments about the synchronization quality of sound, interactivity, and comprehensive quality based on the five-grade quality scales (5: Excellent, 4: Good, 3: Fair, 2: Poor, 1: Bad). Each subject gave a score from 1 through 5 to each stimulus. By averaging scores of all the subjects, we obtained the mean opinion score (MOS) (ITU-R BT. 500-12, 2009) as a subjective QoE parameter.

Assessment Results

Figure 12 shows the notation employed in Figures 13 through 15. As an example of assessment results of symmetric delay case, we show MOS values of comprehensive quality for various values of local lag as a function of constant delay in Figure 13. For the asymmetric delay case, we plot MOS values of comprehensive quality at terminals 1 and 2 in Figures 14 and 15, respectively, for four combinations of constant delays (constant delay 1: 0 ms, 50 ms, 100 ms, and 150 ms; constant delay 2: 0 ms). In the figures, we show only MOS values of rhythm 1 at the slow tempo. We do not show MOS values of

Figure 12. Notation in Figures 13 through 15

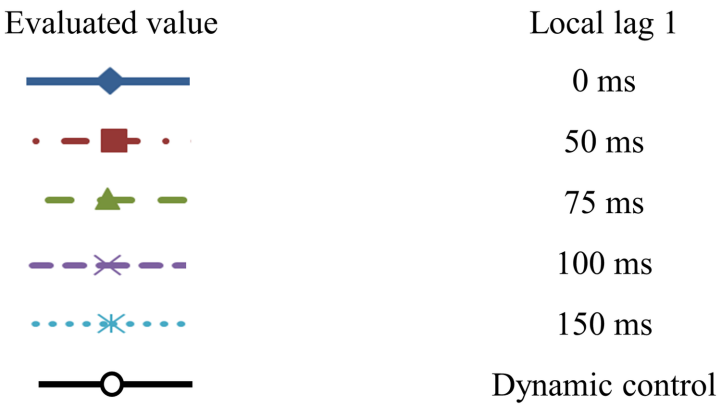
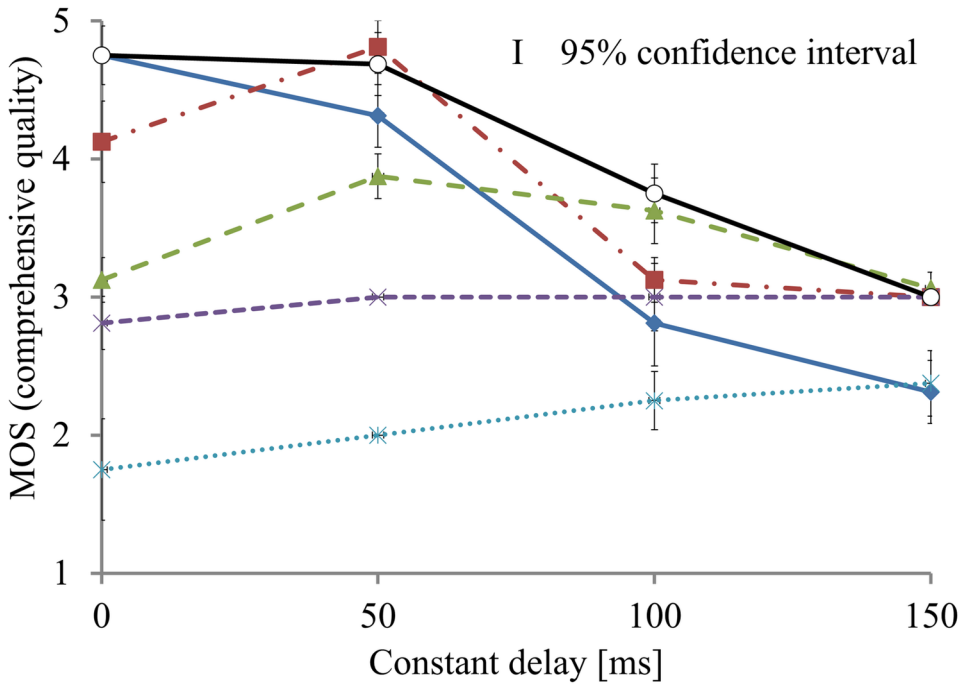


Figure 13. MOS of comprehensive quality for rhythm 1 at slow tempo in symmetric delay case



rhythm 2 at the fast tempo because they had similar tendencies to those in Figures 13 through 15 (Sithu et al., 2014b). The 95% confidence intervals are also plotted in the figures.

In Figure 13, we see that the MOS value of the dynamic local lag control is the highest or second highest for each constant delay. We also confirm that there exists the optimum local lag for each constant delay when the local lag is fixed. From the figure, we find that the optimum local lag is the same as the constant delay when the constant delay is smaller than or equal to about 100 ms, but it is smaller than the constant delay when the constant delay is larger than about 100 ms. The reason is that the quality of sound synchronization becomes higher as the difference between the local lag and constant delay

Figure 14. MOS of comprehensive quality at terminal 1 for rhythm 1 at slow tempo in asymmetric delay case (constant delay 1: 0 ms, 50 ms, 100 ms, and 150 ms; constant delay 2: 0 ms)

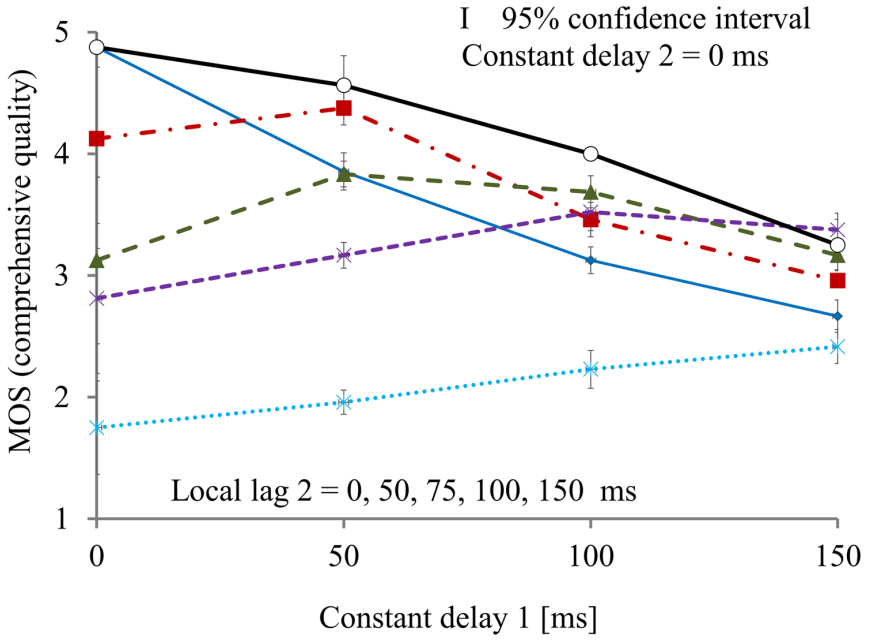
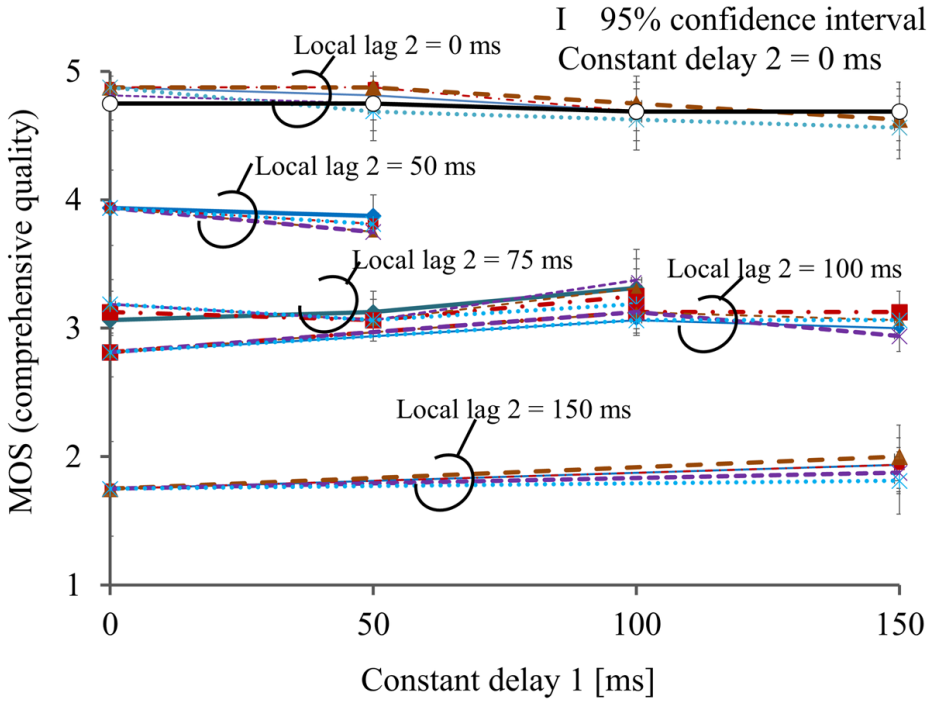


Figure 15. MOS of comprehensive quality at terminal 2 for rhythm 1 at slow tempo in asymmetric delay case (constant delay 1: 0 ms, 50 ms, 100 ms, and 150 ms; constant delay 2: 0 ms)



becomes smaller, and the interactivity is more largely deteriorated as the local lag becomes larger. We further note in the figure that the MOS value at the optimum local lag tends to decrease as the constant delay becomes larger.

In Figure 14, we draw summarized MOS values for various values of local lag 2 since the differences among the values were very small. In the figure, we find almost the same tendencies as those in Figure 13. That is, the MOS value of the dynamic local lag control is the highest or second highest for each constant delay 1. Therefore, the dynamic local lag control is effective. Also, when local lag 1 is fixed, there exists the optimum local lag 1 for each constant delay 1, and the MOS value at the optimum local lag 1 tends to decrease as constant delay 1 becomes larger.

Figure 15 reveals that the MOS values of comprehensive quality at terminal 2 hardly depend on constant delay 1. We also see that the MOS value of the dynamic local lag control is the highest or second highest for each constant delay 1. We observe that the MOS values decrease as local lag 2 becomes larger; that is, local lag 2 of 0 ms has the highest MOS values. Furthermore, we find that there are not so much differences among the values of local lag 1.

From the above considerations, we can conclude that the dynamic local lag control is effective.

FUTURE RESEARCH DIRECTIONS

In the future directions of media synchronization control, we can take advantage of the interdependency among multiple media streams which is called *mutually-compensatory property* in (Tasaka & Ishibashi, 2002). Media streams may be able to compensate for each other from a perceptual point of view. For example, in a video telephone system, if the video quality is low, the overall quality can be kept by improving the voice quality. To this purpose, we have to measure the human perception of mutually-compensatory property. The conventional media synchronization algorithms in (Ishibashi et al., 1997, 2004) take account of human perception of intra-stream and inter-stream synchronization errors (Steinmetz, 1996; Murray et al., 2013; Ishibashi et al., 2014; Zeng et al., 2013) but not mutually-compensatory property. Therefore, we need new media synchronization algorithms by taking advantage of the property. We further need to continue our survey since the research area is still growing and new media synchronization control techniques may be found in the future.

CONCLUSION

In this chapter, we explained three types of media synchronization control in multimedia communication: Intra-stream synchronization control, inter-stream synchronization control, and group synchronization control. We made a survey of control techniques used in a variety of media synchronization algorithms and classify the techniques into four categories: basic control, preventive control, reactive control, and common control. We made a comparison among the algorithms in terms of six factors: Clocks, stored or lived media, intra-stream and/or inter-stream synchronization, master-slave relation, source or destination (location), and synchronization control techniques. Also, we explained group synchronization control schemes and made a qualitative comparison of the schemes. Furthermore, we proposed a new control called the dynamic local lag control in joint musical performance. As a result of QoE assessment, we found that the dynamic local lag control is effective.

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KEY TERMS AND DEFINITIONS

Adaptive Δ-Causality Control: The control employs the local lag control and is usually used in networked real-time games. When the network delays are different among terminals, the control dynamically changes the local lag to the maximum network delay among the terminals.

Basic Control Techniques: The techniques are required in almost all the algorithms, and they are indispensable to preserve temporal relationships among media streams.

Common Control Techniques: The techniques can be used as both preventive and reactive control ones.

Dynamic Local Lag Control: The control synchronizes local information with received information at each terminal by changing the local lag dynamically according to the network delay from the other terminal to the local terminal.

Group Synchronization Control: The control outputs each media steam simultaneously at different destinations in multicast communication.

Inter-Stream Synchronization Control: The control keeps temporal relationship among multiple media streams.

Intra-Stream Synchronization Control: The control preserves the timing relation in a single media stream.

Local Lag Control: The control buffers local information for a constant time called the local lag ($\geq$0ms) according to the network delay from the local terminal to the other terminal. It should be noted that the direction of the network delay under the local lag control is different from that under the dynamic local lag control.

Mean Opinion Score (MOS): MOS is the average score of all subjects in a subjective assessment.

Media Synchronization Control: The control adjusts the output timings of media streams to achieve high quality of media synchronization.

Preventive Control Techniques: The techniques are required to avoid asynchrony before it occurs.

Quality of Experience (QoE): QoE is the quality of an application or service experienced by end-users, and it is also called the user-level QoS (Quality of Service). A typical example of QoE measures is MOS.

Reactive Control Techniques: The techniques are employed to recover from asynchrony after it has occurred.

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