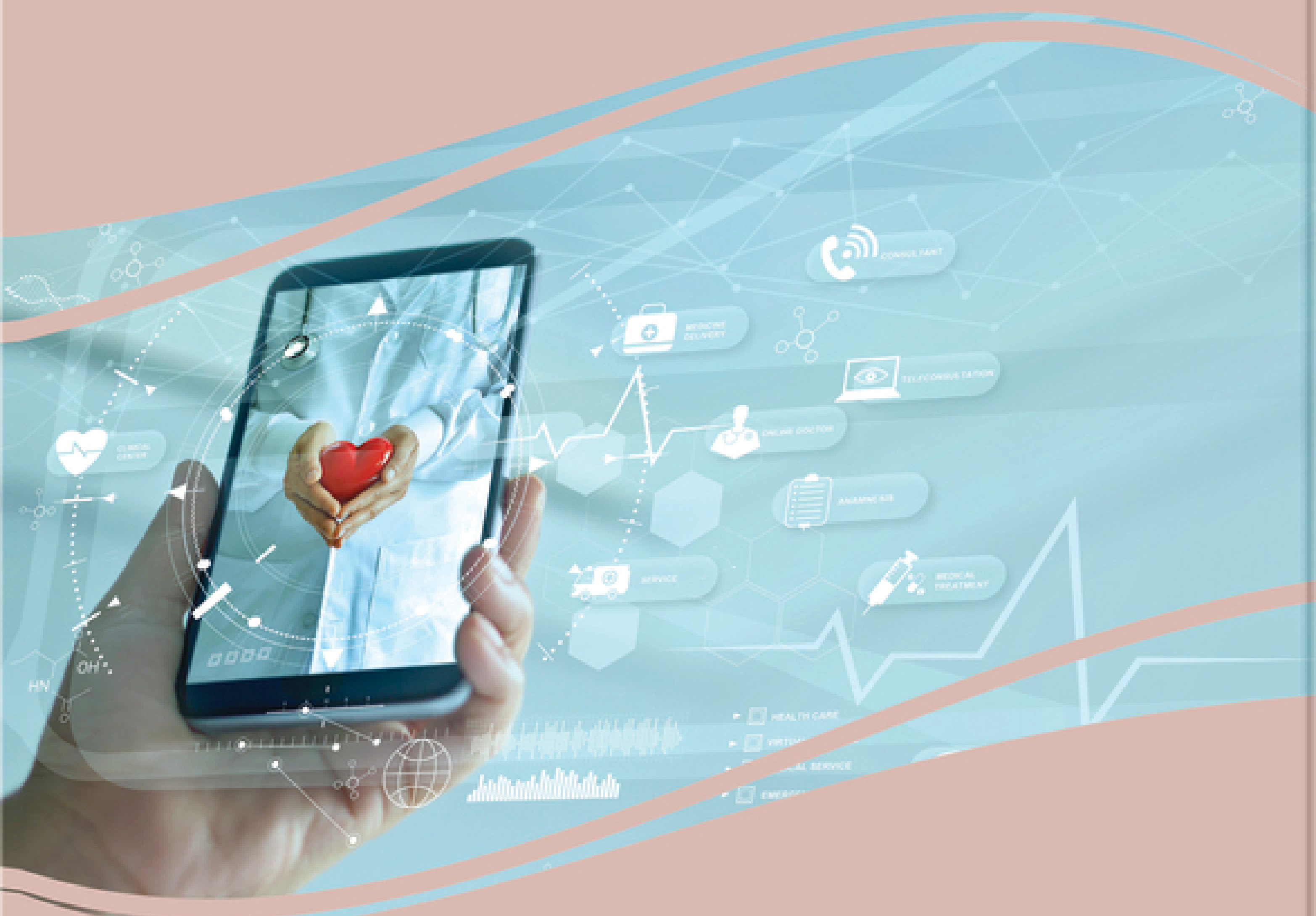
Handbook of Research on

Solving Modern Healthcare Challenges With Gamification



Ricardo Alexandre Peixoto de Queirós and
António José Marques

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Handbook of Research on Solving Modern Healthcare Challenges With Gamification

Ricardo Alexandre Peixoto de Queirós
uniMAD, Escola Superior de Media Artes e Design, Portugal

António José Marques
LabRP, School of Health Sciences, Polytechnic of Porto, Portugal

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E-Mail: cust@igi-global.com • www.igi-global.com

List of Contributors

Abreu, Paulo / *LAETA-INEGI, Faculdade de Engenharia, Universidade do Porto, Portugal* 206
Balakrishna, C. / *Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India* 279
Brandão, Pedro / *Instituto de Telecomunicações, Faculdade de Ciências, Universidade do Porto, Portugal* 293
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Gamification techniques have proven to be very effective in improving motivation and commitment, providing increased performance in both qualitative and quantitative terms. For this reason, it has been applied in more and more areas, with health and healthcare being no exception. The potential of this type of approach is enormous, and, on the one hand, it can motivate positive feelings; it can also foster deviant behaviors that fail to contribute to the individual and common good. This chapter aims to explore the relationship between the development of gamification systems and the ethical and moral aspects that are crucial elements when the target of the process becomes the human mind. The main questions and ethical dimensions that will allow us to constitute a reference framework for the development of gamification systems will be presented. Timely reflection and the inclusion of security mechanisms will allow us to develop better experiences for users, always combining improved motivation with the search for the good.

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Gamification is a very well-known design technique in software development that applies the principles of gaming to non-gaming contexts and environments to increase the user adaptation and engagement of applications. Examples of gamified applications can be seen across all kinds of software categories from health to finance, always with the same goal: provide a better experience to the end-user. This chapter reflects upon the user feedback of gamified applications, especially on health sector, and concludes that gamification is not a solution that can be successfully applied to every context. In the end, industry standard alternatives to gamification are analyzed in order to produce high quality non-gamified applications.

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Applications (apps) offer outstanding opportunities for healthcare services to serve individuals in areas that do not involve technology that improve healthcare outcomes, and that strengthen community health. These opportunities are becoming more common, especially with the increasing use of mobile devices in many segments of society. On the other hand, there are many obstacles that directly or indirectly affect the process of implementing gamification applications. In this study, the authors use Interpretive structural modeling (ISM) and MICMAC aiming to reveal the relations of obstacles encountered, and also to find the root cause of barriers in gamification engagement through applications used in healthcare. Findings showed that the lack of functionality of the apps, having the highest driving power and lowest dependency, was determined as the root barrier whilst other barriers are also divided into levels.

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Given the changes that have been recently felt and the transformation of the classroom from a physical space, with one teacher and a set of students, to a mediating platform through which learning and teaching are performed online, it is necessary to get acquainted with the contexts in which these platforms are implemented and how to use them, as well as with models and systems of e-learning, b-learning, or m-learning. While looking for solutions that allow to implement and use gamification for online learning, one also intends to get acquainted with (some of) these platforms, as well as to integrate and combine "new" technologies such as augmented reality and virtual reality with gamification strategies for e-learning. In order to do so, this chapter presents a systematized reading of the studies that was carried out on this particular subject and of what has been published on this theme.

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The implementation of gamification in immersive environments is a complex and multidimensional process. A socio-technical approach is necessary to cover all the specifications that the system needs to satisfy the needs and the purpose of its genesis. The use of virtual reality (VR) technologies in mental healthcare associated with gamification mechanisms has been gaining popularity. Two projects were developed using VR, one that allows people to experience and better understand mental health conditions through empathy construct and the other can be used to help patients with social phobia or Arachnophobia to reduce their phobias using VR solutions and real-time biofeedback. The authors analyze the aspects

that influence the development of immersive environments and gamification mechanisms and propose a socio-technical methodology based on actor-network theory for the survey and definition of requirements.

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Helena Martins, Lusófona University of Humanities and Technologies, Portugal

Neurocognitive rehabilitation continues to face difficult challenges related to patient and institutional characteristics. This reality requires innovative solutions to increase patient motivation and involvement in the process, turning rehabilitation more meaningful and pleasurable, as well as to help therapists overcome difficulties such as the absence of material and human resources. Innovative rehabilitation techniques have the potential to create motivating, personalized, and ecologically valid tasks. In this chapter, the authors describe the reality of neurocognitive rehabilitation in acquired brain injury and present the advantages and potential of digital information and communication technologies, especially serious games and gamification. Distinctive elements of these solutions and a reflection on the evolution of this area are presented. In order to establish evidence-based practices, it will be necessary demonstrate unequivocally the development of competences by the patients, supported by these new solutions, and its generalization to real-life activities in future research.

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In recent years, laptops and smart phones have become unavoidable, and the restriction in usage of these devices is impracticable. Starting from children to aged persons, many people spend their waiting time, travel time in this nicely, but the issue arises due to their influence in the golden working hours. It leads to waste of time, energy, and some of these practices may lead to addiction. Hence, a techno-cognitive approach of the biomedical analysis of brain can be done through electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). After investigations, a strategy is to be implemented to explore the dynamics of therapy on reducing the addiction. But it is not a simple task of making the addicted persons practice yoga or meditation routinely. It can be made possible through gamification of these practices. This chapter focuses the pre and post recording of the addicted person's brain activity to analyze and measure the improvement after the treatment via gamification strategy. After certain duration, the outcome is addiction removal.

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Ana Francisca Casinhas Coutinho Lapa, School of Health, Polytechnic of Porto, Portugal
António Marques, School of Health, Polytechnic of Porto, Portugal

The following chapter will address the use of gamification (specifically serious games), as well as its results and conditions of use, as an assessment and intervention tool for people with mild cognitive impairment (MCI) and dementia diagnosis. These games are effective for cognitive skills, such as attention, memory, executive functions, and speed processing. Besides this, physical (related to motor coordination and movement), social, psychological, and emotional (related to motivation, anxiety, depression, and stress) skills can be improved by serious games. It will be considered the contexts of the use of different games, such as Episodix, Panoramix, and some other games that are applied as serious games, like exergames. Besides, it will be also referred the different platforms associated with these games, such as mobile applications, videogames, virtual reality, and augmented reality.

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Maria Inês Soares, School of Health, Polytechnic of Porto, Portugal
António Marques, School of Health, Polytechnic of Porto, Portugal

Social phobia usually starts in adolescence. Social situations that include meeting people, talking in groups, or in more specific situations are going to be avoided by individuals. Therefore, this condition has the consequence of significant impairment in different occupations. Recent studies show that gamification is commonly applied to interventions for the treatment of chronic diseases, and although there are interventions concerning mental health, these are few and there is evidence that these interventions have positive effects on mental health, particularly among young people. The desensitization therapy program using gamification consisted of 15 sessions: an initial assessment session, 13 biweekly exposure therapy sessions, and the last reevaluation session corresponding to a total duration of the program of seven weeks. Each session, lasting approximately 50 minutes, is followed a formal structure consisting of the following phases. The intervention focused on shaping appropriate approach behaviors through a process of successive approximations.

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Liliana Correia de Castro, Instituto de Ciências Biomédicas de Abel Salazar

This chapter's first goal is to present the concept of Positive Play as an expression of play focused on social, psychological, and physical well-being and human potential. It presents some of its foundations

in the form of eight maxims that emerged from an analysis on various games developed in the industry and in research settings. Afterwards, it demonstrates of how Positive Play can be integrated in different contexts of action, from diagnosis and intervention to contexts focused on prevention and promotion of awareness and knowledge in the scope of mental health, regarding treatment for Anorexia Nervosa, through a series of in-progress case studies in the form of game prototypes.

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People with schizophrenia and other related disorders experience great difficulties in getting the appropriate treatment regarding not only the type of interventions available but also the conditions that required for a proper treatment, mainly cost, locale, and frequency. The use of gamified mHealth applications for this population is a proven way to provide a set of tools that may help patients to manage their condition using applications on mobile devices, like smartphones, that implement game-like strategies and elements that transform unpleasant tasks into virtual challenges. This chapter addresses the impact and implications that the use of gamified mHealth applications have for people with schizophrenia, a comprehensive guide of recommendations and standards used by the industry on the development of gamified applications and provides a literature review on the subject.

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Maria Teresa Restivo, University of Porto, Faculty of Engineering

Developed within the scope of a SciTech research project, this chapter records in a procedural way the design centred on senior users for a set of three serious games for the eHealth field, designated by the authors as “Carnival.” The chapter, having as its leitmotif the project aforementioned, looking at its motivation, breaks down the systems augmented feedback interfaces—BodyGrip and SHaRe—to evaluate, rehabilitate, and monitor dexterity and manual strength. Topics related to empathy and well-being in the user experience design process, namely guidelines for empathy in different project phases, participatory design, inclusiveness, and amusement are identified. Withal listed the development phases of three games dynamics inherent to the “Carnival” set —“High Striker,” “Claw Machine,” “HotDog Sauce”—punctuating with the discussion and contributions to the e-health area describing its potential for Evaluate, rehabilitate, and monitor dexterity and manual strength.

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Vanessa Solange Arouca Quental, School of Health, Polytechnic of Porto, Portugal
António Marques, School of Health, Polytechnic of Porto, Portugal

In our modern life world, health and well-being strongly depend on the individual's health behaviours. Motivation is a major factor of health behaviour change, and intrinsically motivated behaviour change is desirable as it is both sustained and directly contributes to well-being. This raises the immediate question what kind of interventions are best positioned to intrinsically motivate health behaviour change. The current state of evidence supports that gamification can have a positive impact in health and wellbeing. In recent years, games and game technology have been used quite widely to investigate if they can help make rehabilitation more engaging for users. The underlying hypothesis is that the motivating qualities of games may be harnessed and embedded into a game-based rehabilitation system to improve the quality of user participation.

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Helena Martins, Lusófona University, Portugal
Artemisa Dores, Polytechnic of Porto, Portugal

Gamification is a relatively new approach that allows the use of videogame design techniques in contexts that are originally not game related, including for the promotion and education of health outcomes. Gamification has been used in many contexts, but healthcare practices, which include often boring, frustrating, or painful tasks, can especially benefit from the fun enjoyable games people play for entertainment purposes. Games can be helpful both promoting an increase in health knowledge and behaviors, as well as the positive emotions elicited by health-related contents and behaviors. This chapter begins by discussing the concept of gamification, the gamification toolbox, and gamer taxonomies and the different uses of gamification and game-based approaches in the healthcare context are explored, to figure out what the key success elements are and why this promising approach has yet to achieve its wide-spread potential use.

Chapter 15
Nutrify: Promoting Nutrition Literacy Using Gamification 279
C. Balakrishna, Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India
Thota Ganesh, Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India
Arun Khosla, Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India

Generally, exercise and nutrition are the two ways to maintain a healthy weight. Most of the time exercise is given more importance over nutrition. However, nutrition is equally important or else it leads to malnutrition which is of major concern in many of the African and Asian countries. Through this chapter, the authors attempt to understand the reasons for lack of knowledge about nutrition and help in designing solutions using gamification to alter nutritional behavior. The chapter discusses malnutrition causes and provides an overview of recent gamified developments to promote nutrition and reduce malnutrition. Few online and offline interventions is proposed by categorizing people into adults, children, and teachers. Finally, octalysis is performed on the presented solutions to get an idea of used and unutilized coredrives/motivators and modify for better gamification experience to improve nutrition.

Chapter 16
Gamification: Improving Patient Adherence in mHealth for Diabetes Management 293
Diogo Machado, Instituto de Telecomunicações, Faculdade de Ciências, Universidade do Porto, Portugal
Rui Carvalho, Faculdade de Ciências, Universidade do Porto, Portugal
Pedro Brandão, Instituto de Telecomunicações, Faculdade de Ciências, Universidade do Porto, Portugal

Diabetes is a chronic disease requiring a strict management. MyDiabetes is a mobile application for type I diabetes management that, as other mHealth applications, faces the challenge of user adherence and motivation. Here the authors describe the application's redesign and the implementation of different gamification techniques to tackle these challenges. The transition to the current version of the application was made in two stages. The first addressed the redesign of the application and started implementing gamification techniques. The second stage improved some of the features and added others. After the second stage, a new survey was conducted to evaluate the implemented features and improvements. While objectives and incentives to increase the number of records were endorsed by 56.5% of users, health directed badges and objectives increased the acceptance rate to 91.3%. Long-term effectiveness of the gamification approach will be done in the future.

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Preface

INTRODUCTION

While many fields such as e-learning, business, and marketing have taken advantage of the potential of gamification, the healthcare domain has just started to exploit this emerging trend, still in an ad-hoc fashion. Despite the huge potential of applying gamification on several topics of healthcare, there are scarce theoretical studies regarding methodologies, techniques, specifications, and frameworks. These applications must be examined further as they can be used to solve major healthcare-related challenges such as care plan maintenance, medication adherence, phobias treatment, or patient education.

The *Handbook of Research on Solving Modern Healthcare Challenges With Gamification* aims to share new approaches and methodologies to build e-health solutions using gamification and identifies new trends on this topic from pedagogical strategies to technological approaches. This book serves as a collection of knowledge that builds the theoretical foundations that can be helpful in creating sustainable e-health solutions in the future. While covering topics such as augmented and virtual reality, ethical issues in gamification, e-learning, telehealth services, and digital applications, this book is essential for research scholars, healthcare/computer science teachers and students pursuing healthcare/computer science-related subjects, enterprise developers, practitioners, researchers, academicians, and students interested in the latest developments and research solving healthcare challenges with modern e-health solutions using gamification.

These are all aspects to be covered on this book, sharing what is being done in the actuality to reduce all these problems

THE CHALLENGES

Major healthcare-related challenges such as care plan maintenance, medication adherence, phobias treatment, neurocognitive rehabilitation or patient education are in the center of discussion nowadays, even more with all the negative implications that the COVID-19 pandemic has brought.

Several strategies were used to address these issues but most of them while with promising results at an early stage, tend to decrease or disappear over the process. In this sense, new strategies are being tackled to reinforce patients' motivation by promoting not only extrinsic but also intrinsic motivation. The latter refers to the behavior which is driven by internal rewards. In other words, is the behavior which arises from within the individual because it is naturally satisfying to him. This kind of motivation is considered more effective at long term, since is not related by external rewards that tend to be less enriching after a certain time.

DESCRIPTION AND ORGANIZATION OF THE BOOK

This book presents a comprehensive and recent view of the emerging trends, techniques, and tools for solving modern healthcare challenges with gamification. At the same time, it identifies new trends on this topic from pedagogical strategies to technological approaches.

The book has sixteen chapters organized in three sections, namely:

- Section 1: General and Ethical Considerations
- Section 2: Gamification in Psychosocial Rehabilitation and Mental Health
- Section 3: Gamification in Health Promotion and Physical Rehabilitation

A brief description of each of the sections follows:

Section 1 focuses on General and Ethical Considerations when applying gamification in healthcare scenarios. From ethical issues and structural modeling to software requirements, this section unveils techniques and methodologies that could be used to foster engagement while taking in account all the ethical principles. This section gathers five chapters:

Chapter 1 presents a bioethical framework associated with a decision-making process, aiming to help professionals linked to the development of software-based gamification systems. A deliberation process that will imply that the most prudent decisions are the ones to be taken. Additionally, for these professionals, some varieties of goodness, namely moral, instrumental, technical, and functional goodness will be shown and clarified in the gamification context. Bioethics should not be a technique for repairing situations, but rather as a discussion that allows supported reflections on the progress of science, helping it to be developed based on solid ethical principles. Let us not forget yet that all bioethical discussions are temporally dated, and depend on social, cultural, and economic factors that live in each time and society. However, the circumstances do not change the quality of the action. The circumstances only change its dimension.

Chapter 2 explores why gamification appears to be a good approach to be applied in almost every scenario, including healthcare and well-being applications, but raising at the same time the concern that every context has its own properties and rules - which can lift some barriers to gamification in some cases. A summary of users' feedback is considered and used as starting point to find where gamification in healthcare raises more problems than solutions. The chapter ends with a list of proven industry-standards and strategies to be used as alternative to gamification to respond to different user types and needs of the different contexts in e-health.

Chapter 3 presents a literature review discussing the barriers to gamification addressed in this study. Applications (apps) offer outstanding opportunities for healthcare services to serve individuals in areas that do not involve technology that improve health care outcomes, and that strengthen community health. These opportunities are becoming more common, especially with the increasing use of mobile devices in many segments of society. On the other hand, there are many obstacles that directly or indirectly affect the process of implementing gamification applications. In this study, the authors use Interpretive Structural Modeling (ISM) and MICMAC aiming to reveal the relations of obstacles encountered, and to find the root cause of barriers in gamification engagement through applications used in healthcare. Findings showed that, the lack of functionality of the apps, having the highest driving power and lowest dependency, was determined as the root barrier whilst other barriers are also divided into levels.

Chapter 4 explores the use Augmented Reality and Virtual Reality with gamification strategies for e-learning. Given the changes that have been recently felt and the transformation of the classroom from a physical space, with one teacher and a set of students, to a mediating platform through which learning and teaching are performed online, it is necessary to get acquainted with the contexts in which these platforms are implemented and how to use them, as well as with models and systems of e-learning, b-learning or m-learning.

While looking for solutions that allow to implement and use gamification for online learning, one also intends to get acquainted with (some of) these platforms, as well as to integrate and combine "new" technologies as Augmented Reality and Virtual Reality with gamification strategies for e-learning. To do so, this article presents a systematized reading of the studies that were carried out on this subject and of what has been published on this theme.

Chapter 5 analyzes the aspects that influence the development of immersive environments and proposes the use the Actor-Network Theory (ANT) as methodology for the survey and definition of requirements.

Implementing gamification in an immersive environment is a big challenge, involves making important decisions that have a decisive influence on the results to be achieved. The analysis and specification of requirements for such a system is a complex process, and should consider some aspects such as, to whom it is intended, interactivity, hardware, the type of suitable immersive environment (VR, MR, CAVE, Video 360º), real-time biofeedback measurement devices, the interactive narrative, the objectives, the results, report, surrounding space, among others.

Section 2 describes the best practices to apply gamification in psychosocial rehabilitation and mental health. In this realm, the section emphasizes the neurocognitive rehabilitation, dementia and mild cognitive impairment, social phobia, schizophrenia, among others. This section has six chapters:

Chapter 6 describes the reality of neurocognitive rehabilitation in Acquired Brain Injury (ABI) and presents the advantages and potential of digital information and communication technologies, especially serious games, and gamification. Distinctive elements of these solutions and a reflection on the evolution of this area are presented. To establish evidence-based practices, it will be necessary demonstrate unequivocally the development of competences by the patients, supported by these new solutions, and its generalization to real-life activities in future research.

Chapter 7 presents a Gamification approach for therapy of addicted people regarding social media/ video games. The objectives are to analyze the mental ability of the students by recording their brain activity using EEG; to compare the brain activity in pre and post cognitive therapies using simulation tool and to create health care awareness in order to improve the mental stability of the students by means of technical and scientific proofs through neurocognitive therapy.

Chapter 8 studies the use of the Serious Games with older people, in order to improve the knowledge of its limitations and its defaults, for example, in what it might harm the health of the elderly or how it can make them feel worse in the moment and harm their quality of life and wellbeing. Because of this, more efforts should be delivered so the use of this type of technology can increase in order to help improving the quality of life of older people with MCI and Dementia and also taking into account the multiple need of this type of population. The constant increased number of older people with these conditions can also be another reason since it will become more difficult to deliver face-to-face therapies in a wide scale. Thus, the final positive outcome of the use of this kind of technology is the empowerment of the person with MCI and/or Dementia to reduce the negative impact of these conditions in daily life.

Chapter 9 unveils an approach to control a specific case of phobia, the social phobia. In this realm, gamification can play a central role to control the anxiety and the fear in specific cases by applying the adequate gamification elements.

Chapter 10 presents a novel concept in Game Design and Game Studies called Positive Play. Positive Play is a term that derives from Positive Computing (Calvo & Peters, 2014), which consists of the design and development of technology to support human potential and well-being. Positive Play takes its premise, detaches it from the design of technology and localizes it to the humanistic field of the Design of games and play. The second mission of this text is to support the concept of Positive Play with a series of case studies developed in the scope of mental health, in an yet unexplored context: that of Anorexia Nervosa.

Chapter 11 surveys the use of mHealth for Illness Self-Management for People with Schizophrenia, more precisely, it gathers a set of opportunities and Implications using gamification. The use of mobile health technology for empowerment of people with schizophrenia is an emerging way to answer the needs that are not covered by the lack of professionals, the costs and even stigma, and it can address almost every problem of the user. But approaches are diverse, and every app has its own properties and functionalities. There are many apps on the market, but only few of them are adequately designed, reviewed, and certified by authorities. Therefore, their quality is questionable. But many studies showed, mHealth is effective and even cost-effective, though more research is needed. The future applications should be more personally oriented, improved regarding usability and accessibility, and based on accepted clinical guidelines. Regarding gamification, it is essential to have more comprehensive and explicit guidelines on how researchers, developers and clinicians could use it in order to create mHealth approaches that respond to the needs of its users, without causing harm, and be a proposal to complement existing services.

Section 3 describes methodologies, mechanisms, and tools to promote health and physical rehabilitation. From promoting nutrition, passing by a gamified approach to upper limb rehabilitation and finishing with an app targeted for the management of type I diabetes, this section shows different approaches which can be used to engage patients in their healthy self-control. This section has five chapters:

Chapter 12 presents a work plan for the Interaction and Serious Game design, in an eHealth context, called “Carnival” a game set comprising three games dynamics: “High Striker”, “Claw Machine” and “HotDog Sauce”. These were conceived in parallel within two perspectives: (i) the digital Interface Design (UI), as a mediator of game dynamics, and (ii) the User Experience Design (UX). Focusing on promoting the player’s engagement in the performance of repetitive tasks, the authors aim to defeat the rehabilitation or training process monotony. “Carnival” intends to ensure good communication, providing stimuli for the players to go forward in their performances

Chapter 13 explores the use of gamification in the upper limb rehabilitation. The chapter surveys several approaches which demonstrates the importance of motivation in the rehabilitation process.

Chapter 14 aims at creating a practical framework for planning and designing gamified approaches for health purposes, providing the much-needed conceptual clarity and practical implications for successful gamified approaches in health education and promotion.

Chapter 15 explores the use of gamified apps to control to encourage healthy eating behavior. The awareness to maintain healthy weight and lead a good lifestyle has been gradually increasing in recent years. Exercise and nutrition help to keep the weight under control. The malnutrition problem can be dealt more efficiently using technological resources like Apps, introducing new initiatives and schemes etc. The effectiveness of these methods can be increased by use of concepts like Gamification for maximum reach and output. From various studies and trials which used game elements like narration, badges, vouchers etc., it is evident that employing gamification in this process has provided better results and can be used as a tool to promote and encourage nutritional awareness among individuals. Octalysis is a gamification framework that helps to analyze the core drives/motivators.

Chapter 16 proposes to use gamification to motivate the user to not only input more data, but also to improve their diabetes management. Bases on this, the chapter introduces gamification notions and principles and describes the work the authors did on the gamification and usability of the MyDiabetes mobile application. MyDiabetes is an Android mobile application targeted for the management of type I diabetes. This application can be used to record significant diabetes related data and contains features such as: an insulin bolus calculator, a food database and an advice system based on medical guidelines. To function correctly, the MyDiabetes application requires the user's input. However, in a time where most devices can interact, users see data input as an unnecessary burden. The tougher the task, the more reluctant the user will be to complete it. Adding to this obstacle, the MyDiabetes application must also motivate their users to manage their diabetes correctly

CONCLUSION

This book aims to share new approaches and methodologies to build e-health solutions using gamification and identifies new trends on this topic from pedagogical strategies to technological approaches.

This book serves as a collection of knowledge that builds the theoretical foundations that can be helpful in creating sustainable e-health solutions in the future. While covering topics such as augmented and virtual reality, ethical issues in gamification, e-learning, telehealth services, and digital applications, this book is essential for research scholars, healthcare/computer science teachers and students pursuing healthcare/computer science-related subjects, enterprise developers, practitioners, researchers, academicians, and students interested in the latest developments and research solving healthcare challenges with modern e-health solutions using gamification.

Ricardo Alexandre Peixoto de Queirós
uniMAD, Escola Superior de Media Artes e Design, Portugal

António José Marques
LabRP, School of Health, Polytechnic of Porto, Portugal

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This book is dedicated to our families.

Ricardo Alexandre Peixoto de Queirós
uniMAD, Escola Superior de Media Artes e Design, Portugal

António José Marques
LabRP, School of Health, Polytechnic of Porto, Portugal

Section 1
General and Ethical Considerations

Chapter 1

Ethical Issues of Gamification in Healthcare:
The Need to be Involved

Luis Coelho
https://orcid.org/0000-0002-5673-7306
CIETI, Instituto Superior de Engenharia do Porto, Portugal

Sara Reis
CIETI, Instituto Superior de Engenharia do Porto, Portugal & Instituto de Bioetica, Catholic University of Portugal, Portugal

ABSTRACT

Gamification techniques have proven to be very effective in improving motivation and commitment, providing increased performance in both qualitative and quantitative terms. For this reason, it has been applied in more and more areas, with health and healthcare being no exception. The potential of this type of approach is enormous, and, on the one hand, it can motivate positive feelings; it can also foster deviant behaviors that fail to contribute to the individual and common good. This chapter aims to explore the relationship between the development of gamification systems and the ethical and moral aspects that are crucial elements when the target of the process becomes the human mind. The main questions and ethical dimensions that will allow us to constitute a reference framework for the development of gamification systems will be presented. Timely reflection and the inclusion of security mechanisms will allow us to develop better experiences for users, always combining improved motivation with the search for the good.

1. INTRODUCTION

The ubiquitous presence of digital technologies has been transforming many of the ways we interact socially and with the world. Many of our activities are frequently monitored and the raw information that everyone had access to can now be managed, giving it a customizable character but being able to contain

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underlying objectives. The advancement of technology brings numerous improvements to people's daily lives, however, if it is not well planned and conceived, it can also bring some damage, be it of a social, economic or welfare nature.

Gamification introduces game elements in our daily lives as a motivation to achieve objectives. In (Mavroeidi et al., 2019) twenty two gamification components are identified and sorted by popularity being the most popular points, badges, leader boards and levels (in decreasing order). These elements, when properly integrated into a situation, can be quite powerful and lead to excellent results while providing a sense of fulfilment, a "mission accomplished" sensation (Mekler et al., 2017; Sailer et al., 2017).

Whenever health and healthcare are our focus of concern these effects can be particularly important because, when considering the main causes of death worldwide (Ritchie & Roser, 2018), it is observed that many pathologies could be avoided or that their effects could be drastically reduced if patients' had an active role towards prevention or a consistent adherence to therapies. Cardiovascular diseases or diabetes, for example, are most often caused by the recurrence of harmful behaviors such as poor diet, lack of exercise or chronic stress. In fact, the adoption of preventive measures such as physical activity, healthy eating habits, adherence to medication or even rehabilitative exercises, can lead to an increase in life expectancy and improve Quality-Adjusted Life Year (QALY) metrics (Corder et al., 2020; Schroeder, 2007).

In this context, while seeking a better modern digital world, the implementation of gamification strategies drives us to imagine complex computer systems, virtual realities, pervasive monitoring and intelligent machines. But who designs and develops such systems and games? How are they designed and engineered? Are there guidelines to follow or do they impose limits to previously defined parameters? In addition to the technical skills, gamification experience developers must be aware of the effects it will have on the participant. However, the gamification area involves a wide set of disciplines particularly psychology, sociology, neurosciences, and ethics, which not always receive the necessary attention. In fact, ethical questions or moral guidelines are often barely addressed and only a cultural or socially induced conduct supports decisions, which sometimes is far from what would be desirable. User experience design, interaction design, participatory design, co-design and user research, among others, are disciplines that can provide the required focus on the user and can introduce human-centered concerns during the development process. Nevertheless, an integrated set of guidelines and better-defined boundaries can lead to better processes and optimized results.

In this chapter a bioethical framework associated with a decision-making process will be presented, aiming to help professionals linked to the development of software-based gamification systems. A deliberation process that will imply that the most prudent decisions are the ones to be taken. Additionally, for these professionals, some varieties of goodness, namely moral, instrumental, technical, and functional goodness will be shown and clarified in the gamification context. Bioethics should not be a technique for repairing situations, but rather as a discussion that allows supported reflections on the progress of science, helping it to be developed based on solid ethical principles. Let us not forget yet that all bioethical discussions are temporally dated, and depend on social, cultural, and economic factors that live in each time and society. However, the circumstances do not change the quality of the action. The circumstances only change its dimension.

This is the time of technology so in the rest of the chapter the goal will be to anticipate and predict the main bioethics and moral issues associated with healthcare gamification and devise a reference framework that can help professionals to create better technologies and better healthcare.

2. CONCEPTS AND DEFINITIONS

The expression "gamification" has recently emerged as a way of defining the use of video game elements in nongaming systems with the purpose of improving User Experience (UX) and user engagement (Deterding et al., 2011) or, in a broader perspective, more focused on the process development, "gamification" can be seen as the process of making activities more game-like (Werbach, 2014).

Despite the often-cited definition by Deterding (above mentioned) the concept's boundaries are rather vague. A more detailed perspective is proposed in (Kapp, 2012) where gamification has been defined as the use of "game-based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems". Conceptually, health gamification sits at the intersection of persuasive technology, serious games, and personal informatics (Munson et al., 2015).

In all definitions, a process or a task is underpinned and the existence of a subject who must perform it, different from those who conceive the gamification experience. However, it is not always clear that there is an objective or limit to be reached, being limited to an experience of participation or use. On the other hand, and despite the inherent objective of gamification, which is often to induce engagement or motivation, the ways that are used to build the activation mechanisms for the gamification process are diverse and may reach activation levels, depending on the individual, similar to aggressive persuasion, which raises alerts and leaving open moral and ethical boundaries.

Furthermore, it is also important to distinguish between regular games and the "serious games", a term often related with the purposes of gamification. In the first, the player tries to overcome a series of difficulties for achieving the objectives, however these do not have any implications other than diversion of the involved person. On the other hand, in "serious games", the engagement and the achievements have purpose outside themselves, they have a real meaning.

The gamification methodology is often related with information systems and/or human-computer interaction (HCI) systems but, its good results and its human-centered nature, made their usage popular in areas such as human resources management (Ērgle & Ludviga, 2018), marketing and retailing (Hofacker et al., 2016; Insley & Nunan, 2014), production and services (Castellani et al., 2013; Korn et al., 2015), education and training (Landers & Callan, 2011; Lumsden et al., 2016), and healthcare (Pereira et al., 2014; Ventre et al., 2019; Von Bargen et al., 2014), among many others.

3. GAMIFICATION IN HEALTHCARE

Individuals' engagement in health-oriented strategies, either as a therapy or as a prevention approach, has become a cornerstone in health quality policies. In fact, such engagement can lead to reduced hospital admissions (Simpson & House, 2002) and higher quality of life, yet allowing better effectiveness and enhanced quality health services (Crawford et al., 2002). Nevertheless, despite the substantive research on strategies to engage patients the approaches described in the literature are varied and so are the results achieved, but in all cases the level of engagement comes to influence the outcomes (Bombard et al., 2018).

In the healthcare context, Re-Mission, a game created by HopeLab in 2007, was one of the first examples of a gamified approach with a therapeutic purpose – a shooting game where children with cancer could actively battle virtual tumor cells. Playing the game showed to improve the reliability of medicine intake by the children (Kato et al., 2008). Another important area is stroke rehabilitation where gamified systems are used to increase user motivation. A review of 20 works covering several aspects of this application area can be found in (Tamayo-Serrano et al., 2018). Applications such as Slimkicker[1] - for weight loss, Zamzee[2] – to promote physical activity, Edugames[3] – about virus and bacteria, Empower[4] – for chronic disease patients or Fitbit[5] – to foster wellbeing (in conjunction with a hardware bracelet) are just some examples, among many others, of gamified approaches to healthcare problems that showed to have successful results.

In addition, the same strategies can be used to introduce medium and long term changes on one's behavior, for example leading to a healthy lifestyle (Cudney et al., 2015; Von Bargen et al., 2014), to maintain daily activities (Cotton & Patel, 2019) or to re-enforce medication adherence (Abdul Rahim & Thomas, 2017).

The introduction of gamification mechanisms has been reported to be highly satisfactory (González et al., 2016), contributes to satisfaction (Ērgle & Ludviga, 2018), helps to address lack of involvement while fostering the transition from a passive attitude to a value-creating assertiveness (Hammedi et al., 2017), can positively promote mindset changes (promoting pride, curiosity or optimism)(McGonigal, 2011) and it is likely worthwhile to continue to develop gamified cognitive tasks in the future" (Lumsden et al., 2016). The effects are diverse and words like engagement, motivation, commitment, attractiveness, enjoyment, pleasantness are often used to describe users' involvement with gamification experiences. In fact, the reported success of the technique is supported by underlying physiological mechanisms. Game like contexts, with well-designed achievement-reward loops, can promote dopamine production, which has a major role on positive feelings and reinforces reward motivated behaviors. Nevertheless it is also reported that gamification strategies are not flawless and its objectives can be subverted (Insley & Nunan, 2014), the subjects participation can over exceed the expected limits (Hammedi et al., 2017) and don't always lead to the desired engagement (Ērgle & Ludviga, 2018). The term "exploitationware" has been attributed to describe the "true purposes of gamification", a reassuring way to "give Vice Presidents (…) they're doing everything correct" (Bogost, 2015). Additionally, effects like addiction, undesired competition, and off-task behavior can also be found as undesired secondary effects of the gamification process (Andrade et al., 2016). These conducts can be highly detrimental and raise questions that must be addressed, not only to define limits to what can be asked to the gamification recipient but also to define control strategies that monitor unwanted behaviors and allow to detect design flaws or promote mitigating actions.

The gamification experience must be also analyzed about its methods and purposes, even if the recipients' feedback is positive. According to some authors, the gamification experience can be positioned on the limits of what can be morally acceptable, or even exceed these limits. For example, concepts of exploitation and manipulation can be found when the task purposes do not produce a meaningful result for the "player" (Kim, 2015; Kim & Werbach, 2016). Gamification can trivialize difficult issues, reinforce the wrong mentality and be deleterious for motivation, among other problems. There are also concerns about moral disengagement (Sicart, 2009), a concept where the "player" is able to deactivate self-condemnation mechanisms when in a given situation.

During the design stage of a gamification experience two crucial components must be defined: 1) the world or environment, providing clear boundaries to where the action will take place, be it real or mixed, with nature-inspired or fictional elements and 2) the system or rules, which will guide the player to behave in a certain way, how rewards can be obtained and how goals are achieved. Both components can have embedded moral and ethical values, and, as stated in (Sicart, 2011), "not only is the game world subject to ethical analysis, but also is the set of rules as a pattern for behaviors.". Nevertheless, the world and the game mechanics alone will not allow to address the complete ethical system. The purpose of these elements is to be integrated and provide support for an experience, sometimes fictional, where the player will have a central role. The recipient of the gamification content will use its own moral reasoning and will make ethical choices while engaging in the experience. Thus, only considering the player as an ethical being, with its reactions and acquired values and its behavior when fully immersed in the gamification world will allow to properly consider all the ethical dimensions and moral boundaries (Flanagan & Nissenbaum, 2014).

After this description we can start to glimpse the ethical dimensions of gamification and its implications when carelessly planed, designed, implemented, or managed. Hence, the ethics of gamification must be considered as part of the design process and always in a human-centered perspective, without forgetting the recipient's values. It is important to keep the focus on promoting positive feelings while guiding the player through the tasks, towards the objectives. This technique can be used to motivate or engage, but never to exploit or manipulate (Kumar, 2013).

4. ETHICAL ISSUES

Ethics refers to the personal guidelines that individuals, as free moral agents, use to make decisions and guide their behaviors. When applied to healthcare and biomedical research we find the concept of bioethics which helps health related professionals identify and understand moral dilemmas and provides guidelines and moral principles to decide when facing these complex or difficult decisions (Vaughn, 2016).

Although gamification is usually applied to processes aimed at increasing performance or improving results, sometimes with a profit-oriented component, its applications start to have dimension in terms of healthcare. Healthcare contains in itself ethical issues since it involves fundamental values – the health, well-being, and the dignity of each patient. The urgent consideration of these issues requires prior theorical reflection from which lines of action are formulated.

Gamification often implies the collection of data and it uses underlying psychological strategies to induce a specific behavior. For this several ethical aspects can be considered, namely: 1) informed consent 2) privacy and confidentiality; 3) autonomy and freedom; 4) justice. It can also be used to infer and adapt from the game (Pereira Santos et al., 2016). It is imperative for these professionals to understand the ethical issues associated with healthcare gamification, who are equipped with tools that allow them to make a well-informed decision, considering the morality of choices and decisions. They should also be able to assess the impact that the solutions proposed through healthcare gamification have on the individual and on the community.

To assess the consequences of immersion in a gamification experience, it is necessary to define a set of moral dimensions. From a designers' perspective, many dimensions must be considered. The possibilities are many and dimensions such as, like above mentioned, care, safety, autonomy, justice, privacy, participation, and self-conception can provide a wide and transversal perspective. Since gamification involves the "designer", the "player" and often uses social exposure of achievements or parts of the gameplay, as forms of motivation, then we can identify three evaluation layers for the mentioned dimensions: the organizational layer, the individual layer and the social layer. Additionally, the MEESTAR (Manzeschke, 2015) model can be used to qualify the degree of consideration of ethical dimensions on a four classes score:

1. The process does not collide with any ethical dimension;
2. The process is ethically sensitive, but its application is beneficial;
3. The process is ethically critical and must be permanently monitored or should not be used;
4. The process should be rejected from an ethical point of view.

With this qualitative range, it is possible to assess whether a sufficient set of assumptions was considered as part of a gamification project, and thus validate the process from an ethical perspective, or if, on the other hand, ethically important dimensions have been forgotten and possible direct or indirect consequences may arise. To better evaluate the observed aspects, we suggest building a tabular scheme as shown on table 1. Each line mentions an ethical dimension that can be considered over different levels, when applicable. To each cell we attribute a score.

Table 1. Tabular organization for scoring the degree of considerations of ethical dimensions over different levels. (Table should start blank; values are just for explanation purposes. The number of rows and table should be adjusted for each project.)

Ethical Dim.	Layer		
	Individual	Social	Organizational
Care	1		
Safety			
Autonomy	1	1	1
Justice	1	2	n.a.
Privacy	2	3	
Participation			1
Self-Concep.			

Nevertheless, the ethical quality of the process that is being assessed is exempt from any consideration when the analysis is made above the threshold of the acceptance decision, leaving an open space for qualifying how well the ethical dimensions and layers have been addressed.

Additionally, it is also important to evaluate ethical dimensions and prepare different processes or designs for different age groups, in particular children and seniors, who have very specific characteristics and therefore must be given particular attention in the gamification process. For children, the motivation for participation is facilitated, as they have a propensity for games. Their curiosity, ability to explore and learn quickly, and natural gaming skills, are factors that can be used to promote a commitment with the tasks. When properly motivated, children can be highly devoted to objectives and are able to achieve surprising goals. The involvement of children in healthcare related gamification processes can also be used as an example to follow for adults, accelerating behavior changes. On the seniors age range the diversity of factors is higher, with very distinct scenarios in term of physicals and mental skills. The willingness to learn or to be exposed to new situations is often smaller while their relationship with technology does not come to facilitate the participation in gamified experiences. Customized designed, suited to specific motivations, aiming to particular skills are factors to consider when planning the gamification process. Overall, gamification and game-based interventions can be beneficial for older senior users, especially in the health domain (Koivisto & Malik, 2020). Yet, special care must also be taken with the mentioned age groups. For example, kids are now always aware of the value of money and when game like elements are related with real money, for example to multiply virtual rewards or obtain special virtual powers, problems may arise.

Finally, when ethical considerations are analyzed from a health perspective, and considering the different age groups of the recipients, perhaps not all dimensions can be considered at the same level, with some being more relevant than others.

When considering the senior age range, when planning a gamified healthcare-oriented process, the QALY index should be of particular concern. The Quality-Adjusted Year of Life (QALY) is a standardized measure of disease burden. It combines survival rate and quality of life. It is used primarily in cost-effectiveness analyses to guide decisions about the distribution of limited healthcare resources. QALY is still used to assist decisions about clinical management and individual patient care (Howren, 2013). This metric can be an alternative to more traditional direct metrics by providing a more explicit principle of health resource allocation. When used, in a simple way, it can limit clinical freedom by focusing on the needs of the communities and not on the individual needs of each patient. This principle promotes an economic responsibility by associating it with the freedom of choice of those who care. The reflection must be clear when it concerns about allocation of resources in the health sector and gamification can be used to better distribute and direct efforts to those who need it most. QALY could be an explicit principle of resource allocation and guidance. It could bound clinical freedom by focusing on the needs of the communities and not on the individual needs of each patient.

Health economics begins, exactly, with the proposition that health resources are limited. Therefore, the decision to choose among patients is inevitable. A clear example was the experience lived in the intensive care units on the pandemic time of COVID-19. Gamification can play a major role on decreasing health expenditures, either by actively contributing to disease prevention or by improving individual's engagement on therapy strategies.

The health resource allocation leads us to address two points: opportunity costs and limited resources. The economic impact studies result from the analysis of costs versus benefits. In this sense, how the best value could be generated? How to calculate the best cost-benefit ratio from limited resources? Should gamification also be subject to economic and financial impact studies? In fact, the patient who resorts to gamification in health may perform quite differently from the one who does not. The question of the relationship between costs and benefits must also be answered in gamification.

Thus, changing behaviors and inducing them using motivational strategies, while fostering positive emotions and positive thoughts, with consequent social and economic benefits, allows for effective changes to be achieved (Heekerens & Eid, 2020) and sustainable long-term effects can be observed. Gamification could have a positive effect on health and wellbeing, especially when applied in a skilled way (Johnson et al., 2016).

As mentioned, healthcare gamification can bring numerous advantages, but they must emerge from a deep and assertive bioethical reflection. Benefits and risks as well as objectives and efforts must be measured and balanced. Using a consequentialist criterion, it is intended to maximize the benefits and minimize the risks.

5. AN ETHICAL FRAMEWORK FOR GAMIFICATION IN HEALTHCARE

Gamification has only gained popularity in the beginning of the 21st century, leveraged by the advancement of technology, and thus, its boundaries and foundations still have some open challenges. The main ethical issues associated with the design and development of gamification strategies and systems must be outlined. For those whose main function is to plan and engineer gamification systems and therefore are responsible for the design of the required strategies and goals there is an increased need for moral engagement towards a socially responsible behavior. On each development stage, questions like, is it true, is it fair, is it wise, need to be answered with conscience and wisdom. To endeavor on an ethical analysis induces a careful reflection to our reasoning and reinforces the importance of supporting decision based on tangible facts and not only on personal belief. Such analysis also brings responsibility and shows respect to the recipients of the decisions.

Science allows the researcher to move away from subjectivity while it seeks absolute truth and knowledge from it. Science is objective and rigorous. However, these statements will only be valid if the researcher provides himself with basic ethical principles. While ethics defines the moral principles that govern a person's behaviour or when performing an activity, an ethical framework is a set of codes that serve as guidelines when navigating uncertainty, competing requirements or other difficult or complex decisions. It does not simplify a complex question but can provide insights for analysis by providing a shared framework and language (Xafis et al., 2019). It does not define by itself a theory for justifying actions, but it can be supported by concepts and an underlying logic. A good decision making framework, as described in (Dawson, 2011), should comprise the following attributes:

- Clearly describe aim and scope;
- Problem-oriented instead of theory-oriented;
- Exposes values and their balance;
- Practical but meticulous;
- Flexibility;
- Algorithmic approach trough issues and questions.

To devise a framework for gamification in healthcare we can first consider the purposes and motivation of such approach as a public health strategy. In (Kass, 2001) we can find a reference framework, inspired on the seminal principles devised in (Beauchamp & Childress, 1979), that is composed by six major questions aiming objectiveness, effectiveness, identifying burden, minimizing burden, fairness and balanced decision. The authors state that beyond these concerns, the involvement of target communities have a major role on the success of programs and that "The most important asset (…) is the public's trust". Most aspect of healthcare pose specific ethical questions and to tackle the intricacies of each health related problem many proposal of ethical frameworks can be found: smoking cessation (Breunis et al., 2019), obesity prevention (Have et al., 2010; Swinburn et al., 2005), aging (*Developing an Ethical Framework for Health Ageing: Report of a WHO Meeting, Tübingen, Germany, 18 March 2017*, 2017), care-providing (Levitt, 2014), health promotion (Tannahill, 2008) among others. Despite their specificities, all frameworks share a set of important common principles that constitute a strong fundamental basis for an ethical reflection:

- Utility. To generate tangible benefits while maximizing the relation between benefits and harms;

- Equity/Fairness. To ensure justice by distributing benefits and burdens in a fair way
- Freedom/Empowerment. To respect autonomy of actions and choices;
- Efficiency. Optimal increment in cost-benefit ratio when compared with other alternatives.
- Privacy. Protect privacy and confidentiality;
- Honesty. Promote transparency and provide honest information;
- Accountability. To build and maintain trust by keeping promises and commitments.

Thus, it is important to demonstrate and discuss the ethical questions associated with the gamification design. Poorly designed gamification can be harmful and according to (Kim & Werbach, 2016) there are real concerns about the potential manipulation or exploitation by means of gamification. There must be a rational responsibility in the choice of priorities and effectiveness of the design of these applications. These are new problems that promote bioethical reasoning leading to reflection on its past, present, and future.

According to (Sicart, 2011), who as devised a lot of attention to this topic, computer games could be seen has ethical objects. Also, users become ethical agents and the ethics of computer games must be seen as a network of responsibilities and moral duties. Players must be considered moral and interventional beings. Games should be seen as ethical systems, with rules that create worlds where they play with fundamental values. Nevertheless, it can't be guaranteed that the player will engage in self-reflection and some may not be as capable of moral deliberation as the ideal player (Schrier & Gibson, 2010).

Yet, with gamification, the users' actions and interactions in a non-gaming environment could be monitored for various actions, jeopardizing real world privacy, or, to a further extent, opening space for the creation of psychological, cognitive or behavioral profiles. Moreover, there are also concerns with information sharing. Discovery of social patterns, connections, and exchange of messages. The ownership of this information and the purposes of its use must be a part of the decision process. Under these assumptions we need to introduce fundamental ethical principles.

Consent, Privacy and Confidentiality

In most ethical discussions, the concept of consent appears linked to others as important as: decision making autonomy, the right to choose and the protection against possible harm. As such, in practice, the informed consent should be considered in a more demanding way. With these kinds of applications, the legal context in which it is read and underwritten has several limitations. These limitations may be due to lack of knowledge or communication failures.

Most ethical theories agree that informed consent implies at least three preconditions: information, understanding and willingness. People who accept the informed consent must be legally and cognitively able to consent, must be free of external control or pressure and must have adequate information. The willingness appears as an ethical requirement in the sense that freedom of choice could be broken using other opinions and consequent therapeutic decisions (Bunnik et al., 2013).

The respect for privacy and confidentiality is considered the core of ethical conduct in all processes involving patients. Privacy and confidentiality come from the respect for people´s autonomy, from the desire to above all do the good, the right. These principles also refer to the principles of beneficence and trust. Privacy refers to a person´s interests in controlling access to the information about himself, clearly defining who, how and when the access can be made.

Confidentiality refers to the right of certain information be disclosed only for clinical or research. Confidentiality addresses the question of how personal data is collected. It has an objective which must be previously approved by the person that provides the data and on the use by the entity that collects it. The confidentiality of health-related information is also intended to protect the most vulnerable populations against possible discrimination in terms of therapy and socially or economically.

Autonomy and Freedom

The principle of autonomy is part of Childress and Beauchamp's theory of principles (Principles of Biomedical Ethics). In this theory, autonomy is interpreted as the freedom of the human person. It is translated on the respect for their will and recognize the sick person as worthy and autonomous.

Autonomy is based on rationality. We can write that autonomy is a person´s ability to decide to do what he believes is the best for himself. To exercise this self-determination, two conditions are necessary: a) capacity to act intentionality, which presumes understanding and deliberation; b) freedom, in the sense of being free from any external influence (Beauchamp & Childress, 1979).

Respect for autonomy means being aware of people's rights. Respect for the values and convictions of others. This principle is ethically based on the dignity of the human person.

Justice

One of the most pertinent ethical issue regards to health gamification is the justice. Justice in its conception. Will its use be fair? Will all users be treated equally? Is its use equitable? There must be a balance between costs and benefits in using this technology.

There is an urgent need to question whether, in addition to the challenge of achieving adequate levels of informed consent and confidentiality. Will the gamification be able to rectify or contribute to the access to healthcare? Based mainly on economic or social issues, patients will have another type of follow-up in healthcare. Everyone has the right to reach their maximum health potential, without social and economic conditions being determining factors.

To be able to frame this theme, it is necessary to resort some theories of justice applied to health. These are the ones that should serve as guidance. It is essential to explain its moral importance. That teaches to distinguish what can be considered fair or unfair.

In (Buchanan, 2009) it is argued that we should only demand a minimum level, a "sufficient" level, in terms of healthcare. However, it should be the same for everyone according to the needs of each one. Above this level, considered sufficient, inequalities in access to health are acceptable. This corresponds to the reality of some national health services that only, financially, guarantee basic health care.

This theory was built on three fundamental principles: (1) *the recognition of a set of special rights*, at a decent minimum, which may be demanded by certain minorities, victims of injustice or individuals whose exposure to polluted environments; (2) the consideration that a *"decent minimum*" stems from another principle, called the harm principle. According to this principle, not providing access to health care implies not respecting the principle of above all not doing wrong; (3) *prudence*, which justifies that access to a decent minimum of healthcare allows greater motivation for the general population (Buchanan, 2009).

However, from these assumptions, complex issues arise. It seems unfair not to allow access to health above a decent minimum for people with special needs and who cannot afford it. And, how to define a decent minimum in practical terms. Which for some may be a decent minimum for others not. This could lead to something as dangerous as the creation of a fixed framework in which to define what is meant by decent minimums with consequences that violate basic ethical principles.

The theory defended by Daniels (2001), of universal access to some healthcare, is based on the impact that access to healthcare has on the opportunities generated, throughout life, in a person.

The main issue is centered on what we owe to other to promote and protect the health of a given population. To answer this question, Daniels elaborated the following sequence:

1) Is healthcare really special? According to Daniels (2001), healthcare is special as it has a direct impact on the opportunities that an individual has throughout its existence. And he justifies it saying that the main function of healthcare is the maintenance of an individual's normal physical, mental, and psychological capacities. Both disease and disability affect normal life and therefore restrict the number of opportunities that a person could have during his life.
2) When could health inequalities be considered unfair? The concrete determination that inequalities could be considered unfair is an extremely difficult question to answer. For example, if we think that access to health represents the only way to protect everyone's health, we may be led to conclude, in a wrong way, that inequalities in health are unfair when access is uneven. Such thinking may be a false judgement since there are other factors such as economic, political, or social that could affect the access to healthcare.
3) Considering resource limitations, how could we reasonably respond to health needs? First, we must define what health priorities are and assess what issues there is agreement or disagreement with (Daniels, 2001).

Bearing this, Daniels proposed a deliberative theory named "Accountability for Reasonableness" (A4R). This theory could reduce the disagreements over resource allocation. A4R is centered on the following points: (1) **reasons** – decisions must be made based on evidence, principles, and arguments. Only then could a logical and validated decision be made. (2) **advertising** – requires transparency throughout the process. Transparency in the decision-making process and in the reasons that led to that final decision; (3) **resource** – the existence of a resource allows the decision to be changed at any time during the process. This allows for a process of a continuous improvement; and finally (4) **imposition** – a mechanism that ensure that the other conditions are met (Gibson et al., 2004)

Deliberation Process

With the advancement of technology, namely the introduction of gamification in health, we must provide development teams with ethical bases for decision.

The main objective of clinical ethics is the articulation between the technical and ethical dimensions during the medical act and it must be so in the design of these applications. The balance between the technical and ethical dimensions is crucial.

In the case of medical practice, when the health professionals are faced with an ethical problem, it is always necessary, at first place, dispel all the clinical doubts. Then find possible solutions, list, and analyze which are the conflicts of values. Only after the facts are verified and the conflicts of values have been analyzed should the duty be considered.

The Diego Gracia's deliberation process (Gracia, 2007) is a very useful tool in the decision process. It has the attribute of being able to be adapted and used in inherent areas to the medical practice. It is an intellectual process that aims to choose prudent alternatives. It implies knowledge, mutual respect, and intellectual humility.

This process is human-centered rather than process-centered. It is built on three points: 1) **Facts**: objective and concrete reality; (2) **Value Judgements**: it comes from what is done, from the given importance; and (3) **Fulfillment:** moment of duty.

In ethical terms, it is essential to go through facts and judgments to get duty. In the case of medical ethics and related fields it is necessary to do a very conscious deliberation to act well. This must also be the purpose of gamification in the health context – meet the larger goal of doing the right thing.

The deliberation process, adapted from (Gracia, 2007), consists of:

1) **Deliberate on the facts**: diagnosis, prognosis, and therapeutic possibilities.
2) **Deliberate on the values**: deliberate on existing ethical conflicts. Choose the problem, analyze, and identify the conflicting values.
3) **Deliberate on duties**: identification of the extreme courses of action and the identification of the best option.
4) **Evidence of consistency** guarantees prudence and responsibility. It consists on the existence of evidence of **legality** (the act under analysis is legal or not, it is moral or not). Proof of **publicity**, which is: the decision-making person would be able to defend is position in public? And, proof of **temporality**, which is: at another time would the decision-making person defend the same position? Or if he had more time?
5) **Final decision.**

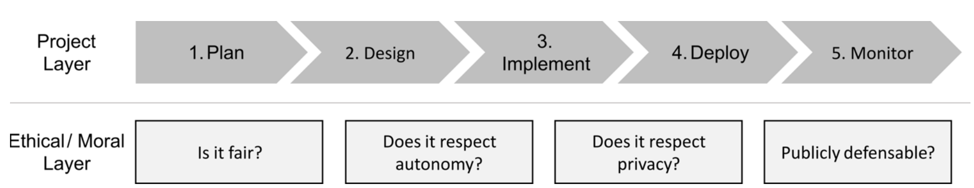
In this process, facts without values are blind. The values without the facts are empty. Facts and values have distinct definitions but are related. Values are anchored in facts (Zoboli, 2012). We give a value to everything we understand. There are no pure facts as they come with values. It is impossible to establish rationality leaving aside the social context and the historical moment that the moral agent is experiencing.

Designing and Operating Gamification

Gamification in healthcare is highly sensitive and, therefore, the path traced will be through a proposal framework. Any model of deliberation or framework in the health field presents numerous challenges. The purpose of this type of models is to help to define and assemble according to a specific ethical referential. It must consider the reality of each case, not neglecting cultural, economic, and social factors.

The development of a gamification project can follow a five stages pipeline as shown in figure 1.

Figure 1. Project and Ethical/Moral layers for a gamification project development



The technical and ethics components must be worked in parallel. This makes the design process more robust and the decision making more consistent.

Project layer includes the technical steps: a) Plan: what problem do we want to solve? What is the reality about this?; 2) Design: part of the project dedicated to addressing requirements and how the can be translated to the experience. Must satisfy the needs identified in point 1; 3) Implement: proof of concept and adaptation. Proof of concept in terms of functionality and proof of adaptation in terms of the target market; 4) Deploy: can include a final testing phase with a small pilot group which will be followed by a release to end-users and 5) Monitor – create tools that allow monitoring the use of the application.

About the ethical and moral layer, four questions must be answered during the five points of the project layer: Is it fair? That means that its use will not create discrimination between users? Are the most vulnerable populations, in this context, protected? Is it publicly defensable?

About the autonomy, it must guarantee total freedom of choice for the users. Users privacy must be ensuring.

And about the last question, publicly defensible means that application designers are willing to defend and argue the conception of the entire application in public. This point is very important as it shows the moral engagement of the designer.

However, for the ethical and moral layer to be met prudently, those questions must be covered in detail. Our aim is to provide the basic tools for creating a logical and rational thinking.

Finally, we intend to understand if the designed solution satisfies the desired objectives.

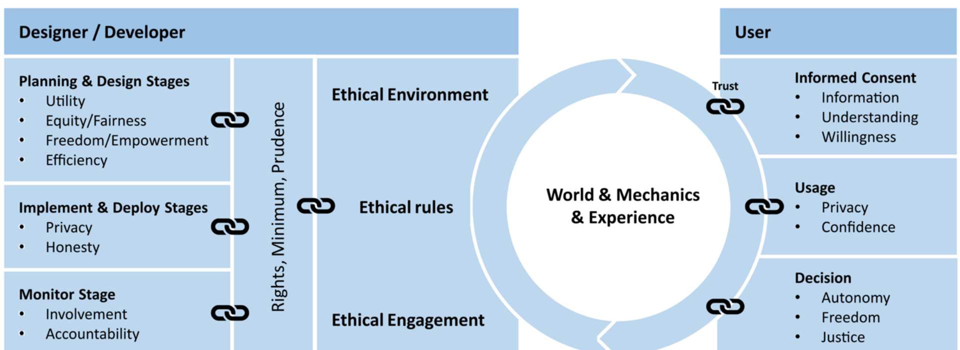
We must add consistency and efficiency. Consistency ensures that decisions made at different times use similar analysis mechanisms. Efficiency ensures that decisions made are effective and timely.

6. CONCLUSION

The development of a gamification process goes far beyond the user's perspective as a simple user of the process. For the success of the gamification system, several perspectives must be considered that encompass culture, psychology, in its emotional and motivational aspects, and morals and ethics, as elements that aggregate the dynamics of the user experience. Only this way, cognitive, emotional, and behavioral engagement can be simultaneously aimed.

In this chapter we have started by covering the main concepts and definitions that can be applied to gamification for healthcare and we have widely discussed the advantages and positive effects as well as the main concerns and risks of gamified experiences. Then we have addressed the main ethical issues and started to introduce general guidelines for ethical reflections during design and development, covering ethical principles, qualifying strategies or frameworks. Finally, we have integrated some of the available theories in order to build a decision framework that can be used on real world projects. A graphical representation of this framework is proposed on figure 2. Two main elements, the designer and the user, are connected by a closed exposure/experience loop, encompassing the several project stages. Each element must have specific concerns regarding ethical dimensions. On the User's side we have grouped ethical issues according to three basilar aspects, which are connected to the experience by a trust link that must be created and maintained. On the Designer's side, the ethical dimensions, referenced by several authors and inspired on (Beauchamp & Childress, 1979), have been grouped according to the project's stages. When evaluating each ethical dimension, towards a decision, the deliberation process of (Garcia, 2008) can be used as a guideline. The level of consideration can be scored using a table similar to table 1. Finally, when transferring the ideas/decision to a gamified idea, the theories of (Buchanan, 2009) and (Daniels, 2001) provide the minimal requirements that should be ensured. The integrated ethical relation of the user with the gamified experience has support on the theories of (Sicart, 2011). The user must be always in the center of every reflection and decision. The proposed representation is flexible and the list of ethical dimensions and other aspects should be adjusted to each situation according to the project's requirements.

Figure 2. An ethical framework for the development of gamified experiences



The existence of complementary training for development teams in this area is essential. They must be able to relate facts to ethical and moral values. It is extremely important to standardize definitions and concepts. Only by this way it could be guaranteed that during deliberations the whole team is discussing with the same level of clarity and knowledge. Three major principles could guide this kind of training: (1) Principle of maximum technical capacity; (2) Principle of a job well done mixing facts and values; and (3) Principle of the authenticity of good.

Gamification teams should have the ability to define what is needed. They should know how to assess people´s needs and give them what they need. No more, no less.

Increasing public awareness of the potentials benefits of these applications may, by itself, influence the perspective of how to supervise and control this information. Another challenge will be to make the criteria of equity, universality, and equality work in a real-life environment while seeking to accomplish health oriented objectives.

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ENDNOTES

1 http://www.slimkicker.com/
2 https://www.zamzee.com/
3 http://www.edugames4all.org/
4 https://ayogo.com/empower.html
5 https://www.fitbit.com/

Chapter 2
Why Gamification Is Not the Solution for Everything

Tiago Pereira da Silva
Independent Researcher, Portugal

ABSTRACT

Gamification is a very well-known design technique in software development that applies the principles of gaming to non-gaming contexts and environments to increase the user adaptation and engagement of applications. Examples of gamified applications can be seen across all kinds of software categories from health to finance, always with the same goal: provide a better experience to the end-user. This chapter reflects upon the user feedback of gamified applications, especially on health sector, and concludes that gamification is not a solution that can be successfully applied to every context. In the end, industry standard alternatives to gamification are analyzed in order to produce high quality non-gamified applications.

INTRODUCTION

Gamification is one of the most well known approaches used by IT companies to create and engage a committed user base for their products. It has been vastly used in software products such as web, mobile and desktop applications. It was also tested in all kinds of product categories, from health applications to personal finance managers. Gamification brings fun to software applications that are rather labeled as serious. By applying game-like logic and design elements to software applications that are not meant to be used as a game, software development companies are able to recreate the same sense of joy and challenge similar to what can be found for instance in video games. The ultimate goal is to keep the user engaged and interested in the continuous use of the product while facing repetitive or boring tasks as games. The successful accomplishment of each task or step gives the same kind of satisfaction as accomplishing with success a level or a challenge in a video game.

Since the appearance as industry standard, gamification has been tested and applied to all kinds of software categories. However the end-user reaction to gamified application is not unanimous. By reading the users' feedback on the main software marketplaces is easy to conclude that gamified applications are not always synonymous of a good user experience. For instance, the user feedback in one of the most

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used personal finance manager applications ranges between “The best finances management app I’ve ever seen and used in my entire life! All the functionality I’ve been looking for, friendly and really nice looking user interface” and “Looks childish, fonts and UI are too rudimentary. Money is serious business, for God’s sake!” (Google, 2020C). The same kind of mixed user reaction can be found in healthcare applications that promise to improve and extend the user life by offering a gamified interface to advice and motivate on the performance of healthy routines. “This app makes diabetes a ‘fun’ thing to manage. It’s easy to use and helps me analyze how the food I eat affects my B.G. levels” and “A physical diary would be better in its display. Childish app. Uninstalling.” are two real reviews of one of the most used mobile application that promises to track blood sugar and help users with diabetes as a fun experience (Google, 2020A).

These mixed reviews implicitly shows that gamification doesn’t work for every application and for every use case. Sometimes trying to make a game-like blood sugar tracker - that has a serious impact on the user’s physical health - can have the opposite expected effect. One of the most recurrent negative reactions to gamified health applications is how they often look clumsy, cartoonish and infantilize a serious matter that in an extreme scenario can mean life or death of the user. Some people tend to reject the use of game-like software that have a real impact on their lives because they don’t get the serious user experience they expect on an application that deals with a real-life threatening situations. Others like how some applications transforms a hard reality into a game and help them going through some serious real life challenges.

The gamification of what used to be simple applications like a step counter, made possible for millions of people around the world to face physical activity as something fun and a challenge that they are willing to take as easily as if they were playing a video game. In fact, the market of fitness applications profited so much of gamification that health applications category is one of the most active categories in marketplaces and play stores around the world. It is also notorious the evolution of these gamified applications from simple mono-feature step counters applications to complete health and well-being software solutions that tracks every motion from physical activity to sleep quality, with direct benefits for the health of their users.

On the other side of the user spectrum, healthcare professionals that use e-health applications on their professional lives, expect to see high performance platforms delivering accurate data and insights. In extreme cases, like in an emergency room, these professionals need, first and foremost, fast and correct information. A fun experience while using these applications is not for sure on the top of priorities of these users. The interaction between the healthcare professionals and these software applications have a very real impact on the life of their patients, sometimes meaning life or death. Should such critical software applications be candidates for gamification? This hypothesis raises challenges and doubts both on software usability and ethics. Applying gamification on software used in critical scenarios is probably not an unanimous question as most of the times seriousness and fun are not a possible mix.

So what should be the IT industry response for the users that have an intrinsic distrust on software applications that transforms their real-life problems into video games? Is gamification the answer for all user experience problems? Can a gamified experience of an e-health application be at the same time serious and provide accurate answers to its users? What alternatives exist to gamification in the pursuit of new users and engagement of the existing ones? How to identify the users and the use cases before building a game-like e-health application and how to deliver the expected user experience?

In this chapter the author explores why gamification appears to be a good approach to be applied in almost every scenario, including healthcare and well-being applications, but raising at the same time the concern that every context has its own properties and rules - which can lift some barriers to gamification in some cases. A brief summary of users feedback is taken into account and used as starting point to find where gamification in healthcare raises more problems than solutions. The chapter ends with a list of proven industry-standards and strategies to be used as alternative to gamification to respond to different user types and needs of the different contexts in e-health.

BACKGROUND

In one of the most famous books about practical design - "The Design of Everyday Things" (Norman, 2002), the author, Don Norman explains with a list of good and bad examples why design is fundamental to create a good relationship between a human and an object and how good and bad design have different impacts on the usability of an object. Don, who begins his book by explaining his own difficulty opening and closing doors, says "all artificial things are designed", which means that somewhere along the way on the process of building something, design is an important part of the object. Although the immediate relationship with design can be very simply put as a binary feeling of liking or not liking the design of an object, it means much more than that. A good design can make a complex object be easily handled, while a bad product design can lead to a bad user experiences.

Don focus on everyday objects and experiences, however all the lessons can be easily transported to software development. Patterns are fundamental aspect of design, people expect that similar objects work under the same fundamental set of rules, that transmits familiarity and confidence to the user. Patterns themselves are studied and created in order to provide a satisfactory experience and minimize possible issues during the handling of an object. There are thousands of design patterns published, most of them aim for simplicity and a satisfactory user experience.

A good example of an industry that is heavily based in patterns is the video-game industry. There are very well identified patterns or game genres on this industry that replicate the same principles making the user instantly familiar facing a new game or challenge. From role-playing games to sports simulations, from action games to rhythm games, these are very well known patterns to most of the consumers of this industry that most of the times don't require more than a little introduction to successfully start playing any given video-game.

The video-game industry generated $138.7 billion in revenue in 2019 according to Forbes (Kevin, 2019) is been expanding the revenue at a 10% year rate. These numbers give us a good sense how games are an important part of our lives and culture. Why is that? The engaging nature of a video-game is based on the simple idea of challenge and overcoming. This creates a sense of achievement to the gamer. Most of video-games are designed to create challenges to keep the user engaged to game. A new level to overcome, a new match to win, a new challenge on a tournament. Some users of video-games are so obsessed with the challenge that became addicted to it. Video-game addiction is now a psychological disorder recognized by all major world mental health organizations (Burleigh, 2019) and it is becoming more and more prevalent. This form of addiction reveals how powerful a game can be and the industry numbers reveal the amount of investment on this area to study and create new ways of keeping users engaged to these gaming platforms and to produce new patterns and models that generates novel ways of keeping the user engaged, interested and connected to the challenge.

If video-games are so powerful and addictive, why not transport some of the practices, processes and patterns from the gaming industry to non-gaming platforms? If there is the evidence that video-games patterns create engaged and interested users why not apply the same patterns to tools or applications where one doesn't expect to see a game-like interface? In the extreme, why not gamify everything, every platform, every application?

WHY GAMIFICATION SOUNDS LIKE A GOOD IDEA?

The instructions for Atari's Star Trek game are simply: "1. Insert coin. 2. Avoid Klingons". These instructions were written by a young Steve Jobs in 1974 during his passage on the gaming company Atari (Isaacson, 2011). To anyone who has seen an arcade machine and knows the basics of a video-game, this is more than enough to understand what actions to take and play the game. Also, the goal of the game is explicitly stated in these instructions. So one can conclude that by reading two simple sentences, the user is able to know how to start the game and what to do. The blend of simplicity and a defined goal creates an almost irresistible willing of accept the challenge from the get-go and play the game until the goal is achieved.

So, why not apply the same approach on different contexts (e.g. non-gaming software applications) and create the sense of challenge that turns a serious activity into a game if users seem more engaged and more interested in performing hard tasks if the environment is gamified? One can argue that due the popularity of the video-gaming industry and the almost universal patterns used on the implementation of these video-games, a boring task when gamified becomes, at least, funnier and the probability of being accomplished is higher. In fact the act of playing is a human instinct since birth that is experienced by everyone (Pellegrini, 2009). There is a sense of joy when one plays a game that can transform a meaningless task into a goal that must be achieved in order to win something. That is exactly the reason why gamification sounds like a good idea. If a software company transforms its technical, grey platform very specific purpose into a colorful and game-like experience with challenges, levels and rewards, in theory this new gamified experience should be more enjoyable and engaging for the user. If the application uses well-known video-game patterns, the user friction with the application business rules is lower, so is the time needed to know and to master the application.

The approach of gamify experiences is happening in almost every market, in almost every category of web, desktop and mobile applications, from financial services to health services. One good example of this change is easily seen in applications like Qapital (Novellino 2015). This service helps users to save money by setting challenges and goals and transforming the money saving habits into a video-game. In addition to saving money, the user also wins badges and other kinds of virtual gifts. The company that developed Qapital claims that is easier to save money in a gamified environment than using more classical approaches of money saving. In fact, if we go back in time 10 to 15 years the simplest way of saving money for the common person was to simply put money aside, now there are a multitude of financial services to do the same but mimicking a gaming environment with the same goal: making a hard task seem fun by taking advantage of well know gaming design techniques and patterns.

In the health and well-being applications and services markets there are now plenty of examples of gamified tools that on a first look seem matter of a more serious approach than a video-game like experience. But the market evolution has come a long way. When these markets were giving their first steps, there ware simple step counters to track one's walks or runs, now we can see all kinds of applications with challenges, games, levels and virtual badges to win based on the kilometers ran or on the number of days the user used the treadmill.

Where there were simple tools to track the levels of glucose on a simple journal, now there are plenty of examples of applications with motivational inputs, virtual assistants and virtual challenges to overcome that reward the user's good behavior on its health routines. In general, people seem to be more attracted by gamified experiences for their day-to-day routines. As of May of 2020, from the top 10 of most downloaded applications on the United States in the Health and Fitness category on Google's Play Store, all of them are gamified tools. This top 10 includes two relaxation tools, two calorie counters, four walking and running applications and finally a home workout and fitness application (SimilarWeb, 2020).

If we take a look on the same ranking but on the 'Medical' category, we see that in the middle of very specific tools aimed for healthcare professionals that include anatomic atlas and drug guides, an application called MySugr, an app to track the glucose levels is featured on the top ten board (MySugr, 2020).

WHY DOES THE CONTEXT MATTER?

MySugr is a very good example of how gamification is being applied to transform the dull habit of keeping glucose levels on a paper journal into a game. MySugar is a mobile application aimed for patients who suffer from diabetes and it is one of the most popular e-health applications in every application marketplace. Users are invited to track and insert on MySugr their daily food habits, blood glucose levels in a game-like environment. The application includes the 'Challenges' feature where the user is invited to perform a set of actions or keep a set of habits until a goal is met. There are completion bars, a list of new challenges and mini-games available to keep the user engaged and interested in using MySugr to track its health condition. For the majority of people that use a glucose tracker application to help in the management of their diabetes condition, this gamified approach seems to work better than a non-gamified application. At least is what one can easily conclude based on the popularity of MySugr and other similar applications that have more downloads and reviews than non-gamified diabetes tracking tools on the same marketplaces.

One of the factors that may explain why gamification works for these tools is the target user type. People with diabetes are encouraged to self-assess and take actions based on their condition without the need of external intervention in order to have the most normal life possible. The user is most of the times a common person with no clinical training or degree but that has the basic knowledge to handle the multiple stages of its condition. One of the steps of the daily process handling diabetes is writing a log or a journal with the daily levels of glucose and act based on these results - either by keeping healthy habits or administering insulin. For these patients, having a tool that helps them manage this condition while challenging them for habits that are good for their overall health status and well-being, is more appealing than use a simple journal, either in paper or in an application.

A different factor that explains the success of gamification in this example, is the daily routine that diabetes patients are obligated in order to keep their good health. For these persons keeping up with the needed routines to fight against their own diabetes condition is a daily struggle that although crucial, can also be exhausting both physically and mentally. Having the help of a tool to get through this daily experience is something that softens a hard experience. If that tool transforms a hard experience into an enjoyable game or challenge with goals and levels that rewards good behavior and that tracks progress in a captivating way, then with no doubt the user feels engaged with the application and with the goals.

On top of that, the common MySugr user doesn't need an extra ton of details about their condition - although this application is capable of track and provide very detailed data - in most cases all that is needed is an easy to use graphical interface for common users with very objective and essential data, a simple and engaging process and a good user experience. These three conditions are met in MySugr and this part of the explanation of the success of this mobile application.

Another kind of healthcare and well-being tools that are very popular among mobile devices owners are the mood trackers - applications that keep a record on the general level of mental well-being while challenging the user to take actions to improve their psychological well-being. The challenge in this particular niche is very intense, with tools that have a minimalist approaches like asking for a quick and general self assessment to keep a record of mood variations and others that offer a more complete intervention providing treatments and strategies to cope with the user's mood. And more recently chatbots that are trained to interact with the user in the most human form possible, understanding and guiding the user into strategies to handle its condition.

MindShift CBT (MindShift CBT, 2020) is an application to track and treat anxiety with techniques based on scientific evidence developed with the participation of three major Canadian universities. It includes a set of tools to help dealing with anxiety and help the user to relax, a journal to keep track of the daily evolution and a motivation module that keeps the user engaged while facing challenges and goals. MindShift CBT uses gamification as an interface to guide the user through well described relaxation techniques implemented by professionals. Although it feels like a game and the award to complete a challenge and meeting a goal is a virtual badge, the path to the goal is built on top of scientific foundations making this application one of the most highly regarded both by users and professionals and one of the most used in the category of anxiety (Google, 2020B).

In this case, gamification is used to simplify complex techniques that are meant to be applied by health professionals and make them simple enough for self treatment by non-trained people that suffer from anxiety, stress or phobia while keeping the user engaged on a process that will likely need daily intervention for a long period of time.

However, the most competitive niche of well-being and healthcare applications is by far the physical fitness applications. Maybe because the target user of a fitness application is virtually anyone, these applications address a vast user base of people that want to keep track of their physical activity. Such a market is a very big opportunity for software development companies. The diversity of potential users opens the space for experimentation and different approaches resulting in thousands of applications available in all major marketplaces. In this category Strava (Strava, 2020) is one of the most successful applications available with millions of active users worldwide. It tracks users' physical activity in a cross platform application that uses mobile devices and wearables to measure and store all kinds of physical activity from running, to cycling to swimming. The gamification in this application happens in different levels. It includes personal goals but also community goals. Because Strava is essentially a social tool that allows the user to share its progress with friends, it also provides the feature of goal and challenges creation not only for the user but also for the community. This social gamification is more dynamic than the traditional gamified challenges because the goals are set by and for the community and the user now has to face the personal challenge and the community challenge. For instance, a user that usually runs on the same running track is able to track its own personal progress along the time and win badges and meet personal goals, but also compare its performance with other Strava users that run on the same place in the same conditions and win community challenges like the fastest person on track or the person that more often runs that track. Strava's multilayered gamification approach engages the user not only to continue the personal commitment but also the community commitment elevating the motivation to continue the practice of physical activity.

One thing in common with all these applications briefly analyzed is that they are aimed for common people, non trained professionals of the healthcare and well-being areas that need tools to help them manage their condition or habits in a fun and engaging way, transforming repetitive or tedious action that some times is hard to follow into a pleasant activity. Transforming a set of actions into steps to achieve a goal, most of the time the award is a virtual badge or a celebrating message on a mobile application but that has echo in the physical world, meaning that the users achieved something that brings positive impact for their lives. But, how about healthcare professionals? If we switch the scenario to a more complex environment like a doctor's office or an emergency room and we change the user type to whom these gamified applications are aimed for to a healthcare professional - a doctor, a nurse or a health technician - is it reasonable to think in gamified platforms to keep track of their work and keep them motivated to proceed with their day-to-day activities? Is it even ethical to think in the possibility of gamify a diagnose tool or a patient management platform?

Maybe because of these relevant questions, it is really hard to find examples of gamified tools aimed for healthcare professionals. In fact, there is a major gap in all areas - not only in healthcare - on the existence of gamified tools for professionals or power users. The target user and the context where the application is going to be used, play a major role on the decision of producing a gamified experience. A gamified tool usually implements game-like challenges to keep the user engaged in making progress on a given activity - in a professional context this might raise some ethical concerns, especially in healthcare where the human relations are more important than performance measurement. It is questionable if a tool that is aimed to be used on a professional context must include engagement strategies like gamification to keep the users interested and motivated.

A few examples of gamified applications exist in the category of training and education of professionals. Systemic revisions are available in this area (Gorbanev, 2018) and the benefits of such applications are also confirmed (Singhal, 2019), however there is a big gap of commercially available tools when compared with the examples analyzed above.

Prognosis: Your Diagnosis (Medical JoyWorks, 2019) is a gamified learning platform to train future and current healthcare professionals. The application provides a set of scenarios where the user must guess the diagnosis correctly in different areas from general practice to cardiology and other medical specialties. The user is provided with challenges to overcome and achieve goals and win virtual badges that can be shared in social networks. This keeps the user engaged in a learning path and rewards each level that is passed with success. The performance is displayed in a dashboard with gauges and completion percentages allowing the user to have a game-like experience while training and self-educating for a complex profession like medicine.

This application is one of the few examples of gamified applications for professionals, although for training purposes only, it still is hard to find, especially in the field of healthcare, gamified applications for day-to-day activities on professional sets like clinics and hospitals. During the research for this chapter no relevant gamified applications aimed for clinical environments or professional practicing were found and that is confirmed by the most recent literature and reviews. The context, the user and the goal matters when comes the time to choose if gamification is a good idea to engage users and create a good user experience.

GOOD AND BAD EXAMPLES - AN USER REVIEW JOURNEY

One of the best features of modern application marketplaces is the instant feedback of the user - the capability of the application audience to give a rate and a written feedback about their experience with the application. It is then possible to read what people think about their experiences with their gamified healthcare and well-being applications and tools.

“Used the first time for mom and it was like playing a kids toy. I meant it was super easy to use. Even my mom felt zero pain (...)”, “User friendly and fun to use”, “Fantastic app which really helps to keep track of your numbers. The friendly and positive time really helped me when I was first diagnosed, and the challenges were a good way to enable me to think about my BG management. A few years after diagnosis, I still use this app for all my records and to help me to work out patterns and goals”. These are some of the positive user reviews of MySugr application that are public on Google’s Play Store (Google, 2020A). The most positive aspects seem to be in the opinion of the majority users that gave a review the easy and fun experience MySugr provides. But there are also negative reviews regarding the experience. “Interface is very confusing. I do not know how to use it and no walk through that I could find. Unfortunately it isn’t very intuitive”. “It’s not user intuitive and when I finally figured out how to enter my blood sugar level, it made an stupid audible LOLOLOL! Sound. Why is it making fun of me? I don’t consider my medical issue something to laugh at!”, “Hate the cutesy game (...), figure out dosage at 3am isn’t a fun game. Aggravated by the clutter and useless silliness of this app. Is this designed for preteens? I just need a log for adults”.

In fact, MySugr developers replied to this last review with the following: “Thank you for the feedback! It’s actually not something we can turn off, as he is the inspiration for the app itself. (...) We understand that our app won’t be a good fit for everyone, and that’s okay”. This is a great point, a gamified application meant to manage diabetes is not a good fit for everyone, some people prefer a more serious approach as the application has a direct impact on their daily routines and ultimately on their condition.

Nevertheless, MySugr is a great success, the vast majority of users highlight the easy to understand game-like experience as one of the best features of this application with an average rating of 4.6 out of 5 possible points in Google’s Play Store and a very high rate of positive reviews.

MindShift CBT, the gamified mobile application to help handling anxiety with a self-service approach, is also present in Google’s Play Store and although the general review is also very positive - an average score of 4.2 out of 5 possible points - the user reviews regarding the usability and experience spread on a very wide range between full approval and full disapproval (Google, 2020B). “Easy to navigate with simple yet effective knowledge and skills to learn and practice! Great app for setting goals, working through fears and other mental barriers for a healthier living. Highly recommend this app for all mental health uses.”. “I love this app. I have fear and anxiety issues due to trauma. I love the walk through when you’re not feeling well. It’s simple and easy to use and I even shared it with my daughter and niece.”. “Very well designed and smooth. Lots of great content and easy to access features.” These are some of the most positive notes about MindShift CBT user experience. But there are also some not so positive reviews. A user writes the following suggestion for MindShift CBT developers: “kill the goal scheduling, it actually sets up failure.” The main complaint of this user around goals and challenges is one of the core aspects of gamification. Given that MindShift CBT is aimed for users with anxiety disorders this can be counterproductive and cause even more stress to the user.

“This app looked promising when I installed it, however as I looked through the different categories it became clear that this app is suited for high school age kids. Might be incredibly helpful for this demographic but not for an adult." can also be read on Apple App Store about MindShift CBT where it is also available (Apple, 2020A). According to this user the interface is childish and not suitable for adults, a very similar critique some users also made about MySugr.

Strava, the fitness application, has also some reviews praising the gamified experience and how the challenges and badges are good factors of motivation (Apple, 2020B). "I have been using strava so much throughout this year to help me train with my cross county team. It is one of the best running apps out there and it really makes non runners like my mom want to get the virtual badges.". "The social aspect of biking got me to use this instead of MapMyRide. I love the badges and how motivational it is to beat your PRs and place in the top 10s.". But some users also feel that the interface is not good for them. "(...) It's also not got a very easy user interface, very complicated.".

Prognosis: Your Diagnosis is also available on Google Play Store and Apple App Store (Medical JoyWorks, 2019) and the reviews are generally very good - with an average 4.8 out of 5 on both marketplaces. "Probably the best medical app I've ever seen because it is designed more like a game. It does not bore you unlike other apps. Thank you whoever made this.". "I've played this game for awhile now. It is always a challenge but in a fun way. Has sharpened my skills.". "I'm not a medical student, but after playing Prognosis, maybe I'll become one! This game manages to make medical diagnoses into a fairly compelling game. Along educating doctors and medical students, I think this game would be a great way to stimulate interest in medicine for undergraduates. Having medical cases presented in a game setting certainly stimulated my interest in medicine."

Although Prognosis: Your Diagnosis is described as "designed for practicing physicians, medical students, nursing professionals and other healthcare practitioners" and it is not listed on the 'game' sections of both marketplaces, some people tend to see the application not as a serious learning tool but as a simple game and give good reviews based on that factor.

WHERE TO DRAW THE LINE?

Gamification is an approach with the ultimate goal of engaging users into the use of a tool transforming common and sometimes repetitive tasks into a game-like activity where rewards are given when a goal is met or a challenge is overcome. Like described above, this approach can be seen in some of the most popular applications in the market and the users seems to like it, especially when these applications are designed to help the users dealing with a health condition or maintaining healthy lifestyles. However, it's important to know who the target audience is and in what context the application is meant to be used before a software development company makes the decision to publish a gamified application.

Some users seem to really enjoy how gamification eases their lives, but usually that is seen among common users that use applications designed for non-professionals. The gamification approach is not seen with the same ubiquity in professional tools, especially in the health context. The further that gamified health applications have reached are the learning and training categories, it is really hard to find - if not impossible - gamified tools for activities such as patient and diagnose management or tools meant to be used in hospitals and clinics, especially in emergency situations.

In fact, designing and providing a gamified application to be used in such critical contexts raises a new level of questions starting by the obvious one: the ethics. Is it ethically reasonable to give healthcare professionals gamified tools to create engagement and fun use of tools that have impact on other people's lives? How would patients react if, in an absurd scenario, their doctor, nurse or healthcare technician were using a gamified application to help treat a serious and urgent situation related to the patient's health? Is it even serious to think that healthcare professionals need extra motivation to use their own tools? How would an hypothetical gamified version of healthcare professionals daily tools impact the data and the functionalities they need to execute their jobs? Is it ethical to award virtual badges to professionals that have good performance levels taking care of their patients? Is it reasonable to create gamified challenges around metrics like the counting of patients taken care in a single day or counting of surgeries in a month and encourage the user to beat these metrics day after day?

These are hard questions that may explain the lack of gamified tools and applications for the clinical environment. Most of them raise ethical issues and have a direct impact on patients and healthcare consumers' lives. On top of that, it is still hard to say if in general, a gamified application produces a better experience than a non-gamified application with the same functionalities. There is a certain resistance to apply gamification to what people normally call "serious matters", being health and well being very serious matters. The same reaction can also be seen in an area with a very large variety of gamified applications like finance that people tend to see as "serious matter", after all, money is a primary need.

"Looks childish, fonts and UI are too rudimentary. Money is serious business, for God's sake!" is one among negative reviews on Google Play Store of one of the most used gamified applications for finance called Monefy (Google, 2020C). There seems to exist a relationship between serious matters like healthcare and finance and gamified applications that give people second thoughts about how serious and committed a professional can be if he is using a gamified tool to proceed with what should be their primary focus.

It's clear that when it comes to gamified applications on markets and areas labeled as "serious", and more specifically on healthcare and well-being, a line can be drawn in order to divide users in two major categories: healthcare professionals and non-healthcare professionals. These two major groups are looking for different experiences when using their tools and applications. Healthcare professionals require reliable applications with trustworthy, fast and reliable information, while non professionals require fun and stimulating experiences that help them handle a condition or manage a disease. Which is the same to say that professionals don't require gamified applications as opposition to common users who do.

Moreover, there is an ongoing discussion around of what gamification really is: if a proven architecture of software development or a concept that works well for sales and marketing communication. One of the most prominent authors that states that gamification is nothing more than a sales strategy is Ian Bogost. He defends that gamification, despite of the context, is just an idea to advertise and sell software and not a honest way of software development (Bogost, 2015). The author goes even further and proposes a new label for gamification: "exploitationware". A choice of words and concepts that has been discussed by other authors in order to define what is in fact an approach in software development or a sales strategy (Todd, 2017). The fact is that there is evidence about the successful application of gamification as a sales strategy (Grobelny, 2018).

ALTERNATIVES TO GAMIFICATION

When it comes to user engagement and user experience on all sorts of applications, gamification is just a way of doing things. There are alternatives that aim for exactly the same goals using different approaches. When it comes to create a richer user experience and user interfaces aimed for engagement and easy of use there are a multitude of design systems exist to respond to these challenges by implementing well documented usage and communication patterns - just like gamification (Kholmatova, 2017). Although a design system is not a direct alternative to gamification, as it only provides base rules to design and implement an user interface leaving behind any business rule or usage strategy, its primary goal is to deliver a user friendly and easy to use interface that ultimately promotes the user engagement.

Some of the most used and popular design systems are sponsored by technological companies that provide all the needed tools and frameworks to implement their design systems. For instance, in 2014 Google presented what is now one of the most recognizable and used design systems in the world, the Material Design (Wilson, 2014). The goal behind Material Design is to create a good user experience across multiple platforms and increase engagement and productivity by providing a clean and predictable environment based on patterns and rules. Another well known design system are Apple's design, Microsoft Fluent and AirBnB design system, all of them cross-platform and implemented as industry standards to build modern, clean and fun user experiences.

Of course that it is possible to mix gamification with any of these design systems, it is always possible to implement challenges and game-like experiences including virtual badges and all the components of gamification along with a design system, however user engagement is always one of the most important concerns when developing a design system. If well implemented, the experience using an application that is built around the guidelines of one of these design systems, avoids the need of a gamified approach. This factor can be one of the answers to produce good and engaging interfaces for professional healthcare professionals without the ethical questions that gamification can raise and that were explored previously.

Another alternative to gamification can be the simple tracking of performance using dashboards, gauges, cards, progress bars and similar elements to produce interfaces that are easy to understand and use and that display information in an organized and intuitive way without pulling the user to a game-like experience. This approach is highly used in IT, especially in scenarios where the health or the general status of a system is critical and must be tracked continuously. Again, gamification is not a common approach in this type of scenario where the target user is a team of IT professionals that must be naturally motivated and engaged to keep systems working without the need for game-like challenges and virtual goals and badges. Keeping the system in good shape is the challenge itself and all is needed is a set of tools that provide the needed data and functionality needed by these professionals. Much like the scenarios described above with healthcare professionals in clinical or hospital contexts.

Taco Potze, co-founder of some companies in the field of blockchain, explains that the alternative for gamification can be more gamification (Potze, 2018). By applying some aspects of blockchain architecture to gamified products, users will be more engaged, especially if the rewards of a gamified experience have real world value. For instance, a user that earns a badge not only earns the badge but also earns a token or some kind of currency that can be exchanged by products or services. This creates an economy around the gamified experience that increases user engagement by creating real value. Although this approach can be easily applied to common users in most of the examples reviewed above, the same is not necessarily true when applied to healthcare professionals, which most certainly would bring ethical and moral questions.

Augmented reality, virtual reality and immersive experiences have also been successfully applied in healthcare contexts, especially in training and education. There are a multitude of examples in this area where the creation of new augmented realities or the full virtualization of a new reality results in a higher user engagement (Zhu 2014). Some studies refer the acceptance of these approaches by healthcare professionals if they are not flow-disruptive and provide some benefits the patient treatment

(Danciu, 2011). This means that the application of these three techniques have a potential application for healthcare professionals beyond education and training that can be used as an engagement strategy.

Other approaches and strategies to create user engagement are well know but not applicable to the healthcare context. For instance, the ‘slot machine effect’ of swiping down in the expectation of new content, very much used by social networks in mobile devices, creates a sense of continuous curiosity that engages the user and encourages to keep using the service in order to see new content. At the moment there are no examples of such approach in healthcare applications.

CONCLUSION

The needs of professional users and common users are very different when designing and implementing an application. Common users look for a fun and easy experience that makes them easily engaged with the application, while professional users look for reliable and useful information and functionality that must help them to execute their daily duties. Common users look for applications that are easy to understand and with little instructions as possible to start, professional users look for complete solutions that speak the same language as them and that provide all the details needed for each situation. A professional user is also a common user and ultimately nothing stops an healthcare professional from using gamified tools.

Applications like gamified fitness trackers were made for everyone, the majority of these applications don’t need any special context or instructions to be used and are suitable for anyone who has the slightest experience with mobile or web applications. Applications like patient managers or ECG interfaces were designed for professionals that know the technical details and language and they expect complex answers and functionality that help them reach their goals. In this case, the goals are already set outside the application, and the professional is already working to meet the goals, gamify a scenario already filled with goals and challenges will only create more complexity, entropy and most probably create new blockers to the daily work of these professionals that weren’t there in the first place.

Gamification is only one of multiple approaches, strategies and architectures available to software developers. The definition of the context and user types that will use a given application is of the most importance when defining and implementing a software product, especially in e-health, and for different scenarios different approaches must be taken. Gamification is for sure a welcomed strategy for most common users as proved by the general feedback, but it can be at the same time an issue for professional users. For that reason, gamification should be considered along with other strategies to be a possible response to a problem, taking always into account users and context. Rarely a single solution is the right response for all issues, gamification is just only one of the available responses to increase user engagement.

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KEY TERMS AND DEFINITIONS

Application: A computer program or software application designed to run on a device.

Design System: A set of components, patterns and rules that define the look and feel of an application.

Engagement: A metric used to understand how valuable an application is to a given user.

Gamification: The application of elements, strategies and patterns typically found in game-like applications in non-game environments.

Marketplace: Digital platform of content and application distribution.

Power User: A user that uses advanced and complex features of a system.

User Experience: Often abbreviated to UX, is the overall experience of a person using an application or platform and how that impacts the human-machine interaction.

Chapter 3
Structural Modeling and Analysis of Barriers Encountered in Gamification Applications in Health

Gözde Koca
Bilecik Seyh Edebali University, Turkey

Özüm Eğilmez
Bilecik Seyh Edebali University, Turkey

ABSTRACT

Applications (apps) offer outstanding opportunities for healthcare services to serve individuals in areas that do not involve technology that improve healthcare outcomes, and that strengthen community health. These opportunities are becoming more common, especially with the increasing use of mobile devices in many segments of society. On the other hand, there are many obstacles that directly or indirectly affect the process of implementing gamification applications. In this study, the authors use Interpretive structural modeling (ISM) and MICMAC aiming to reveal the relations of obstacles encountered, and also to find the root cause of barriers in gamification engagement through applications used in healthcare. Findings showed that the lack of functionality of the apps, having the highest driving power and lowest dependency, was determined as the root barrier whilst other barriers are also divided into levels.

INTRODUCTION

The widespread use of mobile devices, such as smartphones and tablets, increases the use of information technology in almost every field. One of the areas where mobile technologies are used is the health sector. Individuals using technology can track information, such as step counts, heart rate, and medication times, on their mobile devices. When the mobile health market is analyzed, applications (apps) developed for every age and need can be found. With advancing technology, the concept of gamification has come to

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the fore in applications that provide mobile health services. Gamification provides opportunities through motivation and rewards for individuals to follow their health. In gamification, using game techniques to make activities fun and attractive, users are encouraged to control their behavior and health. The most descriptive and widely used definition for the gamification approach is "the use of game design elements in non-game contexts". Gamification can be a useful and exciting tool in situations that require motivation, encourage learning, and aid in problem-solving and communicating with others.

Despite its growing popularity, there are many challenges (i.e., obstacles, barriers) that directly or indirectly affect the process of implementing gamification applications—in general, getting smarter in many areas with the use of technology, statistical monitoring, and analyzing increase. On the other hand, gamification as the health concept's motivation and learning basis provides a new model for individual's behavioral change. Grounded from the vast use of gamification in European countries, although the internet and app usage are increasing correspondingly, there is a lack of gamification usage despite the technological developments. Therefore, the need to address the very novel issue in the lenses of an emerging country occurred. For this purpose, the authors aimed to respond to the main research question of what could be the reasons that challenge the individuals to use mHealth gamification? Given the prevalence of gamification, the authors focused on this research on the population that uses mHealth gamification.

This chapter presents a literature review discussing the barriers to gamification addressed in this study. Questionnaires were created, and user opinions were used to define the relationship of these obstacles. Following the description of the research methods, variables that represent the complex system of gamification are analyzed. Numerous methodologies have been developed to assess the interaction of system variables. Interpretive Structure Modeling (ISM) was developed to identify complex systems. ISM is defined as a computer-aided methodology used to describe the relationships between system elements. It is applied using graph theory, group decision-making, computer applications help, and the social sciences. The analysis of MICMAC (Matrice d'Impacts Croisés Multiplication Appliquee a un Classement/Cross Impact Matrix Multiplication Applied to Classification) analysis is conducted by considering the effects and dependency levels obtained from the accessibility matrix calculated by converting the relationships into numerical values. After defining the relationships between the obstacles encountered in health gamification apps, the influence and dependency levels are determined for all variables in the whole system.

BACKGROUND

Gamification as a General Concept

Gamification rose as a trend around 2010 as it began to be used around the world. This term was first translated in 2002 by Nick Pelling (Pelling, 2011), but it was too early for the concept to be adequately adopted (Jakubowski, 2014). However, today it appears with increasing momentum.

In a very broad manner, the term gamification is used in education, technology, behavior-changing mechanisms in companies, marketing, and the commercial world. The technology's expansion has further become an industry, not only for inventors but also for academics interested in studying it as a scholarly subject. As more studies reveal gamification's efficient outcomes, more interdisciplinary questions are asked on where and how gamification can go forward. The overall concept of gamification can be framed as an incentive for influence. In terms of defining gamification, it is emphasized that the use of game-like rewards and incentives to motivate people toward the desired behavior and to eventually develop sustainable habits (Deterding, Dixon, Khaled, & Nacke, 2011; King, Greaves, Exeter, & Darzi, 2013). This definition has been expanded to further questions in behavioral science, as the creators and end-users of gamification apps are human. Therefore, the behavioral aspect of its adoption is embedded with many unrevealed questions about gamification itself. Those questions examine the use, drivers, and challenges, by whom it will be used, and where and how it will be used, among others. Gathering answers to these questions show us that gamification will be a long-lasting term within every aspect of human life.

The world's current social condition empowers humans to learn, create, and evaluate knowledge with prominent technological revolutions. The thought of enabling technology use has affected a wide age-range of people since the advent of smartphones. Technology user definitions shifted from adults (broadly) to people from approximately 3 years to 99 years. This shift occurred as smartphone usage emerged as an opportunity for various apps to promote change. Hence, this change ultimately led to the phenomenon of gamification, aiming to create positive engagement, retention, and loyalty around major societal and business activities that are parallel with the uncertainty and instability that humans face in the long term. This environment enables gamification to be a significant resource, as younger generations have been born into a digital world and hold different attitudes, beliefs, and behaviors than their predecessors.

For this reason, education has shifted from face-to-face instruction to experiencing and facilitating a new way of learning virtually, not only in professional training but also in innovations in kindergarten. As long as gamification exists, people learn, encourage each other, and achieve socially, as being social is crucial for human life. Real-life situations and role-plays can affect real-life activities, manners, attitudes, and behaviors. Since the cost of games decreases as the market grows (e.g., in terms of demand, devices, cheaper connections, etc.), gamification helps individuals forecast their future.

Gamification in Health

The issues of health behavior have been popular for a decade with the help of mobile technology innovations. Technology eases life in various ways, so as a very personal issue, health technology began with SMS texting to collect personal data and transformed into some interventions, such as preventing or even diagnosing diseases. In addition to the fact of the growing technology, the main reason for the attention to health gamification is the reality of the aging population of the world. The World Population Aging Report shows that the population over 60 years of age is nearly one billion and is expected to double by the year 2050 (UN, 2017). Even in the literature, the majority of studies focus on aging and older adults, for justifiable reasons, but mobile health applications and gamification are for everyone who acknowledges the importance of health. It should be emphasized that numerous academic articles have focused on the prevention and treatment of various illnesses and disorders. However, the main focus of the present study is to investigate mobile health app usage (mHealth) at the societal level, as the public embraces technology and health cognition spreads around the world.

Challenges of Gamification in Health

Integrating technology with health in the palms of a significant segment of the global population addresses human motivations in many ways. Although many industry players are working on the topic of gamification, explorations of the challenges in the healthcare context are still lacking. Although the main related challenges such as health literacy, info exclusion, informatics literacy, ethic and legal aspects, data protection, confidentiality are to be the potential challenges addressed in the technology-based themes, the authors intent was to discuss to identify the rationale to interpret the challenges that support and sustain motivation to use gamification or choose not to. Therefore, in this chapter, the criteria used to decide whether to utilize or quit health care apps were investigated to provide additional information in mHealth gamification. The authors argue that if the providers of mHealth know society's needs, the segment of the population that has the potential to use or is already using the app, will increase. The level of integration will be higher when stakeholders have details on how to overcome these challenges.

According to articles that discuss challenges in the use of mHealth in elder care, the emphasis is on the lack of personalization, meaning that the services were not up to par and did not meet the needs of the targeted population (Meza-Kubo, Morán, & Rodríguez, 2014; Alahäivälä & Oinas-Kukkonen, 2016; Whyatt, Merriman, Young, Newell, & Craig, 2015; Borghese et al., 2013; Konstantinidis et al., 2016; Konstantinidis et al., 2017; Ofli et al., 2015). As technology engagement is low among the elderly population compared to youths, many apps are not easily used without assistance (Borghese et al., 2013; Liu et al., 2014; Manera et al., 2017; Kitakoshi et al., 2017; Oña et al., 2018). Similarly, when the content of the game is not tailored for the right age group, challenges develop (Gerling & Masuch, 2011; Alahäivälä & Oinas-Kukkonen, 2016; Li et al., 2017; Whyatt et al., 2015; Konstantinidis et al., 2014; Li et al., 2018). Above all, lack of integration of new technologies is the most common challenge mentioned in the literature for the elderly. However, this is in contrast to youth, who have an advantage in the use of technology (O'Connor et al., 2018; Malwade et al., 2018; Alloni et al., 2017; Vette et al., 2015; Proffitt et al., 2015; Oña et al., 2018). Many challenges need to be considered in terms of supply vs. demand; in particular, scholars and app developers should examine whether the context of the app is inaccessible to some users, or whether offering the same features for all users would affect their engagement and distance them from the primary purpose of the gamification (Vette et al., 2015; Alahäivälä & Oinas-Kukkonen, 2016).

In Dawson et al. (2020), the challenges in terms of the strengths and limitations of a good mHealth app have been discussed. Through an inductive paradigm, the suitability of the mHealth tools was questioned, and through the previous evaluation tools and the literature, ten challenges were considered under four major categories—content, usability, feature, and other—as can be seen in Table 1, which are chosen for the challenges to be examined in this research.

Content is formed from four subcategories that encapsulate challenges that users face during their use of gamification-based mHealth apps. Information or evidence-based content describes an app's capabilities based on providing information or the techniques incorporated that extend to the relevance and comprehensiveness of the content. The behavioral change embedded in the content with the current disciplinary and evidence-based guidelines is examined through this challenge (Doak, Doak, & Root, 1996; Monkman & Kushniruk, 2013; Stoyanov et al., 2015; Michie et al., 2015). Literacy is also a fundamental challenge, and it concerns how the headings or topics guide the user to the next step in the app; reading level and locution are also essential issues related to the main content. Cultural appropriateness defines the level of coherence in logic, language, and experience. The content of an app could be designed very professionally with the latest knowledge or literacy; however, if the images, language, or desired change in behavior are not appropriate for the audience, the app's success will be in question.

Table 1. Description of barriers/challenges in gamification applications

Main Category	Barriers/Challenges	Identification
Content	B1	Lack of information and evidence-based content information
	B2	Literacy
	B3	Cultural appropriateness
	B4	Lack of content for the right targeted user
Usability	B5	Lack of functionality of app
	B6	The app is not easy to use
	B7	Lack of engagement/interactivity
	B8	Insufficient level of aesthetics/layout/animation
Features	B9	Lack of app-specific features
Other	B10	Source legitimacy in question

Source: Adapted from Dawson et al. (2020).

Usability is the second main category and is crucial in terms of creating a user interface. In gamification, usability deserves serious attention. The app's functionality is the bridge between the user and the app; the ease of learning, use, and the ability to adapt to the app and understand the instructions matters. The interactions, including taps, swipes, pinches, and scrolls, are checked by many users. Additionally, users selectively embrace apps that have easy registration and logins (simple steps). They prefer that data is entered once and then used on multiple occasions (mHIMSS App Usability Work Group, 2012).

Navigation is the challenge in gamification referring to other important aspects, such as numbered screens, numerous categorized topics, easy accessibility to the main menu, a functioning back button, useful links, and easy search button options (Monkman & Kushniruk, 2013). Another important challenge is the app's display, whether images facilitate learning, the use of contrast, open access for people with disabilities, large screens with fonts that are easy to read, and consistent styles. Interactivity or engagement refers to inviting users to share and give feedback, be printable or connected to media tools (e.g., Twitter or text messaging), and have audio and visual features. Similarly, usability functions as attractiveness, which is one of the primary determinants of attitude-related behavior, eventually affecting the human decision-making process (i.e., the halo effect).

In terms of features, there are some app-specific challenges, such as user privacy and security, and integration with other devices through Bluetooth or other new media like Twitter. Whether two-way communication is allowed or not, and whether or not the data can be documented efficiently to advise on the well-being of the person, is also a challenge of app features (Kumar et al., 2013; Donevant et al., 2018).

Some other challenges differ from, but also indirectly relate to, content, usability, and features, such as the legitimacy of health information. App creators must be aware of how different cultures may question the legitimacy of the information sources. Assumedly, many people in Western cultures may have a higher level of familiarity with academic or NGOs-based research; on the other hand, if a private company is the source of information, people may be more hesitant to embrace the accuracy of the results since corporate scandals have occurred. On the contrary, Eastern cultures are highly dependent on any information primarily sourced from the central government. As this presumption is not in this study's scope, it would be an exciting topic for further research. One other issue counted in this challenge is the cost and value of the app. Knowing that the purchasing of apps is increasing can be interpreted in various ways. The main driver of purchasing could be dependent on cultural characteristics, such as where the app has already been tried, or whether scientists have verified it or not.

METHODOLOGY

In this study, the authors are aimed to determine how the barriers/challenges encountered in gamification applications affect each other structurally and identify the root cause of the problems to determine how to take the first step to produce effective solutions. ISM and MICMAC analyses were performed to reveal the structural relationship between the barriers. Both structural methods give useful results in clarifying systems involving human and technology factors. In the literature, there are many studies that use these two methods together and emphasize the structure between the factors (Agi & Nishant, 2017; Gopal & Thakkar, 2016; Dubey et al., 2017; Raut et al., 2017). Similarly, in this study, since the relations between the barriers will be examined, ISM and MICMAC analyses will be handled together. To do so, an electronic questionnaire was designed to reveal the relationships between variables through four options (A is influencing B; B is influencing A; A and B influence each other; no relation between A and B) distributed through a purposeful sampling technique to 17 participants who have been selected as they have experienced or still use mHealth gamification apps in English language. For evaluation consistency, the participants are selected from IT experts to facilitate understanding the challenges and assess the questions' given correlation. Each participant has been asked for their spare time to be able to make the evaluations more accurate.

Analysis of Barriers with Interpretive Structural Modeling

ISM was developed by Warfield (1974a, 1974b, 1974c) in the 1970s to configure complex systems. ISM is a directional graphical representation of a complex system with iterative application of graph theory. It can be defined as a process that transforms vague and poorly expressed mental system models into well-defined models useful for many purposes (Warfield, 1974a). The output of ISM analysis consists of nodes representing system variables and links representing the directions of relationships between these variables. The model provides a hierarchical structure that reveals the contextual relationships between system variables. In this way, interpretable visual structures are created from models that are poorly defined or that are not systematically structured. The flow diagram of the eight steps of ISM presented in Figure 1 is adapted from the study of Çakırlı et al. (in press).

To create the ISM, firstly, system variables must be determined. The variables used in this study are the barriers encountered in the gamification applications listed in the background section and in Table 1. After determining the variables, bilateral relations were evaluated by experts. There can be a one-way or two-way interaction between variables, and variables can be independent of each other. The following notation is used to express these situations.

V: variable i affects variable j (there is a one-way relationship from i to j).
A: variable j affects variable i (there is a one-way relationship from j to i).
X: variables i and j affect each other (there is a bilateral relationship between i and j).
O: variables i and j do not affect each other.

A structural internal interaction matrix, shown in Table 2, was created using this notation. The evaluations in the matrix are shaped according to the responses of the majority of experts.

Table 2. Structural internal-interaction matrix created with barriers encountered in gamification applications

Barriers	B10	B9	B8	B7	B6	B5	B4	B3	B2
B1	A	X	A	X	X	O	A	O	A
B2	O	V	V	O	O	A	V	V	
B3	V	O	V	O	O	O	V		
B4	X	V	X	O	O	O			
B5	V	O	V	O	O				
B6	A	X	O	X					
B7	A	X	O						
B8	X	V							
B9	A								

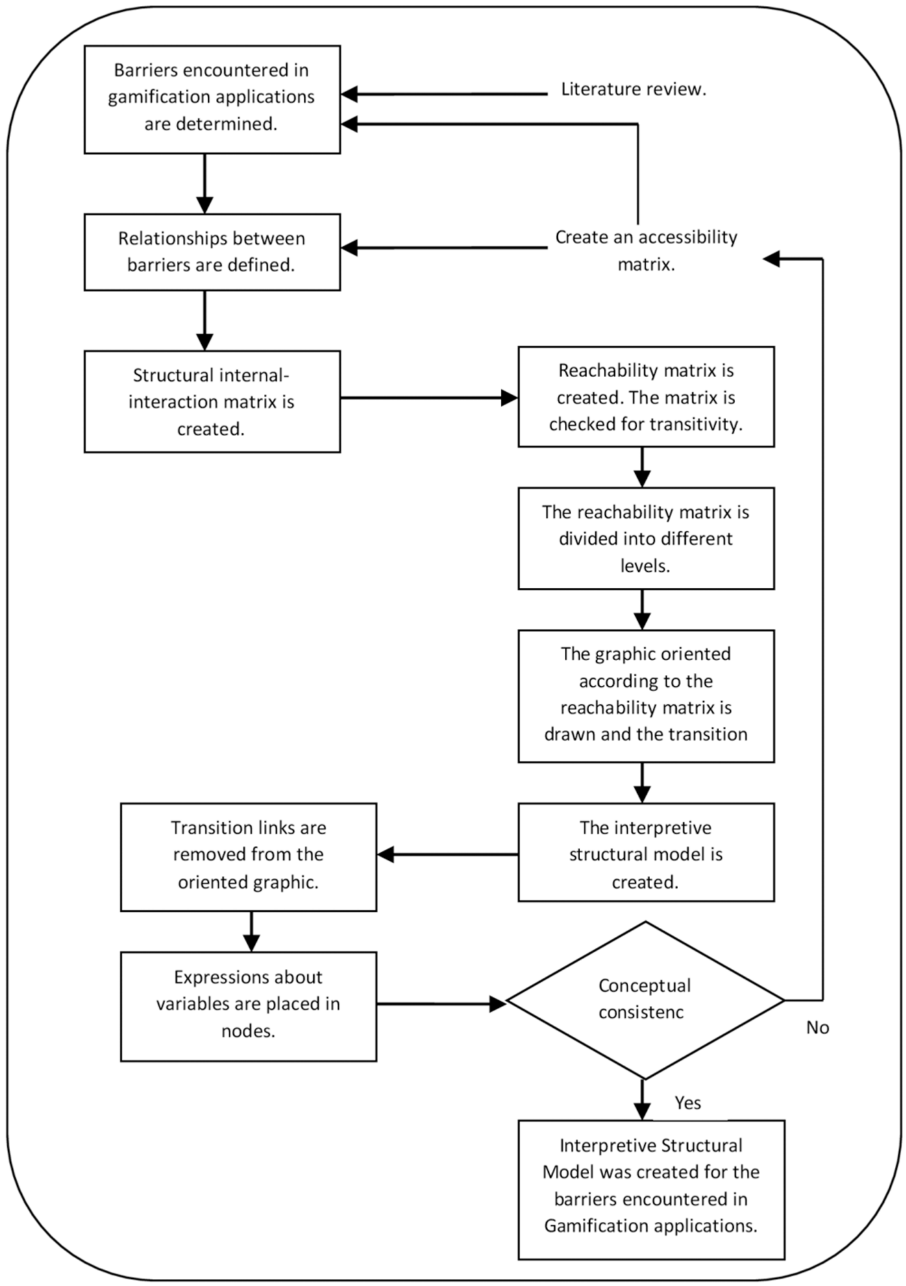
When the fourth stage is reached in the application of the method, a reachability matrix must be created. To create the reachability matrix, numerical values of 1 and 0 are used in the internal interaction matrix instead of the letters that express relations. Here, if variable *i* affects variable *j*, it is coded 1. If variable *i* does not affect variable *j*, it is coded 0. In this system, since the definition is made in one direction—from *i* to *j*—the entire matrix field must be filled. The matrix's diagonal elements will take the value 1 because each variable has access to itself (Hwang & Lin, 1987). Table 3 shows the initial reachability matrix created according to the system described above.

The transitivity feature of the connections between the variables must be checked. For example, a one-way relationship has been defined from the B3 variable to the B4 variable. A one-way relationship is determined from the B4 variable to the B1 variable. In this case, there is also a relationship from B3 to B1, according to the transitional property. The final reachability matrix in Table 4 was obtained by evaluating the relationships revealed in the final matrix as a result of repeated matrix multiplication operations until the reachability matrix became stationary.

The final reachability matrix is divided into levels by bringing it into a canonical form. For this separation process, the reachability set, antecedent set, and intersection sets of each variable must be determined. The reachability set consists of all variables that a variable reaches to and with the arrows coming toward it. The antecedent set consists of one variable, itself, and other variables that can access this variable. The intersection set is the intersection of its reachability and precursor sets for each variable (Malone, 1975). If the reachability set and the intersection set for a variable are equal, the level of that variable is *I*. Table 5 shows the leveling table for the initial state.

Variables at the *I* level (B1, B6, B7, and B9) will be at the highest level hierarchically. After determining the *I* level, the same process is repeated with the remaining variables. Table 6 shows the results of the second iteration.

Figure 1. Eight steps of the interpretive structural modelling
Source: Adapted from Çakırlı et al. (2020).



As can be seen in Table 6, the B4, B8, and B10 variables constitute the II level. After determining the II level, the same process is repeated with the remaining variables. Table 7 shows the results of the third iteration.

Table 3. Initial reachability matrix

Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
B1	1	0	0	0	0	1	1	0	1	0
B2	1	1	1	1	0	0	0	1	1	0
B3	0	0	1	1	0	0	0	1	0	1
B4	1	0	0	1	0	0	0	1	1	1
B5	0	1	0	0	1	0	0	1	0	1
B6	1	0	0	0	0	1	1	0	1	0
B7	1	0	0	0	0	1	1	0	1	0
B8	1	0	0	1	0	0	0	1	1	1
B9	1	0	0	0	0	1	1	0	1	0
B10	1	0	0	1	0	1	1	1	1	1

Table 4. Final reachability matrix

Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Driving power
B1	1	0	0	0	0	1	1	0	1	0	4
B2	1	1	1	1	0	**1**	**1**	1	1	**1**	9
B3	**1**	0	1	1	0	**1**	**1**	1	**1**	1	8
B4	1	0	0	1	0	**1**	**1**	1	1	1	7
B5	**1**	1	**1**	**1**	1	**1**	**1**	1	**1**	1	10
B6	1	0	0	0	0	1	1	0	1	0	4
B7	1	0	0	0	0	1	1	0	1	0	4
B8	1	0	0	1	0	**1**	**1**	1	1	1	7
B9	1	0	0	0	0	1	1	0	1	0	4
B10	1	0	0	1	0	1	1	1	1	1	7
Dependence power	10	2	3	6	1	10	10	6	10	6	64

Table 5. Level partition–iteration I

Barriers	Reachability set (R)	Antecedent sets (C)	Intersection set (RC)	Level
B1	1,6,7,9	1,2,3,4,5,6,7,8,9,10	1,6,7,9	I
B2	1,2,3,4,6,7,8,9,10	2,5	2	
B3	1,3,4,6,7,8,9,10	2,3,5	3	
B4	1,4,6,7,8,9,10	2,3,4,5,8,10	4,8,10	
B5	1,2,3,4,5,6,7,8,9,10	5	5	
B6	1,6,7,9	1,2,3,4,5,6,7,8,9,10	1,6,7,9	I
B7	1,6,7,9	1,2,3,4,5,6,7,8,9,10	1,6,7,9	I
B8	1,4,6,7,8,9,10	2,3,4,5,8,10	4,8,10	
B9	1,6,7,9	1,2,3,4,5,6,7,8,9,10	1,6,7,9	I
B10	1,4,6,7,8,9,10	2,3,4,5,8,10	4,8,10	

Table 6. Level partition–iteration II

Barriers	Reachability set (R)	Antecedent sets (C)	Intersection set (RC)	Level
B2	2,3,4,8,10	2,5	2	
B3	3,4,8,10	2,3,5	3	
B4	4,8,10	2,3,4,5,8,10	4,8,10	II
B5	2,3,4,5,8,10	5	5	
B8	4,8,10	2,3,4,5,8,10	4,8,10	II
B10	4,8,10	2,3,4,5,8,10	4,8,10	II

As can be seen in Table 7, the B3 variable constitutes the III level. After determining the III level, the same process is repeated with the remaining variables. Table 8 shows the results of the fourth iteration.

Table 7. Level partition–iteration III

Barriers	Reachability set (R)	Antecedent sets (C)	Intersection set (RC)	Level
B2	2,3	2,5	2	
B3	3	2,3,5	3	III
B5	2,3,5	5	5	

As can be seen in Table 8, the B2 variables constitute the IV level. After determining the IV level, the same process is repeated with the remaining variables. Table 9 shows the results of the fifth iteration.

Table 8. Level partition–iteration IV

Barriers	Reachability set (R)	Antecedent sets (C)	Intersection set (RC)	Level
B2	2	2	2	IV
B5	2,5	5	5	

Table 9. Level partition–iteration V

Barriers	Reachability set (R)	Antecedent sets (C)	Intersection set (RC)	Level
B5 E	5	5	5	V

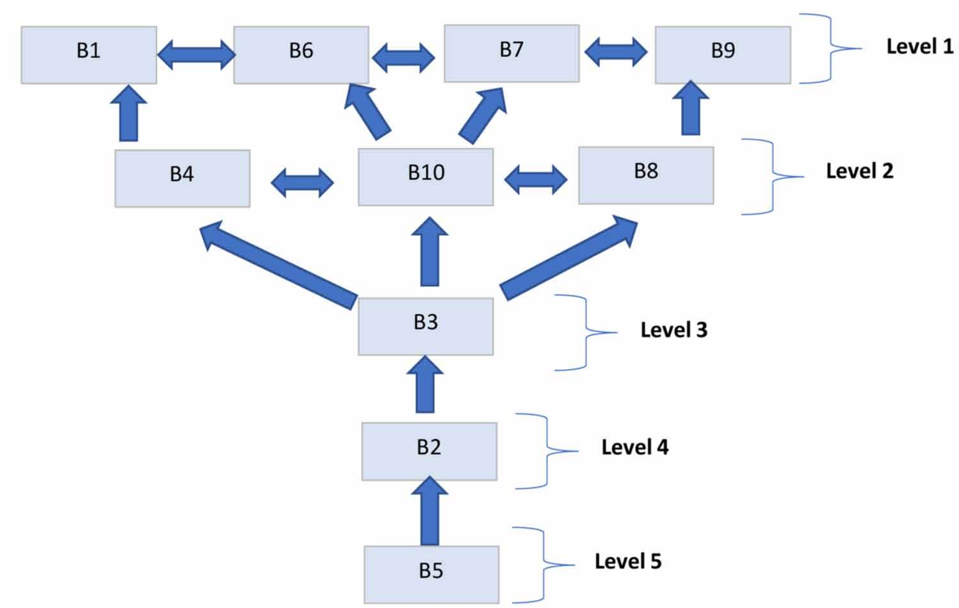
After determining the fifth level, the leveling process is terminated because there is no exposed variable.

After the separation process is finished, the final ISM is created. The resulting final model can be seen in Figure 2. Barriers at the top level of the model are lack of information and evidence-based content information (B1), the application is not easy to use (B6), Lack of engagement/interactivity (B7), and lack of some application-specific features (B9). These barriers affect each other and are hierarchically affected by lower levels. Referring to the four given barriers obtained from the analysis, it can be seen that the most common barriers are embedded in the fault of the gamification applications.

Lack of content for the right targeted user (B4), insufficient level of aesthetics/layout/animation (B8), and Source legitimacy in question (B10) are the second-level variables. In addition to being related to each other, the barriers encountered at this level affect the barriers at the first level, directly or indirectly.

Cultural appropriateness (B3) is at the third level, Literacy (B2) is at the fourth level, and Lack of functionality of app (B5) is at the fifth level. The B5 barrier encountered at the last level is located at the bottom of the building and is not affected by the upper-level barriers.

Figure 2. The final ISM



Analysis of Barriers with MICMAC Analysis

MICMAC analysis was developed by Duperrin and Godet in 1973. The MICMAC analysis aims to determine the driving and dependent power of the factors discussed in the problem and classify them into four groups. These four groups consist of independent factors, dependent factors, related factors, and autonomous factors (Ünlü & Tosun, 2017; Khanam & Siddiqui, 2015; Chander et al., 2013). The four categories are as follows:

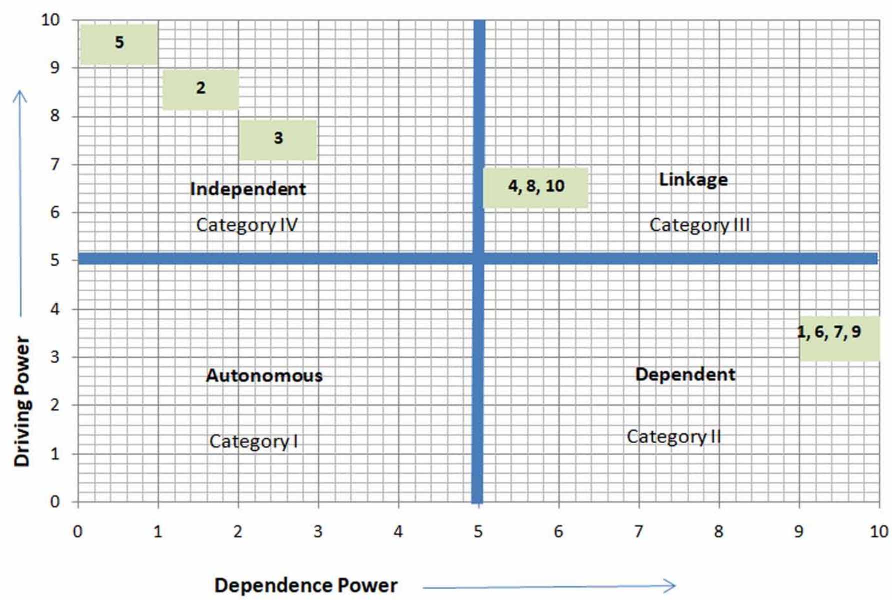
- **First Category:** Variables with low dependency and low driving power. These variables are called autonomous variables.
- **Second Category:** Variables with high dependency but low driving power. These are called dependent variables. These variables are strongly linked to the entire system.
- **Third Category:** These are the categories that have high driving power as well as addiction. These are called linkage variables; any effect on them affects higher-level variables, but these variables

are dependent on lower-level variables. These factors are different from other factors because any action on these factors will have an impact on other factors and have a feedback effect on them.

- **Fourth Category:** These are called independent variables due to low dependency and high driving power. These variables are the most important variables, as they strongly affect other variables. They are also considered entry-level variables in the system.

Variables are shown in a MICMAC diagram as in Figure 3, considering the effect and dependency levels obtained from the final accessibility matrix.

Figure 3. MICMAC diagram



According to Figure 3, there is no barrier in the first category. Lack of information and evidence-based content information (B1), The application is not easy to use (B6), Lack of engagement/interactivity (B7), and Lack of some application-specific features (B9) in the second category are factors with high dependency but low driving power. These barriers are strongly linked to the entire system. Lack of content for the right targeted user (B4), Insufficient level of aesthetics/layout/animation (B8), and Source legitimacy in question (B10) barriers in the third category have strong driving power as well as high dependency. Any effect on this factor affects the top-level variables. Any movement on this factor will have an impact on other factors. Literacy (B2), Cultural appropriateness (B3), and Lack of functionality of app (B5) in the fourth category are factors with low dependence but high driving power.

SOLUTIONS AND RECOMMENDATIONS

This study offers some insights into the design, use, integration, and behavior-changing mechanisms of gamification. Within the scope of the results, the importance of the main categorization of the barriers/challenges, content, usability, features, and other factors has been formulated systematically. Based on their driving power and dependence, ten challenges have been identified, and their importance has been prioritized.

The app's lack of functionality was identified as the most substantial challenge with the highest driving power and lowest dependence. As a usability challenge, one can refer to the ease of use of the app, the clarity of the menu, log-in simplicity, and the single-instance data entry as influences on the audience who tend to use the gamification app. Remembering that the result is limited to users' perspective in Turkey, functionality is one of the top issues when considering who your targeted audience is. Therefore, this finding is very similar to other related studies. Literacy, being in the content category, has become the second-highest driving power but lowest dependence. Like the functionality challenge, we can understand that people are checking the ease of use of an app with clear literacy. Likewise, cultural appropriateness has been the third independent challenge, with high driving power. This finding can be interpreted as the girder, as it has diverted into three other challenges in linkage and dependent challenges sections. Having moderate driving power and dependence, the correct target audience, the legitimacy of the sourced knowledge, and the esthetics/layout/animation become the important challenges belonging to different categories. However, those challenges are linked to others that are placed in the dependent field. The dependent field can be identified as the app not having app-specific features or not being interactive enough, or if the information content is lacking and it is difficult to navigate the app. In conclusion, people find it difficult to embrace the mHealth app in the long run.

None of the criteria evaluated was primarily associated with the related common challenges such as security issues, feasibility of costs, ethical and moral issues, intrusion of lives, data protection and confidentiality, etc. As reminding the main scope was to highlight the rationale of gamification challenges via an emerging country example only with functionality, usability, feature and other could be counted as the limitation of this research compare to given related common challenges.

This research cannot suggest any ranking, such as indicating the importance of the content or features of the app, seeing that the challenges are related to one another. However, by addressing the various challenges, the authors can underline the current challenges that would help the app designers, NGOs, commercial companies, healthcare providers, managers, and policymakers in the same field. From the strategic management point of view, one can acknowledge the importance of challenges in terms of influencing each other (driving power vs. dependency). Moreover, the results apply to many areas, such as content, usability, features, and other categories, in gamification app usage. This contribution may offer a list of challenges in terms of gamification to create a native app that may help to overcome functionality and usability criteria. Furthermore, results analyzed in this research are away from the reductionist approach that the usability of an app is the most important driving power, vice versa. The connection between the given challenges offers a map to analyze the participants' current situation, on the other hand, which could also be the drivers of embracing of gamification if overcome.

FUTURE RESEARCH DIRECTIONS

Gamification is a novel way of learning, acknowledging, and absorbing new information and seems to be more popular as digitalization increases. As it is trending within this book, there is no doubt that it will become more popular in the forthcoming years. There has been significant research progress in mHealth in the developed economies; however, it is a novel topic for emerging economies. Therefore, the amount of research conducted will be increased following a nation's development. However, during the establishment of this book, the authors struggled against COVID-19, as did the rest of the world. Having witnessed the change from what was normal to the global "new normal" through digitalization and acknowledging the importance of the Internet in our lives, the authors believe that mHealth awareness has increased in these isolation times. The use of IT has broadened the minds, and the world has become even flatter due to the COVID-19 pandemic. Learning and teaching platforms were transformed urgently to cope with the change. As time has passed, gamification has been found to be a powerful way to teach various topics, from how to wash our hands to learning coding with algorithms for kids. The term gamification is better known among younger generations.

Compared to some positive effects, we have also been faced with negative effects. As people over the age of 65 have stayed at home, the population faced psychological and physical problems due to lack of movement. This threat seems to be a good opportunity for mHealth apps, as the awareness and the usage count of apps have been increasing. As a result, the population that has never heard of gamification and mHealth apps consequently became more aware of the app world.

This research has some limitations. The majority of the mHealth apps are in English, so the participants in this study do not reflect Turkey as a whole. Optimistically, the research highlights the gap of gamification in the health app, as it is a promising sector due to the aging population.

Further, through subjective judgments, ISM has been used to develop a model of ten challenges. The number of challenges can be increased and different techniques can be used to develop more models. Various assessments can be done with qualitative data, as well. Gamification seems a fruitful topic. In terms of humans' well-being, the research can be done with people from kindergarten-age children to seniors, as it enables lifelong learning.

CONCLUSION

This research identifies the challenges of adopting a mHealth gamification-based app in the scope of an emerging country. The functionality, the literacy, and cultural appropriateness of an app, influence the other given challenges. If the difficulties addressed are to be overcome by the managers, decision-makers, and designers of commercial companies or government agencies, the integration of the aim of health—the idea of well-being—will embrace the increasing number of end-users. In this context, this research assumes contextual interdependencies of given challenges. Furthermore, by offering a map of challenges to the mHealth sector, the importance of levels from the producers' minds to end-users will be acquired, as gamification is still a growing phenomenon.

It is important to note that this chapter of the book argues that gamification apps should be investigated both nationally and internationally. Within the national context, an emerging-country perspective, it can also be concluded that the *attractiveness* of an app is the driving power of the other challenges. Attractiveness is an acknowledged concern in the behavioral discipline, as attitudes transform into behaviors, and the attractiveness of an object/person is a cornerstone of attitude formation.

In terms of this chapter's implications, the challenges influence others through driving power vs. dependence power. This point of view can increase the efforts to overcome difficulties investigated from organizations to the end-customer in the value chain. Another important aspect is to see a map of the challenges as a holistic view, leading to the desire to use Twitter, Whatsapp, and other integrated apps, as influenced by cultural appropriateness; however, the app's functionality is seen as the antecedent challenge.

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KEY TERMS AND DEFINITIONS

Gamification: The use of elements of game-playing in another activity, usually to make that activity more interesting.

Halo Effect: The tendency for an impression created in one area to influence opinion in another area.

Interpretive Structural Modelling (ISM): A methodology for identifying relationships among specific items that define a problem or an issue.

MICMAC: Involves the development of a graph that classifies factors based on driving power and dependence power. An analysis used to classify the factors and validate the interpretive structural model factors in the study to reach their results and conclusions.

Mobile Health (mHealth): The application of mobile technologies for healthcare services (e.g., delivery of low-cost tools for effective disease diagnosis, prediction, monitoring, and management).

NGO: Non-governmental organization is an organization that operates independently of any government, typically one whose purpose is to address a social or political issue.

Chapter 4
Learning Systems and Gamification:
Blending Augmented and Virtual Reality With Gamification Strategies

Barbara Cleto
https://orcid.org/0000-0003-1536-5881
Escola Superior de Media Artes e Design, Portugal

ABSTRACT

Given the changes that have been recently felt and the transformation of the classroom from a physical space, with one teacher and a set of students, to a mediating platform through which learning and teaching are performed online, it is necessary to get acquainted with the contexts in which these platforms are implemented and how to use them, as well as with models and systems of e-learning, b-learning, or m-learning. While looking for solutions that allow to implement and use gamification for online learning, one also intends to get acquainted with (some of) these platforms, as well as to integrate and combine "new" technologies such as augmented reality and virtual reality with gamification strategies for e-learning. In order to do so, this chapter presents a systematized reading of the studies that was carried out on this particular subject and of what has been published on this theme.

INTRODUCTION

In the days that followed the closure of schools, teachers brought up many questions that can be divided in two major groups: those related to technology and those related to pedagogy. Many asked themselves: which platform to use? Which apps? What strategies? How to communicate online? How to keep students motivated? How to communicate content? How to assess? How to combine and integrate pedagogy and technology? Many of these questions are not new and teachers face them daily and, particularly in an online context, they tend to become more prominent.

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One of the major educational challenges that teachers face is to find methodologies and practices that are innovative and creative that allow students to significantly learn (Cleto, 2020). It is crucial to developed new methodologies that allow to engage students and to motivate them towards learning, by easing the process of understanding and, more importantly, by helping them to assume the responsibility for their own learning in the future (Gardner, 1993).

In order to do so, it is (also) necessary to engage and prepare teachers for that process (Cleto, 2020), by giving them training so that they can create and develop educational content that makes the learning/ teaching process more effective, by making it more interesting and appealing, optimising the learning process in order to make the student the responsible for his/her own learning process (Gardner, 1993). These educational resources must be developed so that they allow the student to visualize, explore and handle the contents (Papert, 1993) in order to act upon the subject of study, while changing it, transforming it and understanding it (Appleton, 1993).

It is the school's role to be aware of the processes of change and it is fundamental that it increasingly transforms into a place in which students find their own space while acquiring a full and significant education (Cerqueira, Cleto, Moura, Sylla & Ferreira, 2020). Schools are expected to innovate and change paradigms and regardless of some resistance to change (Lagarto, 2013), some responses to the challenges that teachers and schools face have appeared, such as the flipped classroom format (Tucker, 2012; Mohan, 2018), which have been progressing side by side with the exploration of expanding mobile technologies (namely smartphones and tablets), as schools adopt (Cerqueira et al., 2020) Bring Your Own Device (BYOD) (Attewell, 2015), as well as Serious Games (Zyda, 2005) or gamification mechanics (Deterding, Dixon, Khaled, & Nacke, 2011).

Virtual environment technologies, Augmented Reality (AR) and Virtual Reality (VR) have also been gaining interest and recognition as an educational resource, for the great potential they present regarding their applicability and utility (Cerqueira et al., 2020), being potentially used in classrooms (Velev & Zlateva, 2017) as a complement to more traditional models (in traditional classrooms with aligned tables) or in modern models (as in flexible learning spaces). The use of Virtual Reality or Augmented Reality in the learning-teaching process implies the use of mobile apps, which allows to put cell phones at the service of education (Miguel, 2018), while taking advantage of those small computers that (most) students carry with them, turning them into teachers' powerful allies (Lagarto, 2013).

The growing increase of technological resources and the ease of communication changes the roles of teachers and students (Moura, 2012). It is the student and not the teacher who controls the process of learning (Bidarra & Figueiredo, 2016). Information is now available online, in an interactive and shared way, anywhere and anytime. Students are not mere users anymore and have become prosumers (Tapscot, 2009), reconfiguring and even producing and distributing content (Tapscot & Willimas, 2006; Tapscot, 2009), which is then shared, turning them into co-creators and co-authors (Zwick, Bonsu e Darmondy, 2008, p. 163-196; Ziemba, 2013; Ziemba e Eisenbardt, 2014) and producers of multimedia material, players in virtual environments, holders of updated information and tireless communicators in permanent mobility (Bidarra & Figueiredo, 2016).

This situation challenges schools and incites them to change and to include other models (e-learning, b-learning e m-learning) that allow students a higher level of participation, inside and outside classrooms and a process of learning based on challenges, problem solving and critical thinking (Moura, 2012).

BACKGROUND

One has witnessed a massification of new equipment (hardware), electronic devices (smartphones, tablets, smartwatches, video game console) of reduced dimensions, with similar characteristics to computers when it comes to the ability to process information and to communicate in different digital media (Cerqueira et al., 2020). The use of these devices and the availability of new programmes and apps (software) constitutes an unique opportunity for online learning (Bidarra & Figueiredo, 2016) that exceeds the use of Learning Management Systems and now includes games, social media and other shared environment (Squire & Dikkers, 2012). These "new" virtual environments give a sense of empowerment of "learning by doing" or "learning by playing" (Bidarra & Figueiredo, 2016).

Learning Management System (LMS)

Learning Management System (LMS) or Virtual Environments for Teaching and Learning are software apps or technologies based on the Web that allow the teacher to create and distribute didactic materials, to establish communication through chats and discussion forums, and to monitor, oversee and evaluate the students' participation and performance (de Almeida Pacheco, 2014). However, these platforms are often used as a repository of texts and presentations or videos of face-to-face classes, with a predominance of resources that lack interactivity (de Almeida Pacheco, 2014), which may explain the lack of engagement from students (Wiley, 2000). These management systems, like Moodle or Blackboard, help teachers to create and manage online courses, while allowing them to have access to a variety of resources (Graf & Liu, 2008), including solutions that use gamification as a way to assess and give feedback in real time to the students on the work that they have carried out (Ramos & Marques, 2017).

Gamification in Education

Gamification consists on using and including elements of game design in contexts that are not related to games (Deterding, Dixon, Khaled & Nacke, 2011). The use of elements that are characteristic of digital games such as goals, rules, feedback – bonuses, scores, awards, trophies, badges (McGonigal, 2011) – challenges and levels are used to engage, motivate and incite students to execute tasks beyond the domain of games and videogames and in this particular case, the performance of tasks for learning (Ramos & Marques, 2017). These elements are so essential that only when all of them are present (Ramos & Marques, 2017), can one properly consider it gamification (Kapp, 2012; Kapp, Blair, & Mesch, 2014) and achieve positive effects when it comes to the level of commitment when performing the tasks that are proposed (Gomes, Gomes, Figueiredo, & Bidarra, 2014, p.386).

When properly integrated and idealized, and with well-defined educational goals that take into account the skills that students are expected to develop and learn, gamification activities can motivate students, resulting in a deeper level of commitment while performing learning activities (Hamari, Koivisto & Sarsa, 2014).

Nowadays, and more than ever, games are invading schools (Ramos & Marques, 2017); commercial games are being used and explored as educational resources in classrooms. One of these games is Minecraft: given the success of its use in an educational context, Microsoft has made available an educational version called Minecraft Education Edition (Cerqueira, Cleto & Sylla, 2018). Games or gamified activities, when accessible through computers or mobile devices, have been contributing for the development of new learning environments and interactive learning scenarios (Ramos & Marques, 2017).

BYOD and M-Learning

Mobile learning or m-learning and BYOD (Attewell, 2015) have been growing both in visibility and relevance within formal contexts of learning (Miguel, 2018). M-learning can be defined as “the use of mobile technologies, isolated or combined with other information and communication technologies that allows people to learn anytime, anywhere” (UNESCO, 2014).

By using their own mobile devices, students are developing digital skills: by taking photographs, recording sound or video, editing and sharing content in real time, they are using these devices as learning tools, given that they are creating their own learning materials. The same happens when they have access to educational content created by others, such as when using (some of the) existing apps that were developed for various school subjects (Miguel, 2018), and consequently facing these devices as more than just a tool for mere fun, to access social networks, or that allows them to play (Attewell, 2015).

However, there are some challenges that must be taken into account, namely: i) not all students own similar devices, ii) internet access and speed (at home and at school), iii) technical problems, iv) fear (by teachers and parents) that using mobile devices may be a source of distraction and fun (Attewell, 2015).

Using smartphones enables the access to innumerous resources and may result in a more practical, personalized and student-centered process of learning (Miguel, 2018), and it is in this context that augmented and virtual reality apps with educational potential are used.

Virtual Reality and Augmented Reality (for Learning)

The use of Virtual and Augmented Reality technologies in educational contexts contributes to increase the students’ motivation and collaboration, improving their performance and consequently improving the process of learning (Martín-Gutiérrez, Mora, Añorbe-Díaz, & González-Marrero, 2017; Wu, Lee, Chang, & Liang, 2013). The use of such technologies incites students to assume a more active role in learning by providing the ability to autonomously explore the virtual world, while making decisions based on interactions in real time with the world that is being visualized, making them the protagonists, through “first person experiences”, of the process of learning (Martín-Gutiérrez et al., 2017).

The use of the app Google Expeditions, which can be explored in VR mode (figure 1), by using, for instance, Google Cardboard glasses, or in AR mode (figure 2), and that aids the exploration of places and contexts that could not be explored in any other way (Miguel, 2018), enhances communication skills, and the sharing of ideas, concepts, experiences and artifacts, besides awakening the students’ curiosity and interest (Parmaxi, Stylianou e Zaphiris, 2017).

The student is at the center of the learning process, while the teacher takes the role of a guider or supervisor of the learning process (Series & Klampfer, 2017; Vilaça & Felinto, s/d.).

There are countless Virtual Reality apps that can be used for educational purposes (Pilgrim & Pilgrim, 2016; Series & Klampfer, 2017; Brown & Green, 2016; Stojšić et al., 2017). It is possible to “go inside” the human body and to see it working, from organs to cells, with apps such as InCell, InMind, Anatomy VR (Miguel, 2018).

Augmented Reality apps for education are mainly found in serious games (Pellens, Hounsell, & Silva, 2017), augmented reality books (Bakri, Marsal, & Muliyati, 2019) and even clothes (Figure 3), in apps with georeferencing (Behzadan, Menassa, & Kamat, 2018) and interactive visualization of 3D objects (Goh, Sunar, & Ismail, 2019).

Figure 1. The Heart (Google Expeditions, in VR mode)

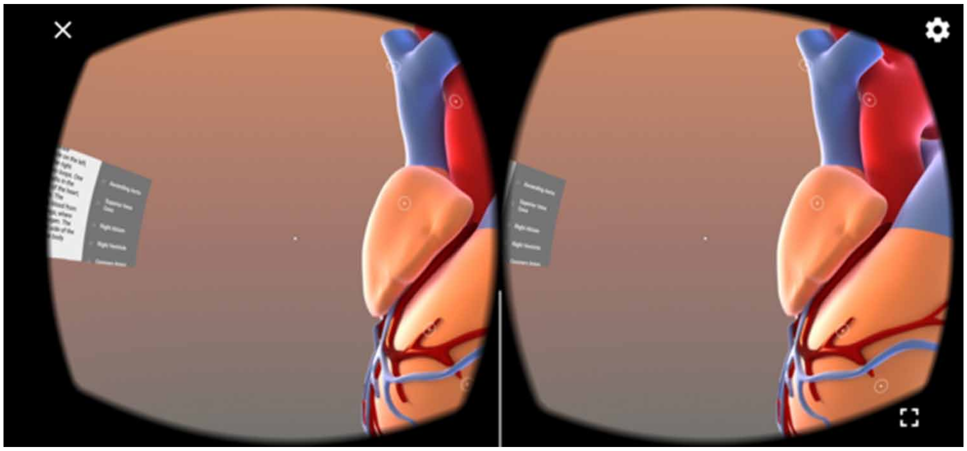


Figure 2. Major Human Organs (Google Expeditions, AR mode)

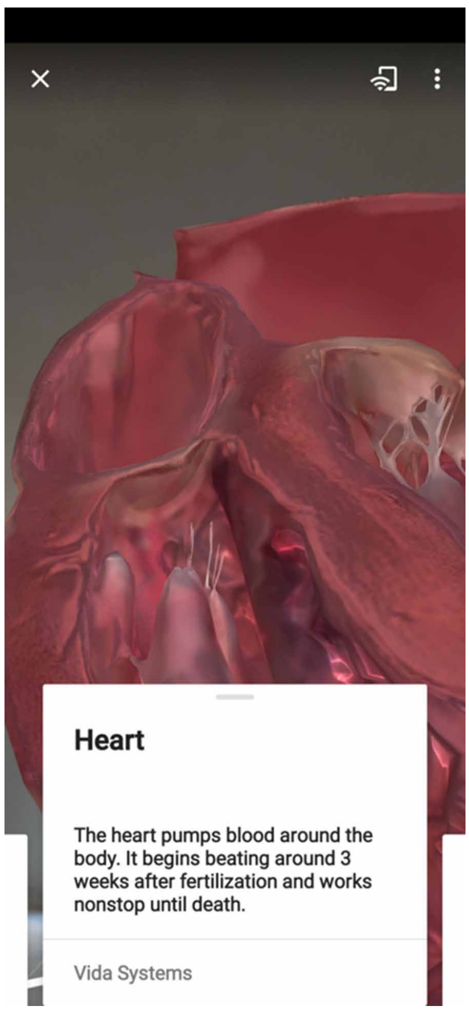
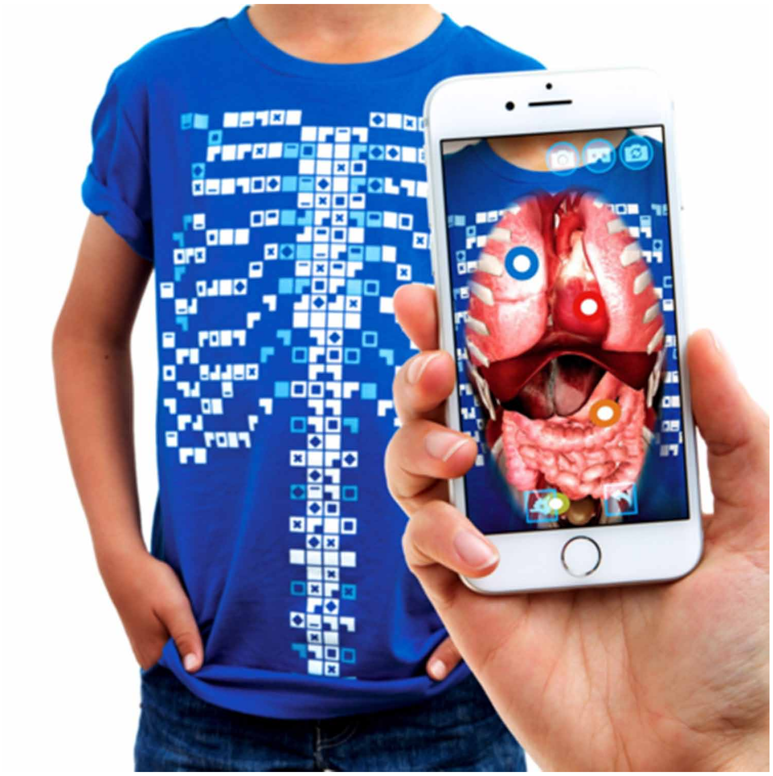


Figure 3. Major Curiscope's Virtuali-Tee



These apps are particularly adequate for special visualization, offering advantages over other forms (Cerqueira et al.,2020) such as printed books, since they simplify the visualization and exploration of 3D models, allowing to simulate dynamic processes (to incorporate animations) that are not visible in real life (Duenser, Walker, Horner, & Bentall, 2012; Kaufmann, 2006). They also enhance the capacity for abstraction and consequently the perception of the shape of the three-dimensional object (Wu & Chiang, 2013), reducing and liberating the cognitive load and cognitive resources (Bower, 2014, Kesim & Ozarslan, 2012).

It is also possible to explore some systems of the human body in AR, by simply using a search engine (figure 4).

However, there are some factors to take into account and that explain the lack of use of these apps so frequently, namely, a sense of discomfort – dizziness and nausea that some people experience when using virtual reality glasses (Cardoso, 2015; Rupp et al., 2016[a]) – the fact that combing real and virtual objects can create confusion (Wu, Lee, Chang, & Liang, 2013; Khan, Johnston, & Ophoff, 2019) demanding more time from users to get acquainted with this type of technology and to feel more comfortable while using it (Gopalan, Zulkifli, & Bakar, 2016; Khan, Johnston, & Ophoff, 2019), the need to have smartphones that are compatible and the existence of a well-functioning free WIFI connection (Stojšić et al., 2017), and the time to prepare this type of classes (Castaneda & Pacampara, 2016). In order to use this type of technology, teachers must be familiar with it and know how to use it; many times, the lack of preparation makes teachers resistant to using it (Martín-Gutiérrez et al., 2017; Hussein & Nätterdal, 2015; Attewell, 2015).

Figure 4. Major Google search AR

Gamification with AR and VR

These two types of technology are rather different from each other: AR allows to integrate virtual elements in a real environment, complementing reality instead of fully replacing it (Azuma, 1997). Reality is not replaced by what is virtual; instead, there is an augmentation and overlap of virtual information over the real world and real time interaction controlled by the user (Liarokapis, Macan, Malone, Rebolledo-Mendez & De Freitas, 2009). It creates a fully environment interactive in which reality is reinforced with virtual information in real time (Kesim & Ozarslan, 2012), without the immersion of the user as it happens in VR. VR enables an artificial simulation generated by a computer in which a real environment can be recreated or an imaginary world can be created (Gandolfi, 2018; Velev et al, 2017). Both allow to visualize and interact with virtual objects, those same objects that are often not accessible in real life, providing a safe, controlled, flexible, and intuitive environment in which to experiment, saving time and resources (Tori & Hounsell, 2018). Both turn the experience from static to interactive in real time, while increasing efficiency and the appeal of learning and teaching, providing a process of learning made through discovering, with a strong interactive component, by allowing the use of gestures (a natural way of interaction) and the abandonment of more common devices such as the keyboard and the computer mouse (Leitão, 2013). These technologies also enable great cooperation and collaboration, given that everyone experience, in real time and simultaneously, the same experience (Leitão, 2013).

By associating gamification strategies with Augmented and Virtual Reality, students are provided with resources that they can effectively work and cooperate in order to solve significant problems and build their own solutions, narratives and connections (Schrier, 2006).

One gamification activity with Augmented and Virtual Reality that meets all these requirements is Educational Escape Room.

Educational Escape Room

The dynamics inside a classroom are changing and teachers are looking for alternatives to expository lectures. Maker culture (Anderson, 2014) and "learning by doing" is now an available option. The co-production of knowledge leads to the rise of new approaches: Project Based Learning (PBL), Game Based Learning (GBL) (Prensky, 2001), gamification (Deterding et al., 2011), and, more recently, Escape Room (ER) for educational purposes (Moura, 2018).

In medicine, some studies that have been conducted (Hermanns et al., 2017; Lázaro, 2019) follow this approach; their results show a higher level of engagement from students in the activities, the development of communication and problem solving skills. The authors recommend the use of Educational Escape Rooms in areas that, traditionally, demand readings and memorization of contents, given that it was verified that students learnt the subject's contents while applying them (Moura, 2018).

Application to Education (in Medicine or Biology)

There are several areas in which Augmented and Virtual Reality can be applied, including medicine, manufacturing, aeronautics, robotics, entertainment, tourism and more recently, social networking and education (Bower, et al. 2014). The potential of using these technologies for educational purposes has been discussed in this article and it is possible to conclude that they motivate and enhance the students' level of commitment, while improving their performance and encouraging them to face learning more positively (Bacca, Baldiris, Fabregat & Graf, 2014). Moreover, they place the student at the centre of the learning process (Bell & Fogler,1995) while providing them with interactions and visualizations that are not possible in the real world (Duenser et al., 2012). They also allow students to simulate and practice surgeries without any sort of risk for the patient (Martins, 2018), transforming medical training in a safe and efficient process with less risks (Agune, Rodrigues, Rone, & Notargiacomo, 2019), highly accessible (Papagiannakis, Lydatakis, Kateros, Georgiou & Zikas, 2018), and economical with reduced costs (Agune et al., 2019). After including gaming strategies it was verified (Agune et al., 2019) that students' behaviour had changed and that they were more engaged, motivated and attentive. Augmented and Virtual Reality technologies are also used in medical treatment, mainly in psychological or psychiatric illnesses such as in the treatment of phobias (Martins, 2018).

CONCLUSION LIMITATIONS AND FUTURE WORK

This chapter is merely the beginning of what is intended to be a long term study that will analyse the ways in which to implement and integrate Augmented and Virtual Reality with strategies of gamification in digital platforms of learning management. One started this article by defining the concepts that are associated with this subject, by recurring to studies that have been conducted, and by pointing out some ideas that may help to thread paths for using AR and VR resources to promote the integration of mobile devices, real and virtual environments and learning and teaching environments (blended learning and m-learning) in order to knock down the classroom walls, connecting schools and the community (Squire, 2013).

As future work, it is intended to explore and develop AR and VR gamification activities for mobile devices.

There are many digital tools designed to create gamification activities as well as a significant number of apps and platforms for the development of AR and VR apps and content.

Open-source or free user-friendly platforms with an intuitive interface must be preferred when developing any resource that makes use of Augmented and Virtual Reality (Bidarra & Figueiredo, 2016).

To develop AR apps, QR codes can be used, by adding a layer of text, image, video or a link for a webpage with more information about each learning activity (Bidarra & Figueiredo, 2016). Images can be used without recurring to markers or a QR code to overlap a layer of information with text, animations or videos in order to provide clues to those performing the activity (Bidarra & Figueiredo, 2016). Markers can either be used or left out to show 3D models that can be manipulated so that they can be seen from different perspectives and orthographic views (Bidarra & Figueiredo, 2016). Biology and anatomy are two areas to be explored, by presenting the organs and systems of the human body in 3D, while explaining how they function. It is possible to get students engaged in the learning process by adding gamification practises, while transforming the app in a quiz or exploring the potential of the Escape Room game.

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Chapter 5
Software Requirements Definition Processes in Gamification Development for Immersive Environments

Paulo Veloso Gomes
https://orcid.org/0000-0002-3975-2395
LabRP, School of Allied Health Technologies, Polytechnic of Porto, Portugal

João Donga
https://orcid.org/0000-0002-8701-2113
LabRP, School of Allied Health Technologies, Polytechnic of Porto, Portugal

Vítor J. Sá
https://orcid.org/0000-0002-4982-4444
LabRP, Polytechnic of Porto, Portugal & Centro ALGORITMI. Universidade Católica Portuguesa, Portugal

ABSTRACT

The implementation of gamification in immersive environments is a complex and multidimensional process. A socio-technical approach is necessary to cover all the specifications that the system needs to satisfy the needs and the purpose of its genesis. The use of virtual reality (VR) technologies in mental healthcare associated with gamification mechanisms has been gaining popularity. Two projects were developed using VR, one that allows people to experience and better understand mental health conditions through empathy construct and the other can be used to help patients with social phobia or Arachnophobia to reduce their phobias using VR solutions and real-time biofeedback. The authors analyze the aspects that influence the development of immersive environments and gamification mechanisms and propose a socio-technical methodology based on actor-network theory for the survey and definition of requirements.

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INTRODUCTION

Exposure to immersive environments can have different objectives, from the playful component, to impactful experiences, application to serious games and development of therapeutic programs. Whatever the purpose of the System to develop, there is one aspect in common, its complexity. Thus, designing and developing such a system is a great challenge, not only technological, but above all, in terms of being able to properly exploit its full potential.

Gamification in healthcare implies the involvement between people and technology, creating a socio-technical system in which the different elements interact and influence each other. This chapter analyzes the aspects that influence the development of immersive environments and proposes the use the Actor-Network Theory (ANT) as methodology for the survey and definition of requirements.

Implementing gamification in an immersive environment is a big challenge, involves making important decisions that have a decisive influence on the results to be achieved. The analysis and specification of requirements for such a system is a complex process, and should consider some aspects such as, to whom it is intended, interactivity, hardware, the type of suitable immersive environment (VR, MR, CAVE, Video 360º), real-time biofeedback measurement devices, the interactive narrative, the objectives, the results, report, surrounding space, among others.

IMMERSIVE ENVIRONMENTS FOR EMPATHY CONSTRUCT AND SELF-CONTROL MECHANISMS

Immersive environments create impactful experiences and have great potential to generate emotions that increase the degree of empathy. Real-time biofeedback allows to assess users' reactions to the environment to which they are exposed. Emotions are part of the empathy process, of the complex ability to share the affective state of another individual (de Tommaso et al., 2019; Santamaría-García et al., 2017).

When a system is developed to generate an immersive environment to create emotions, it makes sense to incorporate art elements to enhance its effect. The art in immersive environments influence the individual process that increases the person's receptivity to the construction of emotions.

Stimuli induce emotions, and emotions trigger personalized reactions, each reaction is personal and occurs in a specific spatial, temporal, and circumstantial context. The same stimulus can give rise to different emotions, in different people, or even in the same person at different times (Paulo Veloso Gomes et al., 2019).

Immersive environments explore multimedia potential, the use of multiple devices and different types of multimedia produce different stimuli and induce different emotions, contributing to the audience's involvement (Soleymani, Larson, Pun, & Hanjalic, 2014). Some art projects use EEG (Electroencephalography) as an input to produce or modulate artistic content, such as animations, music and choreography (Grandchamp & Delorme, 2016). Neurofeedback allows the voluntary regulation of brain activity. Its application intends to enhance and recover emotion and cognitive processes, and their underlying neurobiology (Lorenzetti et al., 2018).

The exposure of an individual to an immersive environment generates emotions, emotions trigger feelings, which in turn, promote actions (Paulo Veloso Gomes et al., 2019).

IMMERSIVE ENVIRONMENTS ARE JUST TECHNOLOGICAL ARTIFACTS?

Immersive environments are complex artifacts involving a strong technological component. However, the concept of immersiveness confronts the duality between giving and receiving. It suggests "to enter", "to dive into", "to be part of", but also to "imbue", to impregnate "and "receive it" (Paulo Veloso Gomes et al., 2019) .

An immersive environment contributes to an individual process that increases the person's receptivity to the construction of their own emotions. Emotions make each person react individually to a stimulus. This reaction is personal, because the same stimulus can trigger different emotions in different people, or even different emotions in the same person at different times (Paulo Veloso Gomes et al., 2019).

Gamification can be used as a motivation strategy in training programs and knowledge transmission. The construction of immersive gamification environments faces some multidimensional challenges, especially when it is intended to use the player's biofeedback as an interaction mechanism in order to influence the game's narrative.

It is intended with the use of biofeedback mechanisms measure the player's reaction to stimuli. In a simpler way, the result can be used to measure the impact of the stimulus, but the result of this measurement can also be used as an element of voluntary, or non-voluntary interaction and allows the game to adapt to bioreactions. Thus, biofeedback as an element of interaction is essential for the use of interactive narratives when it is intended that the user is involved in the environment in a natural and continuous way.

Emotional Behavior

Immersive environments are designed to involve and awaken sensations for the user. Exposure to the immersive environment causes involuntary reactions and changes in emotional state, which consequently affect heart and respiratory rate, skin conductivity, brain activity and eye movements.

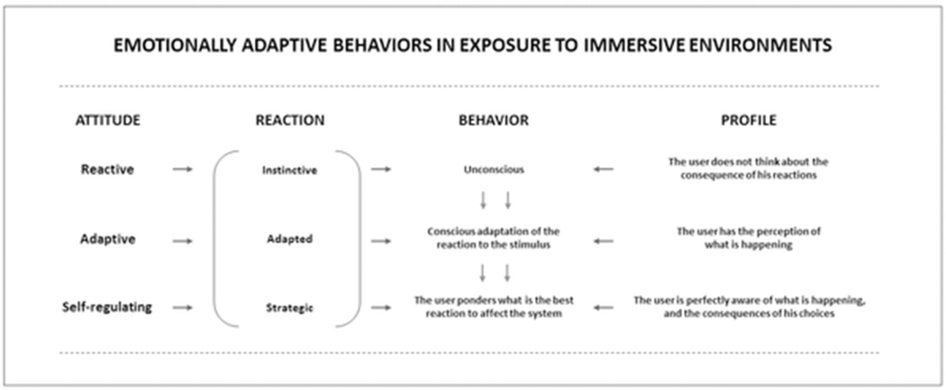
These reactions are very important because they represent the real impact that the exposure has on the person. Its real-time capture is possible using biofeedback devices capable of identifying, registering, and measuring its intensity. Technological developments have allowed biofeedback devices to be incorporated into VR devices, making their use almost, or even in some cases, imperceptible to the user. Looxid Link™ is an accessory device with EEG sensing capabilities that could be integrated with VR glasses like VIVE Pro Eye™ already equipped with a precision eye tracking system. The use of this type of equipment allows much more than just registering and viewing data, these data can be used as an element of interaction between the user and the immersive system. It allows the use of interactive narratives in the conceptualization and design of the immersive system, opening space for application in areas such as neurogaming and biofeedback therapy.

The construction of an interactive narrative to be applied in an immersive environment can incorporate a strategy to take advantage of the user's emotional behavior, the user takes an active role in the creation, emission, intensity and frequency of the stimuli emitted by the system. The effect of stimuli on the user can be determined from the real-time data obtained on the user's physiological signals.

An emotionally adaptive system, through measurement of user emotional data, can adapt continuously its stimulus to the user emotional state, optimizing his experience (Tijs, Brokken, & Ijsselsteijn, 2008). The use of biofeedback systems in the design of an immersive environment transform it into an Emotionally Adaptive Immersive Environment.

The user's reaction to stimuli can be involuntary or voluntary, an adaptive behavior can be developed during exposure or over several exposures to the environment (Figure 1). The concept of interactivity is very evident in the cycle of influence between the system and the user, where the system's stimuli affect the user, and the user's reactions contribute to alter the stimuli produced by the system.

Figure 1. Characterization of the user's profile according to behavior during continuous exposure to immersive environments.



During continuous exposures to immersive environments the human emotional adaptative process affect user´s behavior to stimuli (Figure 1). Over time the unpredictable becomes predictable, the time needed to interpret the occurrences decreases, and the environment becomes familiar to the user. The user becomes more confident, can understand better and faster what surrounds him increasing his perception of the system. This emotional adaptative behavior allows to transform a reactive attitude into an adaptive attitude, allowing the user to have a conscious behavior, reacting in a more assertive way to adapt his reactions to the system's stimuli. Continuous exposures can enable the user to interact with the system in a more thoughtful way, being able to determine which reaction is most appropriate to influence the system. When reaching the level of expert, the user designs the best strategy for his own benefit.

This evolutionary behavioral process means that adaptive immersive environments, through real-time biofeedback mechanisms, can also be interesting from a therapeutic point of view, having an important role in the development of self-regulation strategies by the user, in the face of challenges, adversities or threats, which in daily life interfere with his normal activities.

In non-adaptive systems, different tools can be used to assess the user's emotional state, traditionally the feedback obtained allows to analyze and define changes in future exposures. However, in addition to the inconvenience that the analysis result is not in real time and can only be applied afterwards, the tools used do not always produce reliable results, for example, in a questionnaire, the user for the most diverse reasons, may have felt a certain emotion and respond that he felt another type of emotion, or not being able to explain its intensity.

Immersive emotional adaptative behavior systems in addition to providing real-time responses, they can convert unimodal data into multimodal data. The reliability of the system is increased with the use of multimodal data from different sources of biological signals (Paulo Veloso Gomes et al., 2019).

Biofeedback Interactivity

Immersive environments allow multimodal human-computer interaction between the physical and virtual environment, through natural forms of communication. As can be seen, the importance that individual interpretation exerts on an immersive stimulus influences not only the way the individual perceives and interprets the immersive environment, but also the results that the exposure to that environment should produce. This way it is possible to infer that Immersive environments are complex artifacts involving a strong human component.

The use of interactive narratives in immersive environments allows the environment to adapt and react to the actions of each user. The interaction can be made through conscious mechanisms, when the player is faced with a situation of choice and chooses a path, this strategy allows the player to understand the relationship between an action and its consequences. When it is intended that the player has an immediate perception of his reaction to a certain stimulus, the biofeedback mechanisms, by allowing the system to collect the information given unconsciously by the player, can be used in immersive environments, as elements of choice in interactive narratives, to generate and improve self-regulation of behaviors. According to (Marcos, Bernardes, & Sá, 2002), multimedia technology is ideal to register multi-sensorial information.

Interactivity in adaptative immersive environments is based on Biofeedback-Stimuli dynamic cycle (Figure 2). Core Engine is the central unit, it controls the system software and the connected devices. The user experience can be optimized with the continuously adaptation of stimuli to the user reactions.

Stimuli are generated and trigger physiological reactions in the user. Biofeedback devices capture the data corresponding to each bio signal. These unimodal data are recorded and graded separately.

System incorporate the effects of stimuli processing the unimodal data separately, then merges unimodal data in multimodal data (Poria, Cambria, Bajpai, & Hussain, 2017) to interpret the user's response and use that response to generate new stimuli.

The affective algorithm maps the unimodal data and converts it into multimodal data to identify the type and intensity of emotions created by the stimulus. Then, the algorithm adapts the system's response capacity, considering the type and intensity of the stimuli, with the appropriate response to each situation, selecting new stimuli to send and grading their intensity and frequency (Figure 2).

Interactivity is an important factor for the conceptualization of the immersive environments, the design of a dynamic and adaptive model, as Biofeedback – Stimuli described in Figure 2, is fundamental to analyze and define the data flow generated by bio stimuli.

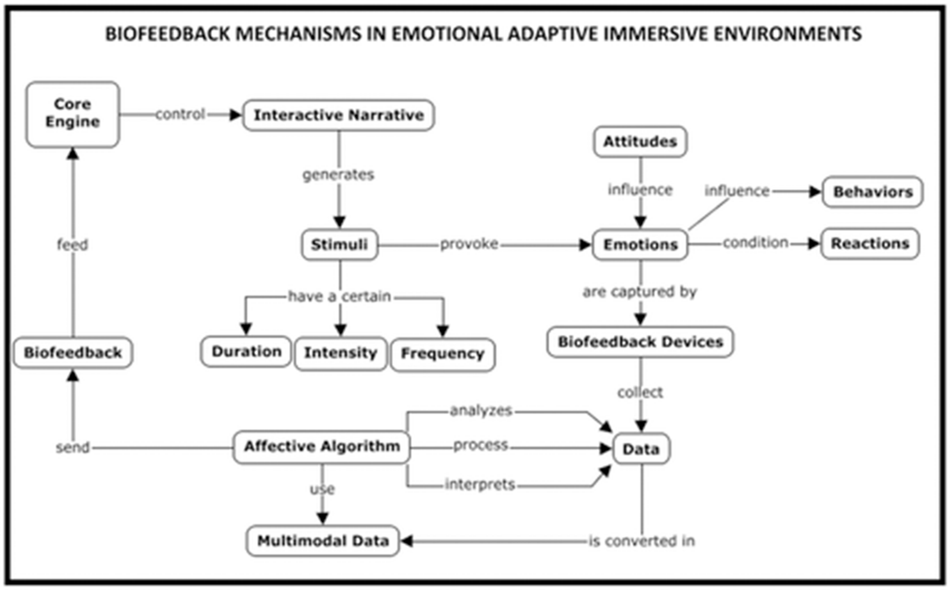
The development of immersive environments consider the four levels of observation, the theoretical information level, physical level, the cognitive level and the intentional mode (Hildebrand & Sá, 2000).

A stimulus can elicit different types of responses. Responses can be involuntary, when the user has no control over it, responds instinctively, without thinking, or responses can be voluntary, when the user is aware of the response he wants to give and chooses to respond to the stimulus in a certain way.

If in a first stage the user has no control over his heart and respiratory rate, brain activity and eye movements, with experience, the self-control of a person's biological status can be developed (Bersak et al., 2001). When the user receives information in real time about a certain aspect of his physiology, he can be able to determine how his mental changes can influence his state. Biofeedback process can control those physiological factors (Bersak et al., 2001).

Emotion sensing and recognition is one of the core areas of affective computing and that provide relevant methods and techniques to affective design (Hudlicka, 2008).

Figure 2. Biofeedback - Stimuli, interactive cycle in adaptive immersive environments.



The term affective feedback appears when the concepts of affective computing and biofeedback are related, its application in immersive environments makes biofeedback mechanisms influence the user experience (Bersak et al., 2001).

A SOCIO-TECHNICAL APPROACH IN THE REQUIREMENTS DEFINITION FOR IMMERSIVE ENVIRONMENTS DEVELOPMENT

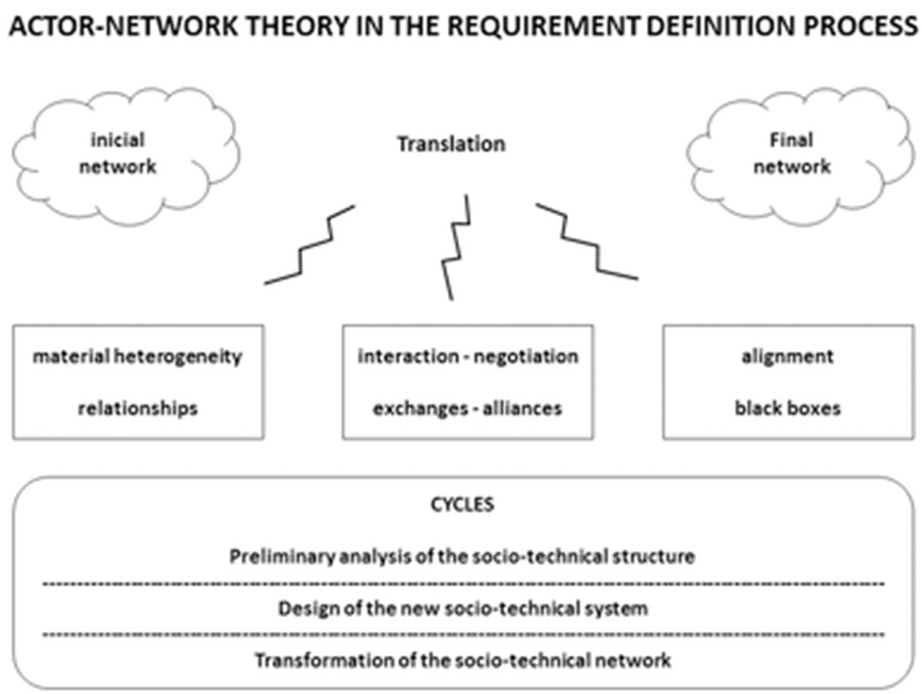
If an immersive environment as a strong technological and human component, it can be considered a socio-technical system. In that perspective, is a strong socio-technical environment where human and non-human elements come together in a heterogeneous network. The Actor-Network Theory (ANT) offers a different type of analysis, focused on the relational effect of the interaction between human and non-human elements in its heterogeneous network (Iyamu & Mgudlwa, 2018).

ANT focuses on the formulation of heterogeneous networks formed by human and non-human actors and on the relationships established between themselves (Iyamu, 2018). The use of ANT in the design of socio-technical systems, particularly in the definition of requirements (*Figure 3*), has been studied and tested over the last few years in collaborative systems (P. Veloso Gomes, 2004). Recently (Paulo Veloso Gomes et al., 2019) used Actor-Network Theory as an approach to design an immersive artifact of digital media art, the e-EMotion-Capsule, to develop an interactive immersive environment as a socio-technical system, where human and non-human elements have established strong relationships.

The ANT approach allows to decompose and analyze human and non-human elements, such as processes, policies, environment and networks, which involve the development and implementation of Information Systems (Nehemia-Maletzky, Iyamu, & Shaanika, 2018). These elements, human, technological and hybrid, are the genesis of an immersive environment.

One of the benefits of ANT is the recognition that technological and human elements are not distinguished and are related to each other, being equally influential in the environment in which they find themselves (Iyamu & Mgudlwa, 2018). This is a critical and important advance in the health sector, as it is impossible to separate professionals, patients and therapy programs (Iyamu & Mgudlwa, 2018).

Figure 3. Actor-Network Theory in the Requirement Definition Process, adapted from (P. Veloso Gomes, 2004).



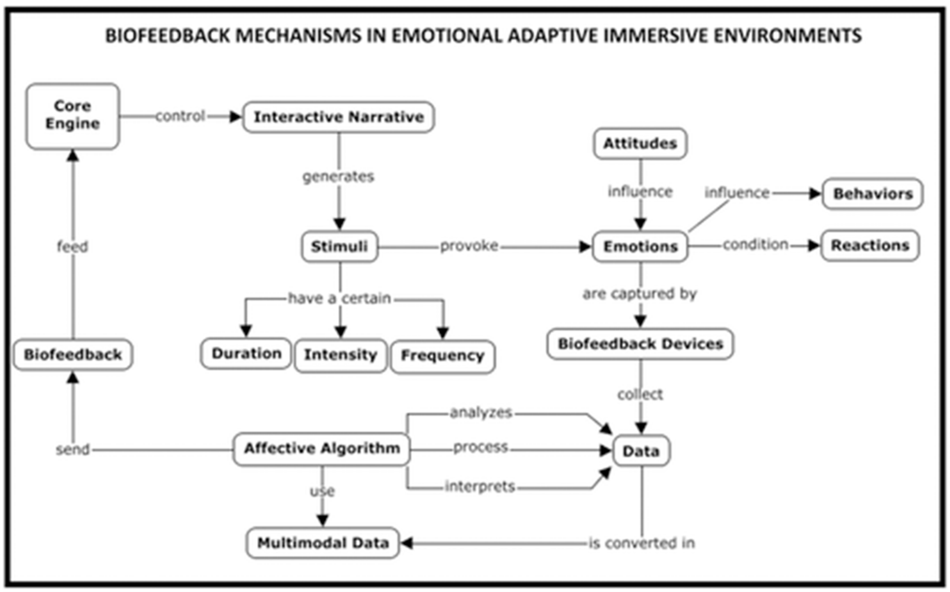
Data Flow Generated by bio Stimuli in Interactive Immersive Environments

One of the main aspects related with real-time biofeedback and interactivity is the data flows generated by bio stimuli, requiring a strict definition of the data flow, its analysis, interpretation, and conversion. ANT can be used for data analysis, mainly because of its descriptive emphasis and detailed narrative (Iyamu, 2018). ANT allows the analysis of non-human actors that can influence the data, from the point of view of size, speed and variety (Iyamu, 2018). This aspect is particularly important since the process of collecting, analyzing and processing real-time data collected by biofeedback, can be influenced by several factors, such as electrical or magnetic interference, collection errors or algorithmic interpretation, sudden movements, errors caused by noise, among others.

Emotionally Adaptive Immersive Environment through affective algorithm can use three types of strategies, the Not Intentional Mode Strategy (NIMS), based on randomness in the stimulus management process, the Intentional Mode Strategy (IMS) that automatically generates stimuli according to pre-defined objectives, and the Controlled Mode Strategy (CMS) through the intervention of a supervisor who controls the system during user exposure to the immersive system (*Figure 4*).

In an initial phase, the system can choose to use the Not Intentional Mode Strategy (NIMS), where stimuli are generated randomly, and the system can assess the participant's emotional state. Subsequently, the system can adopt the Intentional Mode Strategy (IMS), where through the analysis of the obtained biofeedback, the system leads the participant to appropriate behaviors to achieve the intended objectives. The Controlled Mode Strategy (CMS) implies the intervention of a supervisor who controls the system personalizing the type of stimulus while observing the participant's responses.

Figure 4. Socio-technological approach on immersive environment systems development.



Not Intentional Mode Strategy

The use the Not Intentional Mode Strategy (NIMS) can have several applications, among which stands out, the emission of stimuli that will allow to assess the emotional state of the participant. Through this type of interaction the system collects and interprets the bioffedback data to assess the participant's behavioral pattern, defining his profile.

The use of this game mode allows to determine the condition of the participant through the baseline measurement of his biological signals. Baseline values vary from person to person, it is important that the system determines the values of each participant to be able to personalize their behavior, analyzing and adapting the stimuli to each experience.

When necessary, this IMS mode can also be used to adapt to the immersive environment, or for training, allowing the participant to interact with the system freely, adapting their behavior and reactions to randomly generated stimuli.

Intentional Mode Strategy

The use the Intentional Mode Strategy (IMS) can have several applications, among which stands out, the emission of stimuli that will allow to assess the emotional state of the participant. Through this type of interaction the system collects and interprets the bioffedback data to assess the participant's behavioral pattern, defining his profile.

The registration of the participant's baseline values is essential for a personalized interaction. The affective algorithmic calculates the range of values to issue stimuli appropriate to the participant's profile.

Controlled Mode Strategy

In an initial phase, the system can choose to use the Not Intentional Mode Strategy (NIMS), where stimuli are generated randomly, and the system can assess the participant's emotional state. The Controlled Mode Strategy (CMS) is used when third-party interaction is desired, this mode applies to exposures with specific therapeutic objectives.

The supervisor controls the system personalizing the type, frequency and intensity of stimulus while observing the participant's responses. The supervisor assumes the role of participatory observer, influencing the exposure according to the reactions and responses of the participant.

FUTURE RESEARCH DIRECTIONS

Some challenges are identified in this area, namely the portability of systems, so that they can be taken to people with reduced mobility, develop some even lighter and more sophisticated equipment, making them less invasive, so that the participant does not feel that he is using them, providing a more natural experience, the integration of new elements of interaction like multisensory VR devices such as motorized VR chairs or VR sensitive gloves and smell stimulators, this type of equipment is useful to increase the feeling of immersiveness.

CONCLUSION

Observing that the involvement between the user and the immersive system, considering that the user is also part of the system, and the dynamic interaction generated, it becomes difficult to unequivocally separate human elements from technological elements.

This work used the Actor-Network Theory as methodology to create an Emotionally Adaptive Immersive Environment, through the development of an affective algorithm capable of using three different interaction strategies. The Actor-Network Theory as a socio-technical approach allowed to analyze and design a dynamic, interactive, and self-regulating system.

Adaptative immersive environments can be used to induce emotional changes capable of generating states of empathy and self-control behaviors. The use of biofeedback mechanisms during the participant's exposure to adaptative immersive environments generates unimodal data, which when converted to multimodal data, can be used as an element of interaction between the participant and the system.

Biofeedback allows to identify and quantify emotional states and increase the interaction possibilities between the participant and the adaptative immersive environment. Its use as an interactive element influence the course of the interactive narrative.

The heterogeneous network created by the adaptive immersive environment use the biofeedback-Stimuli interactive cycle as an interaction engine, where the human and non-human elements influence each other and merge into a socio-technical system.

Using real-time biofeedback mechanisms during exposure to adaptive immersive environments allows new types of interaction between the participant and the system, the participant is influenced and influence the system simultaneously.

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Section 2

Gamification in Psychosocial Rehabilitation and Mental Health

Chapter 6
The Role of Gamification in Neurocognitive Rehabilitation

Artemisa Rocha Dores
School of Health, Polytechnic of Porto, Portugal & Laboratory of Neuropsychophysiology, Faculty of Psychology and Education Sciences, Polytechnic of Porto, Portugal

Andreia Geraldo
Laboratory of Neuropsychophysiology, Faculty of Psychology and Education Sciences, Polytechnic of Porto, Portugal

Helena Martins
Lusófona University of Humanities and Technologies, Portugal

ABSTRACT

Neurocognitive rehabilitation continues to face difficult challenges related to patient and institutional characteristics. This reality requires innovative solutions to increase patient motivation and involvement in the process, turning rehabilitation more meaningful and pleasurable, as well as to help therapists overcome difficulties such as the absence of material and human resources. Innovative rehabilitation techniques have the potential to create motivating, personalized, and ecologically valid tasks. In this chapter, the authors describe the reality of neurocognitive rehabilitation in acquired brain injury and present the advantages and potential of digital information and communication technologies, especially serious games and gamification. Distinctive elements of these solutions and a reflection on the evolution of this area are presented. In order to establish evidence-based practices, it will be necessary demonstrate unequivocally the development of competences by the patients, supported by these new solutions, and its generalization to real-life activities in future research.

INTRODUCTION

The new digital information and communication technologies (ICTs) have changed the way we live and work and have contributed to countless opportunities in several areas, including healthcare (Entwistle & Newby, 2013; Mühleisen, 2018; WHO, 2005). In addition to the advantages already documented in

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the literature, such as globalization, the narrow of cultural gaps and an easier, cheaper and wider form of communication (Mühleisen, 2018), the widespread use of digital ICTs has untapped potentialities; conversely safety, ethical standards, quality, and respect for the principles of confidentiality of information, privacy, equity, and equality are challenges that this kind of tools brings about (WHO, 2005).

Several concepts have been created to translate the application of digital ICTs to healthcare, including e-health. Although not consensual and with numerous meanings, the concept of e-health was defined by the World Health Organization (2005), at the 58th World Health Assembly, as "… the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research" (WHO, 2005, p. 212). At this same conference, a set of recommendations was made to the member states for e-health's proper development, implementation, and evaluation, enabling the dissemination of cost-effective models and evidence-based practices. As a result, new solutions that might support different sectors and health services have a new capacity for reaching populations that need them, including the more vulnerable groups such as migrants or refugees (Dores et al., 2017; Drda-Kühn et al., 2019).

People who suffered an acquired brain injury (ABI) are a vulnerable group. Although in recent years, ABI survival rate has increased, mainly because of the improvement of emergency services, survival is not always synonymous of a desirable quality of life, often compromised by emotional, cognitive, and behavioral changes (Dores et al., 2016; Menon & Bryant, 2019; Zasler & Martelli, 2003). In these cases, intervention should include neurocognitive rehabilitation as part of a more comprehensive neuropsychological rehabilitation process (Miotto et al., 2008; Zasler & Martelli, 2003).

Despite the evidence about the efficacy and effectiveness of neurocognitive rehabilitation (Cicerone et al., 2019; Geraldo et al., 2018), there is a long path to overcome limitations related to service providers and to the process itself, which is often long, slow, and associated with significant changes in patients' lives.

Integrating digital ICTs in neurocognitive rehabilitation processes has been shown to be an important asset. However, the great potential of digital ICTs remains to be explored, namely developing rehabilitation tasks closer to real-life activities, increasing their ecological validity and engagement capacity building (van der Ham et al., 2018).

Platforms, serious games, and virtual environments have been developed and made progressively available, with good results (Rego et al., 2018; Ma & Zheng, 2011). Boosted by the technological development and the widespread acceptance of gambling and gaming as recreational activities (Griffiths et al., 2012), gamification has emerged as a strategy capable of providing the necessary incentives to improve people's involvement in non-recreational activities, as the ones' proposed during rehabilitation process. Gamification has the potential to enhance characteristics such as perseverance, learning, optimism, and curiosity (McGonigal, 2014), through the increment of motivation related to the pleasure provided by game's experiences (Schell, 2010), thereby increasing the possibility of a successful intervention. Therapists may propose game-based experiences, without an enormous investment in technology.

This chapter proposes to reflect and deepen the knowledge about the use of serious games and gamification in the neurocognitive rehabilitation of ABI patients. We will begin by presenting an overview of the existent scientific evidence and knowledge of rehabilitation services and move towards the identification of challenges and future paths. A section with solutions and recommendations on how to possible overcome the problems previously identified is also included. A section with solutions and recommendations on how to possible overcome the problems previously identified is also included.

BACKGROUND

Technological transformation brought about new forms of intervention and tools with growing popularity, which have been placed at the service of people and the development of societies (Mühleisen, 2018). However, the transformation of professional practices should not occur in an uncontrolled way, including in the Psychology area. All over the word, different associations have made guidelines available to regulate digital ICTs use in the clinical context (e.g., APA, 2013; OPP, 2020). Therefore, neurocognitive rehabilitation practice with these tools should reflect these guidelines.

Acquired Brain Injuries (ABIs)

ABIs are defined as non-degenerative, non-congenital and non-hereditary brain injuries, that occur suddenly, at a given period in the individual's life (Beecham et al., 2009; Greenwald et al., 2003). ABIs are considered one of the main causes of death and disability in Western countries and a global public health problem, considering the possibility of occurrence at all ages, as well as the global impact on the life of the person that suffers from it and their social support network (Kamalakannan et al., 2015; Peeters et al., 2015; Tagliaferri et al., 2006; WHO, 2001). Regarding its etiology, these injuries can be classified as traumatic, in which the brain damage is the result of an external mechanical force, i.e., traumatic brain injuries (TBI), or non-traumatic, in which the damage is the result of a disease, for example, stroke (Menon et al., 2010). Considering the epidemiology of different causes of ABI, Traumatic Brain Injury (TBI) and stroke are the most common (Feigin, 2019; INE, 2019; Lannoo et al., 2004; Peeters et al., 2015).

Beyond the high rates of prevalence, ABIs have significant consequences at the physical, behavioral, emotional, cognitive, and psychosocial levels, and represent a risk factor for future development of neurodegenerative diseases (Menon & Bryant, 2019; Zaslet & Martelli, 2003). The impairment at the cognitive level, particularly in attention, memory, and executive functioning, assumes special relevance in this medical condition. Thus, the deficits in cognitive functioning are frequently incapacitating, due to significant influence in safety, functional independence, productive life, and social interaction levels (Katz et al., 2006). Further, patients' awareness of these deficits is often impaired, with a greater impact on cognitive, emotional and interpersonal functioning deficits (Hurts et al., 2020), which can significantly hinder patient's involvement on the neurocognitive rehabilitation process. This constellation of characteristics raises great challenges in developing effective intervention strategies.

Previous studies signaled a limited spontaneous recuperation, and reduced efficiency of pharmacological agents on the rehabilitation of cognitive deficits (Cruz et al., 2013). A recent study by Fătu and colleagues (2020) highlighted the impact of cognitive deficits resultant from ABI on the rehabilitation plan and process, considering the difficult and slow recovery of these functions and the reduced functional outcome of these patients. Additionally, Fătu and colleagues (2020) showed that cognitive rehabilitation is often neglected in the neuropsychological rehabilitation processes when compared to physical rehabilitation activities, which can also compromise the improvement of patients' functionality and quality of life. In this context, interventions that aim to reduce cognitive deficits (i.e., neurocognitive rehabilitation) are now considered an integral and essential part of the neuropsychological rehabilitation of people with ABI (Cicerone et al., 2011; van Heugten et al., 2012).

(Neuro)Cognitive Rehabilitation: Concepts, Definitions, and Challenges

Cognitive rehabilitation can be defined as the "therapeutic process of increasing or improving an individual's capacity to process and use incoming information so as to allow increased functioning in everyday life." (Sohlberg & Mateer, 2001, p. 3). To improve its effectiveness, integrate a more comprehensive neuropsychological rehabilitation program that embodies the cognitive, social, and emotional dimensions of a person's life is warranted (Ben-Yishay, 1978; Prigatano, 1986). Therefore, the main goal of cognitive rehabilitation is the improvement of the person's functionality and quality of life (Prigatano, 1999; Sohlberg & Mateer, 2001). Reflecting upon this reality, about 95% of the rehabilitation settings for patients with brain injuries offers some kind of neurocognitive rehabilitation service (Cicerone et al., 2000), that frequently integrates a more complex rehabilitation process (Barman et al., 2016; Wilson, 2017).

More specifically, neurocognitive rehabilitation aims to deplete cognitive deficits or impact of such deficits on the affected person's daily routine. According to Cicerone and colleagues (2000), this kind of intervention can be designed to reinforce, fortify or re-establish previously acquired behavioral patterns; to establish new cognitive activity patterns through other cognitive mechanisms for the compromised neurological systems; to establish new activity patterns through compensatory external mechanisms (e. g., environmental structuring and support); or to allow individuals to adapt to their cognitive deficits, even when it is not possible to directly alter or compensate it. Desirably, this kind of intervention must involve a set of medical and therapeutic services that, in an integrated way, aim to improve cognitive functioning and to increase the independence of the affected person (Cicerone et al., 2000; Katz et al., 2006).

Currently, the major challenge in neurocognitive rehabilitation is to define evidence-based guidelines that can be followed by healthcare professionals in their clinical practice. In an effort to address this shortcoming, Cicerone and colleagues (2019), through publishing several systematic reviews with the main goal of summarizing the existent scientific evidence regarding neurocognitive rehabilitation of ABI patients. Through the analysis of 491 articles, only 9 practice standards, 9 practice guidelines, and 11 practice options have been defined for the rehabilitation of cognitive deficits in ABI (Cicerone et al., 2019). These results highlight the difficulty of establishing evidence-based guidelines, that can be accentuated by the methodological limitations of the studies and by the unique functioning profile of each ABI patient.

MAIN FOCUS OF THE CHAPTER

Issues, Controversies, Problems

The last three generations, X (born between 1965 and 1981), Y (born between the 80s and early 90s, also called *Millenials*) and Z (born between the mid-1990s and the years 2010, also called *Digital Natives* or iGeneration) reveal an increasing familiarity and even naturalization with ICTs' use. Especially in the case of generations Y and Z, characteristics such as feedback, recognition, status, transparency, and self-realization seem to be particularly important in their professional life (Kamasheva et al., 2015; Zichermann & Linder, 2013). These same characteristics should be part of the activities, tasks and tools used in neurocognitive rehabilitation; yet, many of the rehabilitation activities are still conducted with the traditional paper and pencil tools or with these tools reproduced in a flat screen. Frequently, solutions that require a high financial investment in technology are not available (Kane & Parsons, 2017).

Additionally, attending to the individuality of each person, the development of neurocognitive rehabilitation process should be based on a comprehensive neuropsychological assessment. This would allow healthcare professionals to design personalized and engaging interventions, according to each person's therapeutic needs (Rajeswaran et al., 2013).

Such characteristics of the therapeutic process rarely turn out to be possible in most of the services due to two types of difficulties: 1) issues associated with the people affected by ABI and 2) issues associated with the institutions that provide the rehabilitation services. Among the constraints that are associated with the injured person we can point out awareness deficits, the slow and difficult progress towards pre-morbid functioning levels, lack of motivation regarding the rehabilitation process, and behavioral, emotional and motor changes that can negatively affect the person's involvement concerning the rehabilitation process (Sohlberg & Mateer, 2001). Regarding institutional issues, matters of geographic location, limited human, financial and technological resources are pointed out as key constraints which seem to impair neurocognitive rehabilitation success (Baganha et al., 2002; Guerreiro et al., 2009; Sousa, 2009).

Further, other often neglected elements may constitute useful assets in rehabilitation such as fun and engagement (Werbach & Hunter, 2012). Besides this, the tools developed should create added value for the final users (Huotari & Hamari, 2017), such as the ability to solve problems, change behaviors (Kapp et al., 2014; Zichermann & Cunningham, 2011), or even the pleasure by itself (Wang et al., 2009).

New digital ICTs have progressively contributed to overcome some of the limitations exposed here. In the next section, we will reflect on the solutions and recommendations associated with their adoption.

SOLUTIONS AND RECOMMENDATIONS

The potential of using digital ICTs in the field of (neuro)cognitive rehabilitation seems undeniable, so in this section we will suggest its adoption in clinical practice. However, any change in professional practices must occur based on clinical and scientific evidence and in an effort of constantly improving the identified limitations during the transformation path. These topics will also be addressed, starting by identifying the challenges and then the possible solutions to surpass it.

Inclusion of Digital ICTs, Serious Games and Gamification

Recently, the inclusion of digital ICTs in neurocognitive rehabilitation processes has contributed to gradually minimize or to surpass previously mentioned limitations.

This kind of programs can be subdivided, at least, into three major categories, which are: (i) online and platform programs; (ii) virtual environments (using virtual reality [VR] technology); and (iii) serious games (Geraldo et al., 2018).

The democratization of digital ICTs has also ensured that virtual reality (VR) is no longer a privilege of specific industries such as the film or the military industry (Gigante, 1993). VR has been defined as "sensory data generated by a computer system, which may be perceived as physical reality, especially when perception is enabled by use of the body in a manner similar to physical reality. The system ideally displays in all sensory modalities; fully encloses the person in these displays; tracks head position and orientation but also the movements of the whole body, determining the visual stereo and spatialized auditory displays as a function of this tracking" (Slater et al., 2009, p. 215) or as "an advanced form of human-computer interface that allows the user to 'interact' with and become 'immersed' in a computer-generated environment in a naturalist fashion" (Schultheis & Rizzo, 2001, p. 210). Progressively, the use of VR rehabilitation has enabled the development of virtual environments with great potential to the improvement of the efficacy and ecological validity of the rehabilitation processes (Dores et al., 2016; Dores et al., 2018; Pietrzak et al. 2014).

The main characteristics of VR are immersion, presence, three-dimensionality (3D), interaction and involvement. Enhanced by these characteristics the virtual environments allow the variation of stimuli from simple to complex, grading and recording patient evolution, ensuring safe learning environments, higher control over the stimuli, the possibility of customized treatment and the inclusion of play in the rehabilitation process (Schultheis & Rizzo, 2001). Nonetheless, most of the environments available in the rehabilitation area are still more directed towards motor rehabilitation. However, there has been a growing number of programs that allow the increased intensity of neurocognitive rehabilitation, by extending tasks to other non-clinical settings, including patients' home due to the inclusion of digital ICTs in this field (Musiat & Tarrier, 2014; Vourvopoulos et al., 2014).

Inclusion of Digital ICTs: Main Advantages

As basic principles, the technological solutions previously presented should allow the complete customization of the neurocognitive rehabilitation programs. They also provide an automatic adjustment of the tasks' difficulty according to patient performance, keeping an optimal challenge level, attempt to upscale motivational aspects and ecological validity of each activity, facilitate the planning of the interventions and allow both the monitorization of the person's performance and the transmission of real-time feedback; and should augment autonomy and engagement in the person's own rehabilitation process (Brunner et al., 2017; Dores et al., 2018; Elaklouk & Zin, 2017; Joseph et al., 2014). Foremost, the possibility of personalizing/customizing and administering services at distance have allowed the increase of specificity, intensity, and duration of neurocognitive rehabilitation programs.

Inclusion of Digital ICTs: Challenges and Possible Paths to Overcome Them

1. **The need of clinical and scientific evidence and how to achieve it**

The inclusion of digital ICT-based tools in neurocognitive rehabilitation processes is increasing and improving efficiency and efficacy of programs and services, while reducing healthcare costs (Rossi, 2006; Musiat & Tarrier, 2014). Nonetheless, the measurement of these tools' impact is not always performed, despite its high importance for the establishment of evidence-based practices. Linking the best of healthcare practices and policies with the existent scientific knowledge might facilitate an informed decision process by healthcare professionals, which in turn improves their clinical practices (Bauer, 2007; Institute of Medicine, 2001).

A recent systematic review of the literature explored the process of assessing efficacy of computerized cognitive rehabilitation programs in ABI (Geraldo et al., 2018). Only 31 studies fulfilled the inclusion criteria and, of those, only 16 were randomized controlled studies. Several methodological issues were found across studies included, such as small sample sizes, heterogeneous samples, and lack of control groups and follow-up assessments. Additionally, the systematic review showed a high heterogeneity of assessment processes, related to the moments, instruments, and variables considered; and high heterogeneity of the rehabilitation programs, related to intervention tools, duration of the program, and length and frequency of the rehabilitation sessions. Altogether, these issues did not enable strong and solid conclusions towards future rehabilitation practices. Nevertheless, this study highlights the need of future studies to include control groups, follow-up assessments, instruments that assess functionality, quality of life and emotional well-being, and techniques that provide direct information about brain functioning, such as electroencephalography and functional neuroimaging (Geraldo et al., 2018).

2. The need of widespread use of ICTs and new solutions to achieve it

One of the reasons pointed out for the lack of widespread use of this technology was the unavailability of the technology for the wider public; however, currently, this problem is being solved with new devices being increasingly accessible and with a greater quality in each development. For example, head-mounted displays, eyeglasses, or gloves are nowadays not only easier to use, but also lighter and cheaper. Additionally, rehabilitation environments need to be accessible to a higher diversity of persons, regardless of their sensory and motor disabilities (WHO, 2001). Multimodal interfaces might contribute to person-computer interactions through different sensory channels, reducing barriers to participation and providing more natural, effective, and real interactive experiences (Turk, 2014).

Sensory interventions are still scarcely applied into neurocognitive rehabilitation, even though they seem to contribute to a coherent representation of the environment and facilitate patient subsequent adaptation to it (Purpura et al., 2017). This effect is apparent whether it considers multisensory stimulation (Campbell, 2013; Padilla & Domina, 2016) or multisensory integration (Stein et al., 2010). Generalization of the skills developed to real-life environments can also be optimized by sensory training, once the brain is trained to use sensory environments for more efficient neurocognitive functioning (Setti et al., 2014).

3. The need of motivation and fun and the role of serious games and gamifications to achieve it

Serious games have emerged as games purposed beyond entertainment (Sawyer & Rejeski, 2002). This concept appeared in the 1990s and translates the intention to apply games in non-recreational areas allowing to attend a specific end, for example, learning. Typically, its purposes are attained even when they are unknown by the player during the process (Rego et al., 2010; Rego et al., 2017; Zyda, 2005). Healthcare is one of the areas that have been exploring serious games for their own purposes, thus benefiting from their application.

Currently, people of all ages spend some part of their lives playing, which makes digital games one of the most popular entertainment sources in the world (Entertainment Software Association, 2019), with estimated revenue in the order of 123,4 million euros in 2021 (Statista, 2019). Portugal stands on the 38th spot in the ranking of the 100 countries that consumed the most videogames in 2018, spending approximately 28 euros per capita (Newzoo, 2019). So, it seems important that the game elements that generate this kind of behavior are recruited to serious games and gamification, allowing neurocognitive rehabilitation to surpass previously mentioned limitations.

Often confused with serious games, gamification does not constitute a complete game environment, but rather the use of some of the elements of the game design (Deterding et al., 2011). Generically speaking, gamification can be defined as the application of game elements to other activities to improve both the process of carrying out them and the results achieved. Through gamification, activities should achieve the element of gamefulness (McGonigal, 2011), simultaneously considering games' elements and the quality of the holistic gaming experience (Werbach, 2014).

Amongst the diversity of game elements available, we highlight characteristics like establishing clear objectives and rules; awarding the achievements through score or trophy systems (reward and feedback system); proposing challenges with different difficulty levels, stimulating the performance; promoting the production of storylines/narratives or even allowing the inclusion of avatars, that involves character creation, which is important for the player from the physical and emotional points of view (Gomes et al., 2014). These characteristics may increase the person's motivation to participate in the rehabilitation process. In fact, the videogame industry has long resorted to the Points, Badges and Leaderboards triad - known as PBL components (Koivisto & Hamari, 2019) - to promote motivation for the participation in games. However, there has been no equal appropriation for serious games. For example, five types of points (Zichermann & Cunningham, 2011) can be used to motivate the most competitive and goal-oriented players (Werbach & Hunter, 2012). By allowing simple and quantifiable feedback regarding the tasks and behaviors that the game aims to promote, points tend to be crucial on the most games (Werbach & Hunter, 2012). The same can be seen with badges, that promote additional behaviors and attitudes in the game; reveal the players' dedication in the completion of the objectives; virtually represent the status of each player and allow to trigger the "tribe" establishment, in a way that a player that collects badges common to certain peers tends to experiment a feeling of identification and belonging with that group (Werbach & Hunter, 2012). In turn, leaderboards, rankings, or rating tables allow the easy and intuitive comparison between the performance of several players simultaneously (Zichermann & Cunningham, 2011). In comparison to the previous two game elements, leaderboards allow, in a more discrete way, to publicly highlight the progression of each player. Unlike the previous two elements, rankings implicate some precaution to avoid exacerbated competitivity (Werbach & Hunter, 2012). However, this can be controlled, for example, through the different types of available ranking, such as incentive ranking, that consists of social stimuli used to increase the players' motivation through which the knowledge of each player is limited to the results of other players with similar ratings.

Even though the application of the PBL triad enables the achievement of important purposes, a successful application of gamification must consider many other game elements (Xi & Hamari, 2019; Werbach & Hunter, 2012). For example, aesthetics should not be neglected (Huizinga, 2000) since the sensorial experience is crucial for the realism and pleasure experienced in the situation (Suh et al., 2017; Werbach & Hunter, 2012).

In addition to extrinsic motivation, intrinsic motivation needs to be promoted. Patients get satisfied with the task itself when specific features are in place, such as greater autonomy, more choice opportunities, more positive feedback, less external control (e.g., given to learn from the instructions), a greater sense of competence resulting from the ability to overcome obstacles and challenges, and the possibility of establishing a connection with other elements (Ryan & Deci, 2000; Martins et al., 2020).

There are many examples of applications that effectively use the elements of game design (Herger, 2014; Xu, 2015; Zichermann & Linder, 2013). For example, one can cite "Piano Stairs" and the "Speed Camera lottery" that have been used with the aim of behavioral change; the "Samsung Nation" or the "Nike +" as examples of external gamification, or the "Ford p2p cup" or the "Multipoly", as examples of internal gamification (Joy, 2017). External gamification could be defined as the use of gamification to improve the relationship of companies with their customers, stimulating identification with the product, fidelity and even profit. Internal gamification aims to increase productivity, foster innovation, and enhance more positive social relationships among employees (Werbach & Hunter, 2012).

In the current context of an increasingly digital world, gamification can be a tool capable of providing adequate incentives to improve the rehabilitation process. By ensuring instrumental or hedonic benefits, gamification can foster corporative, engaging, and rewarding environments (Koivisto & Hamari, 2019; Sarangi & Shah, 2015).

Summing-up, based on the literature and in our experience as researchers and clinicians, in this section we have listed a set of recommendations that contribute to improve the neurocognitive rehabilitation of the present and the future.

Based on these recommendations, in the next section we will present more detailed suggestions on how to solve the major methodological limitations identified in the literature. By following these suggestions, research and clinical practice might progress in a fine-tuned way.

FUTURE RESEARCH DIRECTIONS

Tools and characteristics as the afore mentioned, when properly used, could be a great addition to the already available rehabilitation processes of people with brain injuries. These technology-based solutions may contribute to adequately dealing with a shortage of human resources involved in the rehabilitation process and have the potential to increase access of these processes to vulnerable and disfavored populations in the near future. Notably, they can boost the personalization and individualization of this process, creating funny and enjoyable moments that are prone to induce higher patient motivation, involvement, and therapeutic success (Cruz et al., 2013; Vourvopoulos et al., 2014).

Apart from the monitorization of player performance and progress, practicing with the use of games allows for the use of important rehabilitation principles, such as defining objectives, providing feedback and reinforcement.

Despite the growing number of studies focused on the assessment of the efficacy of neurocognitive rehabilitation programs, the establishment of evidence-based practices is not easy due to methodological concerns (Cicerone et al., 2019) associated with a high disparity of models and programs which makes it difficult to compare the efficacy of each program and make an informed decision. Therefore, the standardization of procedures in assessing the efficacy of these programs would be a step towards a more consistent establishment of evidence-based practices (Geraldo et al., 2018).

To this endeavor, we suggest that assessing participant's performance in two moments – pre- and post-intervention – is a desirable consistent practice, which allows for the comparison of results before and after participating in the program. Follow-up assessments should also be included, to evaluate the maintenance of gains resulting from rehabilitation processes and to inform about retraining needs. Additionally, control groups (both active and passive) within ABI patients would enable the control of spontaneous recovery effects. A tendency towards the inclusion of measures of functionality, quality of life and emotional well-being is growing, which enhances the ecological validity of the assessment protocol and informs about the generalization and transference of the results of the cognitive rehabilitation program (Geraldo et al., 2018).

The exclusive use of traditional neuropsychological outcomes in the assessment of the neurocognitive rehabilitation programs' efficacy does not provide direct information about the impact of these programs on brain functioning itself (Chaytor & Schmitter-Edgecombe, 2003; Nordvik et al., 2014). Even though only two of the 31 studies included in the review performed by Geraldo and colleagues (2018) included neurophysiological correlates as outcome measures, both reported significant differences at brain activation between pre- and post-intervention. Thus, the inclusion of neurophysiological correlates in protocols to assess the neurocognitive rehabilitation programs is crucial to better understand the dynamics of brain processing and cognitive functioning (Geraldo et al., 2019).

Based on another systematic review, Geraldo and colleagues (in press) suggest that neurocognitive rehabilitation programs promote significant changes in functional connectivity, which are related with changes on traditional neuropsychological outcomes, and reported even in the absence of improvements on those outcomes, due to its apparent higher sensitivity. Functional connectivity is considered an essential measure to study the brain functioning and its deviation from normal patterns, and can provide significant insights to assess and develop neurocognitive rehabilitation programs (Castellanos et al., 2010; Patel, Spreng, & Turner, 2013). Additionally, although functional magnetic resonance (*f*MRI) is the technique most used to measure neuronal activity, electroencephalography (EEG) is a great alternative that presents advantages, such as higher temporal resolution, lower costs and higher portability (Patel et al., 2013; Wallace et al., 2011; Roca-Stappung et al., 2012), being specially relevant for working with clinical populations due to mobility restraints.

Not surprisingly, scientific evidence indicates that the effectiveness of gamification depends on the context and the target population (Hamari et al., 2014). Thus, the application of gamification and game-based approaches must consider dimensions such as context, users' characteristics, and game elements, such as dynamics, mechanics, and components (Werbach & Hunter, 2012). Even pondering all these dimensions, one size fits all solutions should not be expected.

CONCLUSION

This chapter discusses the application of serious games and gamification to the context of neurocognitive rehabilitation of ABI patients, reflecting on both its advantages and challenges.

Despite the growing scientific evidence of the positive effect of neurocognitive rehabilitation on the (re) acquisition of functionality and quality of life of people with ABI (Cicerone et al., 2019), there seems to be a promising pathway in the optimization of this process. This can benefit from the application of digital ICTs in ways still unexplored, in addition to the applications already known and documented in the literature (Dores et al., 2016; Dores et al., 2018; Geraldo et al., 2018; van der Ham et al., 2018).

The use of platforms, serious games and VR for neurocognitive rehabilitation has enabled the development of solutions that allow overcoming some of the limitations of the area (e.g., lack of connection with the patient's experience, and lack of customization). However, effective use of the main elements of gamification (e.g., badges, points, levels, leaderboards) may enable a whole new level in the quality of the services provided. Concretely, this may be achieved by transforming training activities into stimulating and rewarding games. With the introduction of these changes, it is expected greater patients' adherence to the rehabilitation process, fostering therapeutic alliance and health literacy (Richards & Caldwell, 2016).

Even with all the advantages that may result from the inclusion of gamification in neurocognitive rehabilitation, the development of these tools should be accompanied by research (including performance and efficiency assessment), facilitating the development of evidence-based practices. Studies with control groups (passive and active), pre- and post-intervention assessments, and multiple measures of cognitive and psychosocial domains are an important requirement, as well as the use of neurophysiological indicators (e.g., assessed through EEG), and neuroimaging techniques to study brain-behavior relationship and the neuronal plasticity to complement behavioral and neuropsychological assessment measures. Thus, the documentation of the effects of the intervention can occur in a double course, blending information from both behavior and brain functioning, as advocated by neuropsychology (Geraldo et al., 2019).

In conclusion, the discussed new technology-based solutions have the potential to highly increase efficiency, effectiveness, and efficacy of the neurocognitive rehabilitation, contributing to reduce the associated health care costs and to link up cognitive rehabilitation to patients' real life contexts. We argue that the connection between these elements will have the power to enhance the development of both research projects and intervention practices.

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KEY TERMS AND DEFINITIONS

Acquired Brain Injury: A brain damage caused by traumatic brain injury or neurological diseases such as stroke, rather than congenital or genetic disorders.

Badges: Simple feedback system that enables the establishment of goals that guide game behaviors. It virtually represents the status of each player and can trigger the formation of tribes.

Electroencephalography: A cost-effective, noninvasive way to image brain function, through the record of electrical activity of the brain, with millisecond functional accuracy.

Functional Connectivity: Statistical dependencies among remote neurophysiological events, either at a synaptic or population level. It does not imply neither anatomical correlations nor the influence of one neural system over another. Functional connectivity can be indexed by measures such as correlations (temporal domain) and coherences (frequency domain).

Gamification: Use of elements of (video)game design in other contexts, benefiting the activities of those contexts with the characteristics that the game enhances, such as creativity, perseverance, and learning.

Leaderboards: Feedback system that allows the comparison between the player's own performance with the performance of other players. The two main types of leaderboards are the no-disincentive (i.e. the player sees himself constantly in the middle of the leaderboard, unless he is in the first places), and the infinite (i.e. the player sees the maximum score achieved by someone in the game, and their exact position in the set of all people who play/have played the game).

Neurocognitive Rehabilitation: Part of neuropsychological rehabilitation, aims to improve cognitive functioning or minimize deficits due to brain diseases or trauma.

Neuropsychology: The field of knowledge dedicated to the study of the neural mechanisms in its relations to cognitive functions and behavior. It is thus a field of neurosciences that involves cognitive sciences, behavior sciences and their interception.

Points: Simple and quantitative feedback system, through the allocation of positive or negative points contingent to the player's performance.

Serious Games: Games with another purposes besides entertainment, that can be used to promote learning or behavioral changes.

Chapter 7
Biomedical Analysis of Social Media/Video Games Addiction and Gamification of Neurocognitive Therapy for Rehabilitation

Venugopal D.
KPR Institute of Engineering and Technology, India

Kalirajan K.
KPR Institute of Engineering and Technology, India

Seethalakshmi V.
KPR Institute of Engineering and Technology, India

ABSTRACT

In recent years, laptops and smart phones have become unavoidable, and the restriction in usage of these devices is impracticable. Starting from children to aged persons, many people spend their waiting time, travel time in this nicely, but the issue arises due to their influence in the golden working hours. It leads to waste of time, energy, and some of these practices may lead to addiction. Hence, a techno-cognitive approach of the biomedical analysis of brain can be done through electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). After investigations, a strategy is to be implemented to explore the dynamics of therapy on reducing the addiction. But it is not a simple task of making the addicted persons practice yoga or meditation routinely. It can be made possible through gamification of these practices. This chapter focuses the pre and post recording of the addicted person's brain activity to analyze and measure the improvement after the treatment via gamification strategy. After certain duration, the outcome is addiction removal.

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INTRODUCTION

The utility of electronic gadgets in 21st century becomes doubled, tripled or even more. The handheld devices like laptops, tablets and smart phones have been tightly bounded with us. The usage of these devices is unavoidable in the digital era. Strict protocols for the usage cannot be followed since they gradually become a non-living partner with us. The implementation of protocols is also not necessary if they are used wisely and in dignified manner. If not, as a consequence, the impact of social media and video games diverts the people to a greater extent. From kids to elder persons, huge quantity of people spends their waiting time, travel time and leisure time in social media and video games nicely. But the issue starts when they influence in their golden working hours of them which leads to a lot waste of time, energy, attitude issues, etc when lead to addiction. Addiction is the phenomena of uncontrollable influence or effect of something which is beyond our control. It is the right time to address this issue and find the best ways to prevent or cure this addiction.

The main objectives of this chapter include the biomedical analysis of addiction of people with different age groups towards social media/ video games. Further, gamification of neurocognitive practices and therapies like yoga and meditation for the purpose of practicing by these addicted people and others. The post analysis of their behaviors and comparison. Case to case analysis and providing appropriate solutions to the individuals based on their analysis.

OBJECTIVES

1. To analyze the mental ability of the students by recording their brain activity using EEG.
2. To compare the brain activity in pre and post cognitive therapies using simulation tool.
3. To create health care awareness in order to improve the mental stability of the students by means of technical and scientific proofs through neuro cognitive therapy.

BACKGROUND

For many people, video games are a fun and enjoyable hobby, but for others, they can become a harmful habit. Video game usage becomes problematic when it impacts a person's relationships and daily functioning. At present time, video game addiction is not included in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), but the World Health Organization has classified gaming disorder as a disease in the International Classification of Diseases.(Anderson et al, 2012) More than 2 billion people play video games globally. Online video game addiction statistics show that anywhere from 1–10% of gamers have compulsive addiction issues. (Stevens, M. et al, 2019) Addiction towards social media and video games impacts a greater extent in the day to day life of humans irrespective of their age groups. It consumes lot of time of younger generation and kids. (I Dewa Putu Eskasasnanda et al, 2017) The subsequent effect of this is the lack of interest and concentration towards studies and skill development of youth and kids.(Nazir S et al, 2019) This gives much more effect in adults from age range from 21-40 by the way of influencing in their jobs. They get diversion of their intended duties and it reflects in the development of a nation. (Yubo Hou et al, 2020) Even it has been creating problems in the life of older people. Most predominantly, irrespective of age groups, the health issues like eye strain, body pain, back pain, etc results due to this addiction (Andreasen et al, 2016) The situation is uncontrollable even in normal cases if those are handled by regular practices of word of mouth, set of instructions and with simple punishments (Guangheng Dong et al, 2013) When the people are addicted, the condition is worse and it requires a different methodology to be followed. The cognitive practices and therapies have been instrumental in those type of cases. The outcome or end result will be more effective if case by case analogy and based on that the subsequent methodology if adopted for rehabilitation. That is, individualized psychotherapy program for addiction to information and communication technologies. Authors analyzed the way men and women arrive, stay, and respond differently to cognitive behavior group therapy for social anxiety disorder (Maya Ashera et al, 2019) A study and review on various types of meditation which gives positive effects physical & mental healthiness of human being reducing stress, improving concentration level, attention level has been made. Result particularly specified that ancient yoga style called as mindfulness meditation is best & helpful in getting effective results in the various stress related clinical problems of human being like chronic pain etc. which are extracted by human brain cognitive states that is using EEG signals which are more helpful in detecting & avoiding structural, behavioral difficulties. (Seema S et al, 2017) In this article, the authors have successfully explored multivoxel pattern analysis (MVPA) of functional magnet resonance imaging (fMRI) data can be used to infer the mental states of students (Torres-Rodríguez et al, 2018) Author developed EEG-based real time stress detection system among student's samples by applying time frequency analysis to extract useful information from EEG & implemented hierarchical SVM as classifier (Vanitha V, Krishnan P, 2016) Both the symptoms of Internet gaming disorder and the proportion of students at risk of the disorder were reduced after the gamification program. The changes observed in students were related to higher levels of positive affect and lower levels of negative affect. Evidence from this study indicates that Internet gaming disorder and risky online behavior are detrimental to the emotional well-being of Hong Kong primary school students. More importantly, the findings demonstrate that our newly developed WIT program can have a social impact in successfully mitigating the symptoms of Internet gaming disorder and enhancing emotional well-being over time. (Chau Chor-lam et al, 2019)

RELATED WORK

Internet gaming disorder (IGD) and internet addiction (IA) is constantly increasing, the treatments of IA and IGD prevalence and different treatment-related outcomes were discussed. (Francesca Gioia, 2019, pp 157-176) The researcher focused on different approaches to the treatment of Internet addiction based on research after reviewing the definitions, theories, causes, consequences, and symptoms of Internet addiction (Libi Shen, 2019, pp 675-700) The search and screening process identified 70 qualifying papers that collectively reported on 50 apps and technologies. The most commonly observed gamification elements were levels or progress feedback, points or scoring, rewards or prizes, narrative or theme, personalization, and customization; the least commonly observed elements were artificial assistance, unlockable content, social cooperation, exploratory or open-world approach, artificial challenge and randomness. (Vanessa Wan Sze Cheng, et al, 2019) A meta-analytic review demonstrated the efficacy of cognitive behavioral therapy for alleviating the symptoms of disorder and its associated depression and anxiety (Stevens et al, 2019) A multinational systematic review revealed cognitive behavioral therapy to be the most frequently adopted treatment for Internet gaming disorder (King, D et al, 2017) Instead of treating the problem of Internet gaming disorder holistically, this study focused on treating the specific symptom of cravings through psychoeducation and mindfulness training. The findings showed that reducing clients' cravings for Internet use mitigated their symptoms of Internet gaming disorder. (Zhang et al, 2016) Prescribed use of a gamified mindfulness meditation application significantly decreased depression symptom severity as measured by the PHQ-9. For College students and mental health providers fun, inexpensive, and non-stigmatizing applications as a feasible intervention to improve symptoms associated with depression were discussed. (Fish MT & Saul AD, 2019). The created game and system must be usable across treatment settings and at different phases in the recovery process. Pairing low-cost devices with customized games would allow for better fit with each patient and eventually lead to effective games for rehabilitation (Rachel Proffitt, 2016, pp 132-157) Task identified was to move the definition and conceptual history of gamification away from essentialist notions of play and games and towards a more nuanced understanding of gamification as a philosophy of design with situational outcomes. (Harsha Gangadharbatla, 2016, pp 1-26) Emphasizes that one of the key concepts of gamification was goal-focused activity and this works best when there were clear checkpoints in an activity that could be used by the learner to establish their progress and identify remaining tasks. (Dr. Ian Glover, 2013) Addressed the use of games and gamification techniques for health and health social media. It provided an overview on how some scientific publications focused on the disadvantages of the games for health (i.e., aggressive behavior, sedentarism, game addiction, etc.(S. Syed-Abdul & M. Househ, 2016) Few commercially available apps yielded integrated evidence-based interventions (eg, extended-release naltrexone, buprenorphine, naloxone, Self-Management and Recovery Training recovery, or CBT) and a concerning number of apps like SoberWorx was used to avoid harmful drinking and illicit substance use. (Tofighi B et al, 2019) The work on the topic explored the new family of requirements for people with digital addiction and how to meet these requirements through software-based motivational approaches.(Jingjie Jiang et al, 2015)

PROPOSED WORK

There are lot of works being carried out in the related area and the proposed work is the hybrid of the cognitive approaches, biomedical engineering and fusion of modern gamification approaches with the aid of virtual reality (VR) or augmented reality (AR).

Proposed app Description

The proposed app is designed to cater the following requirements

- A complete gaming experience for the needy people through fantasy videos with mesmerizing audio for the individual, group of people of people from different categories.
- A techno cognitive strategy to monitor the brain activities directly.
- Providing interactive platform virtually among the group.
- Conducive AR/VR environment for the attraction.
- Exclusive gamification approach for therapy for social media or video games addiction
- Conversion of practicing the prescribed yoga modules or therapy as a habit.
- The habitual yoga practices lead to own observation against the addiction among the addicted people.

MAIN FOCUS OF THE CHAPTER

The chapter addresses the pre and post analysis of the brain waves through biomedical equipment. This analysis is done for the people with different age groups and being addicted to social media or video games. The addiction level is also different from person to person. Therapies like yoga, meditation, etc that are most suited to prevent or cure these kinds of addictions have been discussed. Also, specific therapy to be adopted, duration, frequency of doing is also given in a brief manner. Most importantly, gamification of these strategies has been explored.

Dynamics of Therapy

In the recent past there has been an increased multi-disciplinary research on cognitive psychology and its impact on correlation between emotions (stress, anxiety) and creativity. Yoga, is regarded as a holistic approach to health in reducing anxiety and stress in an individual. Mind-body interventions are beneficial in stress-related mental and physical disorders, which Yoga is supposed to help in building coping skills with a small daily routine of exercise, breathing, and meditation. This will give motivation to adopt alternate therapies in daily life style of human beings. it is a well-accepted fact among medical practitioners, researchers and in health sectors, structured and timely yoga practices will improve the physical and mental abilities of the humans.

Specific Yoga Modules

Table 1. Different Therapy with duration and outcome

Sl.No	Name of the therapy	Duration	Outcome
1	Balasana Or Child's Pose	around 20-25 seconds	improving your mental health
2	Standing Forward Bend Pose Or Uttanasana	around 10-15 seconds	Reduces and relieves stress effectively
3	Navasana (Boat Pose)	at least 10 seconds and preferably 30 seconds	Reduces back pain and weakness
4	Padangusthasana (Big Toe Pose)	15 seconds	Strengthening and better stretching
5	Corpse Pose Or Shavasana	5 minutes	Improves concentration

Biomedical Analysis

Usage of both qualitative strategies (ethnography, survey and more) as well as quantitative methods (such as muscle and brain activity using techniques such as EMG and fMRI), to provide a more comprehensive analysis. This work will analyze the samples of addicted persons through biomedical signal processing and will develop a structured model for yoga practices. The samples will be motivated to undergo yoga and their mental and physical strength will be periodically analyzed and recorded. After specified duration, the best practices will be identified to reduce the impact of addiction. This work is intended to make an analysis of brain activities of students during pre and post cognitive approaches like Yoga, meditation etc. with the aid of biomedical signal processing techniques using matlab simulation tool. The proceeding section describes about the sequence of steps for the biomedical analysis.

Methodology (Theorization):

1. Designing the process for structured interviews and questioners to collect data from addicted persons. Conduct of experiments in both controlled and in-vivo environment, so as to gain richer perspective on the role of affective states of the samples
2. Followed with data collection, analyses and validation is done.
    a. For validation, techniques such as triangulation (by collecting information from multiple sources) and/or specific descriptions has been utilized in an unstructured format with the individuals who have been personally involved thus ensuring their consistency in field-data to a large extent
    b. In the inquiry the main source of data would be - field-notes from participant-observation, document analysis, semi-structured discussion and informal conversations. Data collection, recording and analysis would be an ongoing process, which all happens concurrently. In the course of the inquiry, the generic coding process will be used across all qualitative research genre. Coding is the process of examining the raw qualitative data which will be in the form of words, phrases, sentences or paragraphs and assigning labels. Just as a title represents and captures a book or film or poem's primary content and essence, so does a code represent and capture a datum's primary content and essence.
3. Based on the validated data theorize the general findings as best practices.

Practical Biomedical Signal Recording Method

This portion describes about recording the medical data of the addicted samples and the test usually takes 30 minutes to complete the procedure and typically involves the following steps:

1. The physical size of the samples has been measured and positioning of electrodes is determined. These spots are then scrubbed with a special cream that helps the electrodes get a high-quality reading.
2. Then, a sticky gel adhesive is put on 16 to 25 electrodes. They are then be attached to various spots on the scalp.
3. Once the test begins, the electrodes send electrical impulse data from the brain to the recording machine. This machine converts the electrical impulses into visual patterns that can be seen on a screen. These patterns are saved to a computer as pre-test EEG signal information.

The above section explains the pre-bio medical analysis of addicted person's data both theoretically and practically. The preceding discussion will be on the gamification of therapies and imposing the practices to the addicted sample persons. Followed by the post analysis of the same samples will be analyzed.

Gamification

Gamification is application of the elements of games to other areas and make experience of the user as a fun or enjoyable. It improves the brain activity by using audio-visual elements. It is a proved fact that a pleasure-giving chemical dopamine is released when people do something which are having fun. It encourages to have continued connectivity with the activity intended to do. Dopamine is an organic chemical that has a very important role in our organism, deeply connected with the reward system. In other words, whenever we feel we achieve something significant, our level of dopamine peaks, and we feel a lot better. It is responsible for feelings like satisfaction, achievement, arousal, attraction – and yes, it can also very easily open the way to addictions.

Gamification Strategy for Therapy

Some of the strategies for yoga has been dealt here.

Native Theatre

It is otherwise called as D & D yoga which fuses yoga and reploying game. It promotes an interactive 3D theatre experience of yoga. Adventurous stories related to the flow of yoga have been created and the peoples utilize rolling of dice to explore the world of imagination, war fields and various levels to be completed to restrain the obstacles.

Yoga Studio

Yoga studio is the app that comprises HD videos and ready-made yoga practices and many varieties of built-in programs.

Pocket Yoga

The AV (Audio video) instructions makes to do each pose through the integration of desired own or recorded music.

Global Yoga Academy

In this app, user programs can be customized and tracking the performance is based on the levels.

Daily Yoga

Daily Yoga is very useful to develop yoga as a daily routine. It has set of defined protocols developed for yogic practices from beginner programs to advanced yogis.

YOGAR

YOGAR is an app for HoloLens which provides a 3D learning experience via Mixed Reality (MR) that allows people to practice yoga interactively in a well-known space with a calm mind. Learners hear audio instructions and relaxing videos guide them effectively through each pose.

Proposed Gamification Approach for Therapy

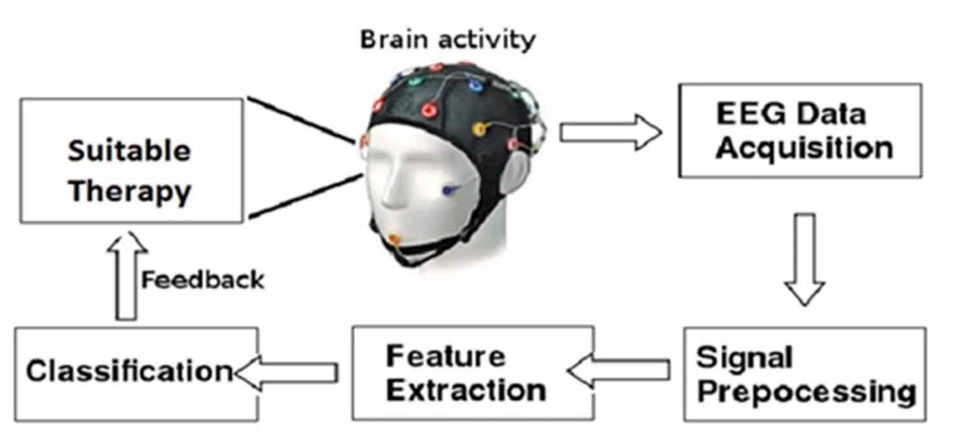
The yoga modules specified in previous sections consumes a total duration of 7.5 minutes for a single routine. According to the body conditions, age, level of addiction, working nature of the people the degree of practice varies. The number of times a particular practice should be practiced also differs. The proposed way integrates 3d animation video with customized music as well as native theatre. This provides an absolute fun experience for the human being by the way of fantasy videos with mesmerizing audio and especially a competitive environment for the same set or group of people. This strategy influences the brain activities directly and make the persons attracted to the gamification. This approach is a win-win situation for the addicted persons as well as the persons trying to treat them. The flow of the methodology is as described below.

- Grouping the individuals based on the body conditions, age, level of addiction
- Forming an online communication among the group purposely without providing the real details about them.
- Provision or creation of conducive atmosphere for them.
- Exposing them to the proposed gamification approach for therapy and diverting them from the social media or video games.
- Inculcating the habit of practicing the prescribed yoga modules or therapy in a regular basis.
- Gradually, the gamification approach diverts the addiction towards the yoga modules.
- The result of regular yoga practices leads to self-control and realization about the addiction among the addicted people.
- Then addiction has been completely overruled by the yoga practices and the outcome is the rehabilitation.

Exposing the Proposed Gamification Approach to Addicted Persons

The sample persons for whom the pre-recording is done are exposed to the above gamification approach. The duration of exposing is approximately 50-100 days depending upon the individuals.

Figure 1.Brain activity recording



Post Analysis

- After a month of training of the therapies the same procedure is repeated and recorded the EEG signal from the same subjects.
- Using MATLABTM simulation tool the signal processing is done and further by applying Feature extraction algorithm EEG signals are classified to extract its relevant frequency information to classify for further the status of human brain activity before & after performing Alternate therapies.
- Thus, the post biomedical analysis (as discussed earlier) has been done to the samples exposed to the gamification approach. The analysis and comparison of pre and post signals recorded is done. The result clearly interprets the level of cure and it illustrates the extension of duration required if any. This could be done after every month to have a prominent result. This technical analysis is useful to have more accurate treatment for the addicted persons. Moreover, it is a modernized method the addicted members will have to experience which could be imposed very easily over them and they will accept it without negligence or opposing. Also, it would be very much interactive, lively and cheerful experience for the addicted ones.

Case to case analysis:

The individual analysis and recording procedure elucidate the outcomes in a transparent way with high degree of accuracy. The result is clearly visible and understandable to all the users. The most prominent factor is to have a case to case analysis of the individuals and adjustments could be made at any stage of the practice. The period of exposing is also reduced or increased based on the requirements. The method has only two major needs, one is biomedical analysis and gamification. The medical analysis consumes only low recurring and non-recurring expenditures and the gamification requires only the high initial expenses for installation. Thus, the cost-effective solution is suggested to cater the needy peoples in affordable manner.

Modern Approaches for Gamification

The input arm of the closed loop will be intimated by wearable sensor technologies which accumulates real-time data about the interaction of the individuals during game play, including motion capture, eye movements, and physiological data from EEG, EMG (electromyography), HRV (heart rate variability), and GSR (galvanic skin responses). These technologies are slowly becoming much easier to access and capable of providing better-quality, research-grade dataset to drive the video game mechanism. Thus, in addition to performance-based feedback and adaptivity, future-generation closed loop video games (CLVG) will be able to provide real-time feedback based on neurofeedback and biofeedback. It will adapt game challenges based on physiological inputs. Note that here we are not referring to the isolated neurofeedback and biofeedback approaches that exist today, but rather we envision synergistic multimodal gaming that involves closed-loop integration of real-time behavioral and physiological data. These combinations will be able to generate more robust, sustainable features and cognitive gains. The output arm of the closed loop will also be enhanced by modern and emerging engagement technologies: virtual and augmented reality (VR/AR), which generate more real-world gaming environments with enriched feedback and adaptive stimulus displays.

Societal Impacts

1. This cognitive enhancement based on gamification will give motivation to adopt Alternate therapies in daily life style of human beings, especially the addicted persons.
2. This will help in decline of physical and Psychological issues and mood disorders related issues.
3. Helping in building a good concentration level, confidence, dedication, overall health level etc. among the people.
4. This system will bring the vibrancy in the practices and will produce expected results and scientific conclusions.

FUTURE RESEARCH DIRECTIONS

The gamification approach could be modified with virtual reality and augmented reality to have a better visual effect and realization. Real time gesture and posture of yoga will motivate the persons to involve in a more precise way and the result will be ultimate.

CONCLUSION

All the people from different generations, due to the grasping level of children, exposure to the technological developments of the elders, the youth population has the practice of using social media. As discussed in the chapter, the controlled usage is not a problem but the addiction should be eradicated. This chapter addresses this addiction problem by the way of gamification of yogic practices and pre-post analysis. It concludes the thing that the gamification strategy will work well for removing addiction. Further, the individual care and attention could be provided for the betterment of the individuals. As a whole, gamification of the practices will attract all the generation peoples and will provide improved solutions. Thus, it will lead to the path for social media/video games addiction free society.

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Chapter 8
Gamification in Dementia and Mild Cognitive Impairment

Vitor Simões-Silva
https://orcid.org/0000-0003-2831-9729
School of Health, Polytechnic of Porto, Portugal

Susana Alexandra Mendonça Gregório
School of Health, Polytechnic of Porto, Portugal

Tarcisio de Tarco Moura Luz
School of Health, Polytechnic of Porto, Portugal

Ana Francisca Casinhas Coutinho Lapa
School of Health, Polytechnic of Porto, Portugal

António Marques
https://orcid.org/0000-0002-8656-5023
School of Health, Polytechnic of Porto, Portugal

ABSTRACT

The following chapter will address the use of gamification (specifically serious games), as well as its results and conditions of use, as an assessment and intervention tool for people with mild cognitive impairment (MCI) and dementia diagnosis. These games are effective for cognitive skills, such as attention, memory, executive functions, and speed processing. Besides this, physical (related to motor coordination and movement), social, psychological, and emotional (related to motivation, anxiety, depression, and stress) skills can be improved by serious games. It will be considered the contexts of the use of different games, such as Episodix, Panoramix, and some other games that are applied as serious games, like exergames. Besides, it will be also referred the different platforms associated with these games, such as mobile applications, videogames, virtual reality, and augmented reality.

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The global aging of the population has become a major health challenge worldwide. The increase in life expectancy can lead to health problems related to cognitive decline, due to brain changes caused by aging (Vogel et al., 2016). Thus, some people when older will need help to perform one or more activities of daily living, such as bathing, dressing, or going to the bathroom (Kingston et al., 2018). It is predicted by the World Health Organization that in 2050 the world population above 60 years of age will almost double from 12% to 22%, exceeding the number of children under the age of five (World Health Organization, 2020). This problem can also increase age-related conditions, such as Neurocognitive Disorders (Tong et al., 2019).

Neurocognitive Disorders (NCDs) include various forms of cognitive conditions. NCDs can be divided into two types, Dementia, and Mild Cognitive Impairment. Concerning Dementia, it includes Alzheimer's, Vascular's dementia, and Parkinson's disease. Mild Cognitive Impairment (MCI), is a promodal of dementia and an intermediate stage of cognitive change between normal aging and dementia (Oh & Lee, 2016).

Relatively to Dementia, it interferes with independence on the routine and the daily. However, this is the opposite of what happens in the case of the MCI, which does not interfere with the independence of daily life (American Psychiatric Association, 2014). Therefore, the difference between MCI and Dementia focuses on the severity of cognitive decline leading to functional impairment. Because of this functional impairment, these diseases increase the costs for the economy (Fratiglioni et al., 1999; Knopman & Petersen, 2014; Oh & Lee, 2016; Wimo et al., 2006).

It is important to notice that the lack of physical activity may deteriorate the health condition of the people living with the diagnose of dementia, in particular, the physical, cognitive, emotional, and social functions. However, the participation in the physical activities might be restricted because of some conditions that these patients might have, such as lack of spatial orientation and balance problems Taking this into account, these type of conditions can originate lack of interest for this type of activities, so these people most likely will not participate in physical activities. Besides this, dementia also has functional symptoms that can affect the daily life of these patients (Van Santen et al., 2019).

According to the cognitive-enrichment hypothesis, it states that the type of activities that people engage during their lifespan has an important impact on the functioning level of the old age. This hypothesis also states that an enriched environment can stimulate cognition and physical activity while optimizing brain functioning. According to this, cognitive stimulation, physical activity, and social engagement is an essential intervention with people that have Dementia (Ben-Sadoun et al., 2016).

Taking into account pharmacological therapies, they are one of the many treatments available for many causes of dementia and besides this, many medications offer limited benefits and often cause sedation and loss of autonomy (Schwarz et al., 2012). Therefore, the importance of nonpharmacological therapies is growing, aiming to delay the decline of cognitive function in dementia and MCI (York Health Economics Consortium, 2017). Also as the volume of people with MCI and Dementia is increasing and the funding for health care becomes more scarce, it will become increasingly more difficult to deliver face-to-face therapies, which leads to a need for cost-effective, wide-scale solutions to be developed (Barr et al., 2014). Thus, it can be concluded, that it becomes important to invest and to join efforts in discovering and creating new forms of intervention that have into consideration all the different and multiple needs of the elderly population in particular.

It is to refer that the role of technology in healthcare is underexplored, even if it could be focused on the improvement of sensory impairments by facilitating activities of daily living and providing pleasure. In the case of people living with dementia, it can establish the links between behavioural disorders and their respected cause, so that the personal clinician may be able to propose corrective actions and lifestyle training (Kenigsberg et al., 2016).

Considering assistive technology, it must be specifically made to consider one's capacity. In particular, Serious Games may be a relevant tool to maintain the patient's autonomy. These types of games are a new approach to virtual education and are also an entertaining tool able to empower a person by structuring knowledge and educate stakeholders to deal with a critical situation that a patient with Alzheimer's Disease may live for example (Kenigsberg et al., 2016).

GAMIFICATION FOR DEMENTIA AND MCI

Taking into consideration Gamification, this term refers to "the use of game design elements in non-game contexts" (Alsawaier, 2018; Sailer et al., 2017; Sardi et al., 2017). The idea of this concept is to use the game aspects in real life situations, in order to improve the motivation and performance in a specific activity. Gamification is being used in different areas such as health, marketing, education, social network and environmental protection. Even though Gamification is being more used nowadays, a limitation that its evidence still has is that it wasn't studied sufficiently until now (Sailer et al., 2017). Serious Games in the last years have become a matter of notice in various subjects, such as education, healthcare, marketing, and training (Manera et al., 2017; Zucchella et al., 2014). It must be referred that Gamification and Serious Games are different concepts that can have similarities, however, Gamification focuses on games elements, while as Serious Games focuses on the use of the system of gaming to achieve the goals wanted (Sanmugam, 2014).

Gamification is a plus when being used because it promotes the acquisition of knowledge and stimulates the brain, while promoving the social integration, auto-satisfaction, self-esteem and pride. These facts were appealing to the healthcare because Gamification has good results with the lack of adherence in treatments and the increase in the healthcare costs (Sardi et al., 2017).

Noticing Serious Games in the healthcare, it is important to mention, that some Serious Games refer to the term of computer games that are meant to be used in the health domain (Manera et al., 2017; Zucchella et al., 2014). This term can also be used for games that were made and designed with no recreational purpose (Sardi et al., 2017). They are a novel intervention strategy that focuses on applying games aspects to healthcare and that can be used as a tool for assessments, rehabilitation, and stimulation (Manera et al., 2017). It is known that gamified interventions are efficient because they work with various types of rewards, being some of them the scores, the achievements/badges, the likes, the animated feedback (Lewis et al., 2016).

Considering that games can potentially assess a variety of factors associated with diseases such as MCI and dementia, by keeping individuals active and stimulated, while potentially slowing the rate of cognitive decline (Tong, Chan & Chignell, 2017). Considering the cognitive-enrichment hypothesis (that was mentioned before), a video game used as a Serious Game can be utilized as an enriched environment, because it involves physical exercise while using entertaining aspects (Ben-Sadoun et al., 2016). Besides this, Serious Games are also able to enhance cognitive functions and neuroplasticity at any age (Ben-Sadoun et al., 2016; Kühn et al., 2014). The cognitive function stimulated by the videogame depends on the type of the game (Ben-Sadoun et al., 2016).

Taking into account the game design, it must have the characteristics of the target group. The games that already exist strive towards community and interaction goals so that the older person can collaborate with their peers to achieve the goal that they might have in common. Besides this, it is also important that the game makes the elderly feel empowered about their healthcare and that they can control the system (Groznik & Sadikov, 2019). It is to notice that the games should not have a competitive environment nor make comparisons between the users because if someone is having lower scores than the peers, it might harm the motivation and can trigger negative emotions regarding health (Mora et al., 2016). Besides this, they also should not display distracting elements because they might induce stress (Groznik & Sadikov, 2019; Mora et al., 2016).

Even if several studies prove that Serious Games have beneficial outcomes for older people and people with dementia, there still exist problems on using some Serious Games available, because of the design tools used in the game and the technological illiteracy that some people might have (Manera et al., 2015).

It is important to take into account the "Gameplay Bricks model", a model for a solo game that states that a challenge in a game happens when there is a good combination between a goal (bricks game) and the means (bricks play) (Ben-Sadoun et al., 2018). On one hand, the Bricks Play invites the player to "shoot" (hit distant targets), to "manage" (manage resources to reach some objectives), to "move" (take control of a character), to "randomize" (generate value), to "write" (enter an alphanumeric to trigger a game function) and to "select" (select an item on the screen) (Ben-Sadoun et al., 2018). On the other hand, the Bricks Game model invites the user to "avoid" (avoid elements, obstacles, enemies or opponents), to "destroy" (destroy elements or enemies), "match" (maintain one or more elements in its place or an equilibrium status) and to "create" (assemble, build, create elements) (Ben-Sadoun et al., 2018).

Considering the "Gameplay Bricks model" and the normal characteristic of a game should be adapted for a Serious Game for Dementia, so that it can be able to sustain generalization of what was learned in the game to real-life situations (Ben-Sadoun et al., 2018; Manera et al., 2017). Ben-Sadoun and collaborators (2018) consider that the model could be adapted to Serious Games, by adding ergonomic criteria based on a key element of the gameplay, such as the game rules, because the game must allow the participant in the game to understand its principles and rules. Besides this, it also suggests that this model should be adaptable to cooperative challenges.

It is important to mention that when a person with dementia is using a Serious Game, the caregiver and a trained person must be present (Manera et al., 2017; Tziraki et al., 2017). On one hand, the caregiver should be present, because of the low level of autonomy that the participant in the game may have. To allow the presence of the caregiver more easily, it should be organized group sessions or be provided remote assistance. On the other hand, a trained person must also be present, to make sure the game is being safely played, to motivate the client, and to embed a positive social and emotional context. The game must be played either at home or at a clinical facility. The latter has the advantage that allows a complete standardization of the training and provides secure and a controlled environment, although, the travel to the clinic and the time spent might represent a cost for the client (Manera et al., 2017).

About strategies that can be used to improve the client's motivations, they should be the following ones: the presence of a trained clinician to motivate the participant; an adequate set of training pace; modifying the timely manner based on how the patient changes; good design of the game; being in the flow zone (being a focus in the activity and having high levels of enjoyment and fulfillment); feeling self-efficacy during the game and existing a well-defined reward system in the game (Manera et al., 2017).

It is to notice that when a person gets better in a game, she might generalize that to the real-life and gain autonomy, however, even if she does not, her motivation and quality of life will get better (Manera et al., 2017).

According to the findings of Manera and collaborators (2017), most of the Serious Games are more suitable for people who have initial cognitive decline than the people who are already in a state that is losing autonomy in their ADL's.

Studies that were already carried out with the elderly predict that Gamification has positive results in the cognitive development, as it stimulates the brain, promotes the acquisition of knowledge, improves working memory, attentional capacity, visual attention, emotional control and speed processing (Lumsden et al., 2016; Sardi et al., 2017). Although this fact, not many studies have been done on Gamification with the elderly (de Vette et al., 2015). However, the studies made with gamified interventions in MCI's and Dementia's pathology, that worked with cognitive training, showed that gamified interventions were a positive process concluding that it has a positive effect on the episodic memory in cases of MCI. This study also pointed out that it is very important to have non-pharmacological interventions using gamified aspects and different technologies in the beginning stages of neurodegenerative diseases so that cognition may be improved, reducing memory deficits and increase motivation (Savulich et al., 2017).

It is important to notice that a Serious Game can be effective if its fun and engaging and if it helps the person to generalize what learned to the real world. According to Foshay (2014), a Serious Game is good if it has the six following attributes: Conflict or challenge; Rules of engagement; Particular goals; Continuous implicit or explicit feedback; Interaction with the environment; Compelling storyline.

It is to notice that in our opinion, a Serious Games should be used in a client, after the health professional knowing some relevant things about him, such as the diseases he might have. After knowing that, the Serious Game should be used according to the client interest and skills. So, we should use a Serious Game that involves the skills that we want the client to get better at and one that goes according to what he likes.

Assessment with Gamification for MCI and Dementia

Recently neuropsychological evaluations are made by health professionals, in a controlled environment, for example, a clinical setting. The main diagnostic tools that are used are validated neuropsychological pen-and-paper tests or scales (Valladares-Rodríguez et al., 2016). However, advanced cognitive evaluation mechanisms are needed to help make an early diagnosis. These new mechanisms should overcome the limitations of current neuropsychological tests, including delayed detection, being perceived as intrusive, non-ecological, dependent on confounding factors, or their administration being expensive, among others (Valladares-rodriguez et al., 2019). Serious Games are one of the most promising areas of evaluation because it is an easier way of administration and collection of data, it can also have better randomization of the presentation of stimuli in repeated administrations (Valladares-Rodríguez et al., 2016).

To detect the presence of dysfunctions neuropsychological evaluation, it is necessary to examine cognitive impairment in older adults and neuropsychological domains such as attention/concentration, language, visuospatial abilities, motor coordination, executive functions, and memory (Valladares-Rodríguez et al., 2016).

There are four different approaches to cognitive assessments in Serious Games. The first one is the use of an existing game and the use of its platform to create cognitive measurement opportunities. This approach requires a good recognition of the particular cognitive abilities that are tapped by concrete tasks in video games. The second approach uses the mimic testing mechanism (Valladares-Rodríguez et al., 2016). In this case, the starting point is a traditional neuropsychological assessment, and the objective is to create a video game that has the same validity by replicating its mechanics. The third approach is made by using assessment tests in their computerized form, in a virtual reality environment. The last and most popular approach replicates real-life situations through virtual reality (Valladares-Rodríguez et al., 2016).

Intervention with Serious Games for MCI and Dementia

A Serious Game can be used from two to four times a week, however, this should be adapted to every person's condition and their objective with the game (Manera et al., 2017). The timing of each session might also vary according to the person, his/her physical constraints, and his/her objective (Manera et al., 2017).

In the opinion of Ben-Sadoun and collaborators (2016), the time that people with dementia spend playing the game should be less than the time that older people with no health condition play. This is because they will most likely get tired after 30-40minutes of training, so the people with dementia should take breaks during the game.

Taking into account exergaming, which combines exercise and gaming (Van Santen et al., 2019). According to the perspective of Van Santer and collaborators (2019), the lack of physical activity may deteriorate the health condition of the people living with the diagnose of dementia, which was the reason for the emergence of exergaming.

Exergames are meant to be a fun physical activity, which sometimes might be used for people living with dementia so that they can be more motivated. Studies show that this type of game can improve physical, cognitive, emotional functions, executive functions, the processing speed and reduce symptoms of depression. The cognitive, emotional functions are positively influenced by the interaction with the game. Regarding the physical exercises, they are promoted by the exercises that exist in the game (Van Santen et al., 2019).

According to Van Santen and collaborators (2019), exergaming has a positive effect on the quality of life of the ones that have to diagnose of dementia and their informal caregivers, because they usually notice a positive change in the behaviour of people living with this diagnose. However, a limitation of Exergames, according to Ben-Sadoun et al (2016), is that it just induces light intensity aerobic activity, because the platforms for this type of games have limitations in the capture of movements in-depth and consequently these games only involve movements with the upper limbs and a person has to be in the same place most of the time.

According to our way of thinking, a Serious Game would be more interesting to an elderly if it has realistic design characteristics, and it is not too childish. It would be also good to have simple commands and rules for it to be easier to use for elders that have illiteracy technology. We would also like to add that it being direct and having information about what it is happening, the present place and date would be good way to help the elderly with dementia to feel in control and not disoriented. It would also be a good suggestion to create different levels of difficulty in the game, for him to go according to different capacities of the elderly.

Virtual Reality for MCI and Dementia

In the last year's gamification has spread to an immersive environment, so Virtual Reality Games in Dementia have been created. Virtual Reality (VR) is a technology that provides a three-dimensional environment, sensory inputs, and track changes (Van Santen et al., 2019). VR also allows interaction with

Table 1. Example of Gamification on MCI and Dementia

Gamification Platforms	Description
Brainy App	It is a public application available through a download. This application allows the player to do a brain health survey that asks questions about the following subjects: social activity and mental activity; cardiovascular health; physical health; habits of smoking and habits drinking. After the survey, users can play activities to improve some areas that they might be lacking and that might increase their risk of Dementia (O'Connor et al., 2014)
Pursuit Rotor Task	It trains the performance of activities of daily living (ADL's) through the control of their routines by thought and action (Groznik & Sadikov, 2019; Mzzzzzora et al., 2016).
*Caregiverspr*o-MMD	This gamified platform is a support tool for the patient and the informal caregiver and is supposed to improve social collaboration, adherence to treatment guidelines, recognition of progress indicators. Besides this, it also provides strategies and tools to improve treatment interventions and medication adherence (Tzallas et al., 2018).

the created environment with a higher degree of similarity and giving immediate performance feedback (Manera et al., 2016; Moline, 1997).

Relatively to the VR systems, they can be classified according to the virtual environment (for example desktop, goggles-and-gloves, large screen, virtual room) and the type of interaction technique (such as fully immersive, semi-immersive, non-immersive and passive or active interaction) (García-Betances, Jiménez-Mixco, et al., 2015). The VR systems include 3D displays that drive the person into a virtual environment for the highest level of immersion and also more sophisticated approaches including wrap-around display screens, actual rooms augmented with wearable computers, and haptic devices (Manera et al., 2016).

Studies show that exposure to natural environments can have a positive impact by inducing positive feelings (such as pleasantness and calmness) and reducing negative emotions (like fear, anger, or sadness) (Ulrich, 2002). Besides this, the exposure to this type of environment also exists many positive changes in biological variables, like blood pressure, muscle tension, and brain electrical activity (Park & Mattson, 2009; Ulrich, 2002).

It should be referred the challenges that exist to provide the kind of experiences mentioned before in older people since they usually present reduced mobility, lack of energy, fear of falling, pain and some medication which all combined can affect the ability and desire of this population to engage in outdoor

Table 2. Example of Gamification on MCI and Dementia (continuation)

Gamification Platforms	Description
The *Memo*	An existing Web App that can be used offline on any computer or tablet. The client creates a normal account while the clinicians create a professional account to be able to see the progression of the person playing. The exercises that exist in this app are meant to train visual memory training, working memory training, associative memory training, flexibility/attention, processing speed, inhibitory control, mental flexibility training, anticipation, and inhibitory control training (Robert et al., 2020)
Panoramix.	Game that aims to evaluate the cognitive areas that are considered relevant for diagnostic indicators of cognitive impairments, such as episodic memory, attention, semantic memory working memory, working memory, procedural memory, and gnosis. Existing gamification or emulation in the digital field of tasks linked to the cognitive area to be studied ensures that games evaluate exactly the areas for which they were designed. In addition to the focus group sessions to gather information on the specific needs of the elderly, that should be covered by the *Panoramix* package (Valladares-Rodriguez et al., 2018)

experiences (Appel et al., 2020; Benjamin et al., 2014). This might be worsened by the lack of accessibility in the streets, weather/seasonal conditions, and high demand on staff time (Appel et al., 2020; Benjamin et al., 2014). VR technologies can be really helpful in reducing isolation and increasing occupational participation of this population, since it is well documented this technology can reduce stress, depression, and anxiety in older people with age-related conditions. Besides this, VR technologies can be an accessible, affordable, and comfortable and safe tool that allows older people with age-related impairments to experience different kinds of stimulation that their reality can't provide itself and improve the well-being in general (Appel et al., 2020).

VR has already been used in the healthcare, specifically in the diagnosis, cognitive training and caregiver education for Dementia such Alzheimer's Disease and also cognitive rehabilitation in MCI (García-Betances, Jiménez-Mixco, et al., 2015; Ge et al., 2018; Tarnanas et al., 2014; Zygouris et al., 2014). Mainly because of the ability to create a more stimulating and familiar environment that has the potential to engage persons with dementia uniquely and to provide a more personalized feedback experience (Baus & Bouchard, 2014; Cohen-Mansfield et al., 2010; Leone et al., 2012; Manera et al., 2016; Oh & Lee, 2016; Rizzo & Kim, 2005). This technology delivers a cost-effective, comprehensive, flexible, and accessible intervention for older people who struggle to attend appointments because of distance, lack of transport, or even disability (Oh & Lee, 2016; Weniger et al., 2011).

It should be referred that the potential applications of VR and Augmented Reality (AR) technologies in Dementia and MCI have been studied (Aruanno et al., 2017; Chua et al., 2019; Davis et al., 2017; De Luca et al., 2018; Fasilis et al., 2018; Hofmann et al., 2003; Hwang & Lee, 2017; B. R. Kim et al., 2011; Man et al., 2012; Optale et al., 2010; Zygouris et al., 2014). VR is defined as a simulated real 3D environment, which drives the person to the sensation of being present in another place from where it is and by using head-mounted displays (Benoit et al., 2015; García-Betances, Arredondo Waldmeyer, et al., 2015). AR refers to the way of emphasizing the real environment by overlapping virtual elements in the real environment, using a camera or a smartphone, for example (Aruanno et al., 2017; Benoit et al., 2015; García-Betances, Arredondo Waldmeyer, et al., 2015). Mixed reality regards an interception of both virtual reality and augmented reality and includes 3D components which can be seen in the real environment (Aruanno et al., 2017). Even if all forms of this technology involve an interactive component, it also can include interactive computer-based cognitive training (ICT), with decision-making and learning in the virtual environment (D'Cunha et al., 2019).

Intervention using Virtual Reality for MCI and Dementia

VR has been widely used in MCI and Dementia on cognitive training and rehabilitation (Aruanno et al., 2017; Davis et al., 2017; De Luca et al., 2018; Fasilis et al., 2018; Hofmann et al., 2003; Hwang & Lee, 2017; B. R. Kim et al., 2011; Man et al., 2012; Optale et al., 2010). In a study of Optale and collaborators (2010), VR used in memory training showed outcomes on improving memory functions in older people with MCI in a 6-month randomized controlled trial using a head-mounted display and a combination of auditory and visual stimuli to create a virtual environment and a joystick so people could navigate the virtual surroundings. The scores of MMSE decreased in only 3 months of intervention and maintained for the following 3 months. The same occurred with the depressive symptoms measured with the Geriatric Depressive Scale. There were also noticed other improvements in digit span forward and verbal story recall (Optale et al., 2010).

Noticing studies that focus on cognitive rehabilitation, some of them target tasks related to shopping in the supermarket (Hofmann et al., 2003; Man et al., 2012). In a study of Hofmann and collaborators (2003) with people with Alzheimer's disease, was incorporated in ICT digital photographs of the participants' real social and local environment and 120 decisions, in particular photographs illustrating a shopping route on a computer touch screen where participants were asked to do a couple of tasks, like route navigation and free recall task. Results indicated that people with Alzheimer's disease performed worse at baseline testing when compared with the other groups, but after 12 sessions, people with Alzheimer's disease had a significant reduction in mistakes and revealed they liked the experience and admitted they could apply the training to help them in the daily life (Hofmann et al., 2003).

During the present study, different cognitive functions were evaluated, such as Working Memory with Digit Span Forward & Backward, Memory Retention with Babcock Story Recall Test, Attention with Trail Making Part A, Problem Solving with Hanoi Tower, Rigid Thinking with Wisconsin Card Sorting Test, and Executive Functions. It was registered improvement in the performance of each cognitive test, mainly with a statistically significant difference in the case of Functional Memory, Memory Retention, Executive Functions, and Rigid Thinking (Fasilis et al., 2018).

In a study of Aruanno and collaborators (2017) was examined the use of the HoloLens device, an augmented reality system that shows computer-generated 3D objects in the real environment with people that have Alzheimer's disease In his study the participants should click to open objects to show their content and match items by using short-term memory and progress through the scenario. It should be noticed that the participants were able to follow the instructions with assistance when required from a career and affirmed they enjoyed the experience and considered that it was appealing and would like to use it again, although careers observed some difficulty from participants in clicking on the objects (Aruanno et al., 2017). Besides, another study of Küçük, Kapakin, & Göktaş (2016) refers it is not clear how AR can influence memory, however, it seems that visualization of the learned material might have an important role, as well as mobile AR tool for memorizing suggests a reduction on cognitive load and also the exerted learning effort.

A systematic review of Moreno and collaborators (2019) focused on the use of VR on cognitive rehabilitation in MCI and Dementia and on the changes in psychological functioning after intervention indicated an improvement on diverse levels of cognition, such as memory, dual tasking and, visual attention and also a reduction in psychological aspects, like a reduction of anxiety, higher levels of well-being and increased use of coping strategies, showing positive results and the feasibility for the intervention. About the levels of immersion, 50% of the technology was semi-immersive, 18,2% as immersive and, 18,2% as non-immersive (Moreno et al., 2019). The average number of sessions was almost 14 and the average duration time of a single session was 30 minutes with the frequency of two or three times per week, across the 22 selected studies. The participants of this study also indicated a good level of acceptance by enjoyment with technology, satisfaction, interest, engagement, motivation, safety, and, helpfulness (Moreno et al., 2019). It was not reported adverse effects in more than a half of the studies and between those which were referred about 5%, the most frequent included simulator sickness (Davis et al., 2017), negative emotions when participants failed in specific activities (Delbroek et al., 2017), oculomotor disturbances, nausea and disorientation (Flynn et al., 2003), neck pain (Lee et al., 2016) and dizziness (J. Park & Yim, 2015), which proves that adverse effects in VR probably are not exclusive of MCI and Dementia (Regan & Price, 1994).

VR interventions are mainly used in stroke, just as it was referred on the studies of De Luca et al. (2018) and Kim et al. (2011). Their studies were focused on the cognitive recovery in individuals who had a stroke, with outcomes on visual attention and short-term visuospatial memory (De Luca et al., 2018; Kim et al., 2011). There also exist robust results on cognitive rehabilitation in Dementia, such as cited in the study of Davis and collaborators (2017), where was examined the effect of salient visual cues on wayfinding performance by analyzing the speed of navigation and the number of goal acquisitions and it was concluded salient cues do increase navigation speed and goal acquisition in individuals with Alzheimer's dementia and MCI.

In the case of cognitive rehabilitation in MCI, for example, the study of Hwang & Lee (2017) aimed to investigate the effect of VR on cognitive function and also the balance in the participants and it showed being effective for improving cognitive functions such as memory. Focusing on changes in psychological functioning after the intervention, the study of Manera and collaborators (2016), concluded that both participants with MCI and dementia reported strong feelings of security and low discomfort, anxiety, and fatigue. Participants with MCI or dementia referred that think that VR is more satisfying, secure, comfortable, and provokes less anxiety than a paper-based task.

In a meta-analysis of Kim, Pang, & Kim (2019) focusing on the effectiveness of VR for people with MCI and Dementia, results show positive effects on physical fitness, cognition and, emotion and with this improve cognitive and routine functions of older people (García-Betances, Arredondo Waldmeyer, et al., 2015; Neri et al., 2017). The effects were greater in people with MCI when compared with people with dementia and also when the intervention was conducted in the community when compared to in an institution or both. It was also referred that a task was more effective than a game and semi-immersive technology was more effective than full-immersive technology including the 3D display and HMD (Kim et al., 2019).

Interventions based on VR provide more diversity, comprehension and, security, besides this, they can also be challenging and complex for older adults to use (Cherniack, 2011); this type of interventions can be unsafe for older people with reduced vision or other sensory problems (Van Schaik et al., 2008). Nevertheless, with the adequate conditions of methodology and interaction technique, it can be assured a safe implementation for people with both sensory and cognitive impairment (Kim et al., 2019). The intervention effects registered were slightly higher when the evaluation method was self-reported when compared with observer-reported, although, in the case of people with MCI is important to use both to confirm the effectiveness of the intervention (Huckans et al., 2013). Thus, it is suggested the use of more objective measures so these results can be confirmed (Kim et al., 2019).

VR is also able to provide diverse forms of sensory stimulation in a comfortable and safe immersion environment, which can enhance functional learning and transfer of learned functions (Sánchez et al., 2013).

In a study of Moyle and collaborators (2018), which used "The Virtual Reality Forest", sensory experience with a large interactive screen and designed to immerse the user in the virtual environment to improve the quality of life of the person living with dementia. The Microsoft Kinect motion sensors were used to manipulate seasons and various animated objects, allowing participants to interact with the scene through hand and arms movements, so specific movements trigger and move animated objects, such as ducks, fish, dragonflies, butterflies, and boats and also can be noticed a strong change between the spring and autumn seasons, for example. Animated objects remain on the screen so that they can be manipulated only while the user's hands are detectable by the motion sensors. Participants were involved in a Virtual Reality Forest session for a maximum of 15 minutes in a room reserved for the intervention with a trained facilitator, who was a health professional to employ the coordination of activities for each health unit. Initial indications suggest that the Virtual Reality Forest has a positive impact, improving the pleasure and attention of people living with dementia. The results around fear and anxiety suggest a broader investigation with a larger sample. The impact of this intervention is sustained and needs to be balanced with the daily experience of living with dementia and few activities are likely to have a sustained impact. The images and sounds involved in VR make the participants feel physically present in the virtual world which can address the need for more self-engaging activities for people with dementia (Moyle et al., 2018).

Also on the review of D'Cunha and collaborators (2019) was referred to as the role of VR in Reminiscence. It is thought Virtual Reality can be used to trigger autobiographical memories because of its level of immersion and visual realism (Benoit et al., 2015; Chapoulie et al., 2014).

In cases of older people with MCI and dementia, it has been used Mixed virtual and augmented reality with the image-based rendering which refers to the computerized reconstruction of a real environment, in particular, a location familiar for the participants using photographs in this case. The participants use 3D LCD shutter glasses while sitting in front of the screen and realized attention tasks using a wireless mouse. Participants referred to high levels of satisfaction with the virtual game when compared with the paper version and also participants who registered high levels of apathy showed more interested in the virtual reality than non apathetic participants (Manera et al., 2016).

Another study of Siriaraya & Ang (2014) focusing on older people with dementia in long-term aged care used three different virtual reality settings (reminiscence room, virtual tool, and gardening) and semi-structured interviews with care staff were done to determine the real efficacy of the interventions. Results revealed that the activities in the virtual reality triggered reminiscence as expected, which allowed the participants to remember stories from memories, for example, from their gardens and also in particular because of their interaction with virtual objects which mostly had personal value for them. Positive feelings emerged because virtual reality was considered as an escapement from their reality, although was one participant also revealed negative feelings and sadness while remembering past experiences (Siriaraya & Ang, 2014).

In a review focused on the Episodic Memory (EM) assessment and intervention in normal and pathological aging using VR by Corte and collaborators. (2019), it is thought that VR can be a promising tool for dealing with EM assessment and intervention thanks to its immersive properties and the possibility of providing realistic and complex resources, specifically the use of non-immersive systems. In EM VR systems were used in two orthogonal axes, immersion, and interaction (Corte et al., 2019). On the first axis, there was an extreme non-immersed system that presents the VR environment in desktop computers and fully immersive systems that employ head-mounted monitors with motion monitoring systems allowing sensorimotor contingency. In the second axis, at the lowest level, there were systems in which the participants were passive. However, at the highest level, the participants could interact in a complex way with the environment, thanks to different types of devices (for example, steering wheel, cybernetics), sensors, and posture tracking (Corte et al., 2019). It is difficult to conclude about which VR resources are the most adequate in the assessment and stimulation since, some studies have analyzed the impact of different degrees of the interaction of the VR system, only one study was employed in Fully Immersive Systems. Surprisingly, an RV immersion dimension has not been studied extensively (Corte et al., 2019). The best technological resources (for example, interaction) of a given system may depend on the population that is being tested which is particularly important in the design of VR correction tools. It is also to refer that the best technological resources for a given system depend on the population that is participating in the study, which is particularly important in the design of VR correction tools (Corte et al., 2019).

In short, it can be concluded that VR interventions are promising and helpful in cognitive rehabilitation and can reduce psychological symptoms in individuals with Dementia and MCI, and should continue to be studied in the future with more consistent study designs (Moreno et al., 2019). Many studies referring to VR in elderly people are focusing on the search for the diagnosis of dementia, verifying the lack of studies with more solid data in a VR intervention, and also the lack of guidelines on the VR development process and the duration and dose effective interventions. Therefore, the current results can contribute to determining the guidelines for the intervention in VR with elderly people with cognitive impairment (Kim et al., 2019). However, VR activities seem to grow further because of its cost-effectiveness, flexibility, comprehension, and useful patient-centered care (Coyle et al., 2015).

CONCLUSION

Studies suggest that with the process of global aging has been using tools such as Serious Games, in mobile applications, videogames and virtual reality, and some results show positive changes and effects in the process of assessment and also intervention on older people in different areas like cognitive, physical, social, psychological and emotional. However, in our way of thinking, there should be more studies focused on the use of the Serious Games with older people, in order to improve the knowledge of its limitations and its defaults, for example, in what it might harm the health of the elderly or how it can make them feel worse in the moment and harm their quality of life and well being. Because of this, more efforts should be delivered so the use of this type of technology can increase in order to help improving the quality of life of older people with MCI and Dementia and also taking into account the multiple need of this type of population. The constant increased number of older people with these conditions can also be another reason since it will become more difficult to deliver face-to-face therapies in a wide scale. Thus, the final positive outcome of the use of this kind of technology is the empowerment of the person with MCI and/or Dementia in order to reduce the negative impact of these conditions in daily life.

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Chapter 9
The Use of Gamification in Social Phobia

Vitor Simões-Silva
https://orcid.org/0000-0003-2831-9729
School of Health, Polytechnic of Porto, Portugal

Vanessa Maravalhas
School of Health, Polytechnic of Porto, Portugal

Ana Rafaela Cunha
School of Health, Polytechnic of Porto, Portugal

Maria Inês Soares
School of Health, Polytechnic of Porto, Portugal

António Marques
https://orcid.org/0000-0002-8656-5023
School of Health, Polytechnic of Porto, Portugal

ABSTRACT

Social phobia usually starts in adolescence. Social situations that include meeting people, talking in groups, or in more specific situations are going to be avoided by individuals. Therefore, this condition has the consequence of significant impairment in different occupations. Recent studies show that gamification is commonly applied to interventions for the treatment of chronic diseases, and although there are interventions concerning mental health, these are few and there is evidence that these interventions have positive effects on mental health, particularly among young people. The desensitization therapy program using gamification consisted of 15 sessions: an initial assessment session, 13 biweekly exposure therapy sessions, and the last reevaluation session corresponding to a total duration of the program of seven weeks. Each session, lasting approximately 50 minutes, is followed a formal structure consisting of the following phases. The intervention focused on shaping appropriate approach behaviors through a process of successive approximations.

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SOCIAL PHOBIA

Social phobia, also called social anxiety disorder, is the third most common neuropsychiatric disorder after depression and substance abuse, with a prevalence of approximately 12% throughout life in Western societies and which increases with age, and generally starts in childhood or adolescence (Bas-Hoogendam et al., 2017; Cabral & Patel, 2020; Erin et al., 2017; Hirsch, 2018; Kampmann, Emmelkamp, & Morina, 2016; Kishimoto & Ding, 2019; Lange & Pauli, 2019; Leichsenring & Leweke, 2017; Leigh & Clark, 2018; Miloff et al., 2015; Morrison et al., 2016; Rose & Tadi, 2020; Serlachius et al., 2019). Social phobia refers to the fear of exposure to one or more social situations, as well as excessive concern about your social performance and the focus is on fear of being negatively assessed (American Psychiatric Association, 2014; Apolinário-Hagen et al., 2020; Bas-Hoogendam et al., 2017; Clauss et al., 2019; Emmelkamp et al., 2020; Erin et al., 2017; Felnhofer et al., 2019; Hirsch, 2018; Kampmann, Emmelkamp, Hartanto, et al., 2016; Kampmann, Emmelkamp, & Morina, 2016; Kampmann et al., 2019; H. Kim et al., 2018; Lange & Pauli, 2019; Leichsenring & Leweke, 2017; Miloff et al., 2015; National Collaborating Centre for Mental Health, 2013; Perna et al., 2020; Rose & Tadi, 2020; Serlachius et al., 2019; Wechsler et al., 2019). It should be noted that social phobia is characterized by anticipated anxiety and hypervigilance to social stimuli and the fact that individuals with this pathology are concerned with social judgment, creates an ambiguous and unpredictable situation (Clauss et al., 2019). Thus, social phobia is associated with a high intolerance to uncertainty which suggests that ambiguous or uncertain situations are critical for the disorder (Clauss et al., 2019). It is possible to mention that this pathology affects more females than males (Cabral & Patel, 2020; Rose & Tadi, 2020).

Therefore, social phobia represents a continuum of several feared social situations (Leichsenring & Leweke, 2017). In these situations, individuals who have a social phobia avoid eye contact, divert their attention from external suggestions and focus on internal ones, which contributes to the persistence of fear (H. Kim et al., 2018; Lange & Pauli, 2019). Studies have shown that individuals with this pathology show less fixation on the face, especially avoiding the eye region, which is perceived negatively by other people, as well as this type of behavior becomes more evident as the emotional intensity increases (H. Kim et al., 2018). People with angry or irritated facial expressions are more avoided compared to people with neutral or sad facial expressions (Lange & Pauli, 2019).

Social situations can be grouped into different groups that involve observation, interaction, and performance (National Collaborating Centre for Mental Health, 2013; Wechsler et al., 2019). As such, these include meeting people, talking in groups or more specific situations, such as at meetings, talking to authority figures or giving presentations, starting conversations, being seen in public, eating or drinking while being watched, working, going shopping, among others (Emmelkamp et al., 2020; National Collaborating Centre for Mental Health, 2013; Wechsler et al., 2019). Individuals with social phobia will try to avoid the above situations, which is not always feasible (Hirsch, 2018; Miloff et al., 2015; National Collaborating Centre for Mental Health, 2013; Pepper et al., 2019; Perna et al., 2020). Consequently, this condition results in significant impairment in different occupations, which, consequently, translates into a decrease in quality of life (Ahmed-Leitao et al., 2019; Bas-Hoogendam et al., 2017; Cabral & Patel, 2020; Kampmann, Emmelkamp, & Morina, 2016; Kampmann, Emmelkamp, Hartanto, et al., 2016; Kishimoto & Ding, 2019; Leichsenring & Leweke, 2017; Miloff et al., 2015; National Collaborating Centre for Mental Health, 2013). Individuals with social phobia are more likely to have a low level of education, to be single, and to have a lower socioeconomic level (Cabral & Patel, 2020; Perna et al., 2020;

Rose & Tadi, 2020). Social phobia also has implications for society, particularly at the economic level, due to the loss of productivity and the costs of using healthcare (Miloff et al., 2015; Perna et al., 2020).

The course of social phobia tends to be chronic with the recovery rate being low (Canton et al., 2017; Clauss et al., 2019; Leichsenring & Leweke, 2017; Rose & Tadi, 2020). It is important to note that there are coexisting conditions such as other anxiety disorders, avoidant personality disorders, hyperactivity and attention deficit disorders, depressive disorders, and substance use disorders (Cabral & Patel, 2020; Leichsenring & Leweke, 2017). Therefore, social phobia is associated with an increased risk of behavioral problems, depressive and substance use disorders, as well as cardiovascular disease and increased risk of suicide (Bas-Hoogendam et al., 2017; Cabral & Patel, 2020; Leichsenring & Leweke, 2017).

About the etiology of social phobia, it is understood that it results from the interaction between several biopsychosocial factors, as in most psychiatric disorders that often lead to cognitive changes, such as the tendency to interpret most social situations negatively and to a propensity to inaccurately infer about the attitudes of peers, as well as the feeling and fear of being evaluated by others (Erin et al., 2017; Gray et al., 2019; Lange & Pauli, 2019; National Collaborating Centre for Mental Health, 2013; Serlachius et al., 2019).

Recent studies suggest that genetic and environmental factors explain most of the individual differences of people with this pathology (Leichsenring & Leweke, 2017; Rose & Tadi, 2020). Therefore, risk factors may include behavioral inhibition in childhood, family history of anxiety or other psychopathological conditions, the presence of negative life experiences, separation from parents, disturbed family environment, reduced academic performance, low self-esteem, sociodemographic characteristics, and physiological, genetic, and environmental factors (Ahmed-Leitao et al., 2019; Cabral & Patel, 2020; Leichsenring & Leweke, 2017; Rose & Tadi, 2020; Wang et al., 2020).

Exposure to phobic stimulus, in most cases, causes an immediate response to anxiety that can take the form of a panic attack linked to or predisposed to the situation (Paschali & Tsitsas, 2014). The phobic situation is usually avoided or is supported with intense anxiety or distress (Paschali & Tsitsas, 2014). Consequently, prevention often interferes with the person's routine occupational functioning, social activities, or relationships (Paschali & Tsitsas, 2014).

Several neuroimaging studies have supported that the amygdala and its connections play an important role in attributing emotional salience to stimuli and in the downward modulation of associative, attentional, and interpretive processes (Freitas-Ferrari et al., 2010). In anxiety disorders, an anomaly in the normal functioning of this circuit impairs communication with prefrontal areas responsible for inhibitory responses, which, consequently, causes an increase in amygdala responsiveness and a consequently sustained processing bias related to the threat in anxious individuals (Freitas-Ferrari et al., 2010). Some authors point out that, in this pathology, there is an increase in the activation of prefrontal areas to regulate (Bas-Hoogendam et al., 2017; Bruhl et al., 2014). However, this regulatory effect is not effective for controlling and regulating amygdala hyperactivation in individuals with social phobia (Bruhl et al., 2014). Other authors defend the reverse and ascending process, that is, that there is an increase in the activation of the prefrontal structures resulting from hyperactivation of the amygdala (Bruhl et al., 2014).

In turn, the insula plays a key role in the detection and interpretation of internal body states (Freitas-Ferrari et al., 2010). Furthermore, the insular cortex is involved in the recognition and experience of aversive states, such as disgust, fear, and pain (Freitas-Ferrari et al., 2010).

The hippocampus has been referred to in terms of emotional processing and regulation and response to positive stimuli, including autobiographical memories (Ahmed-Leitao et al., 2019; Zhu et al., 2019).

Several studies have suggested that, in social phobia, there is an increase in brain activation in the hippocampus (Bas-Hoogendam et al., 2017).

Thus, structural and activity changes in the amygdala, hippocampus, and insula have been proposed as biomarkers of social phobia (Cosci & Mansueto, 2020). People with this pathology show differences in the level of cerebral blood flow, which is increased specifically in the amygdala-hippocampus region, right dorsolateral prefrontal cortex, left inferior temporal cortex, and decreased in the cerebellum (Cosci & Mansueto, 2020). Since social phobia is associated with a high intolerance to uncertainty and unpredictability, as previously mentioned, studies show that social phobia moderates the relationship between the bed nucleus of the stria terminalis (BNST) and other brain regions in response to unpredictability (Clauss et al., 2019). Social phobia is associated with BNST connectivity and BNST-amygdala dissociation, thus moderating BNST's connectivity with the amygdala (Clauss et al., 2019). Individuals with low or medium social phobia had a stronger amygdala response to threat images, while individuals with high social phobia had an increased BNST response (Clauss et al., 2019).

Besides, multiple neurotransmitter systems, such as serotonin, dopamine, and glutamate, may be implicated in the pathogenesis of social phobia (Bas-Hoogendam et al., 2017; Cosci & Mansueto, 2020; Leichsenring & Leweke, 2017; Perna et al., 2020; Rose & Tadi, 2020). Neurobiological research also suggests that there is a dysfunction in the regulation of serotonin and dopamine, since there is a greater synthesis of serotonin and a lower striatal density of dopamine in individuals with social phobia (Bas-Hoogendam et al., 2017; Cosci & Mansueto, 2020; Leichsenring & Leweke, 2017).

Regarding the diagnosis, psychiatric disorders are commonly diagnosed in a clinical context and not through exams, through the reporting of symptoms and the completion of evaluation scales (Allsopp et al., 2019).

As for the diagnostic criteria, these include the fear of acting in a way or showing symptoms of anxiety that offend other people or lead to rejection, in addition to the fear of humiliation and of being assessed negatively; fear or anxiety is almost always caused by social situations and are disproportionate to the real threat posed by the social situation; fear, anxiety or avoidance are not attributable to the physiological effects related to substance abuse or other medical conditions, cause clinically significant distress or occupational impairment, are persistent for about six months or more, and are not best explained by symptoms of other mental disorder, among others (American Psychiatric Association, 2014; Leichsenring & Leweke, 2017; Park & Kim, 2020; Perna et al., 2020; Rose & Tadi, 2020). However, if fear or anxiety is restricted to speaking or acting in public, social phobia should be specified as performance anxiety (American Psychiatric Association, 2014; Leichsenring & Leweke, 2017). To assess the disproportion between fear or anxiety and real risk, the sociocultural context is recommended as a method of judgment, since the influences of culture may be important (Park & Kim, 2020).

As for its evaluation, an instrument used is the Anxiety and Avoidance Scale in Performance and Social Interaction Situations (AESDIS), being a self-answer questionnaire that measures the level of anxiety and avoidance in various situations of social interaction (Gouveia et al., 2003; Pinto-Gouveia, 1997). This scale is derived from the Liebowitz Social Anxiety Scale (LSAS) which assesses the degrees of anxiety in 24 situations (11 of social interaction and 13 of social performance) (Gouveia et al., 2003; Pinto-Gouveia, 1997). Pinto-Gouveia, Cunha, and Salvador (2003) added 34 new situations selected through clinical interviews with patients with social anxiety. AESDIS is composed of two subscales: the anxiety subscale and the avoidance subscale (Gouveia et al., 2003; Pinto-Gouveia, 1997). Answers to each of the items (58 items) are given on a 4-point Likert scale (Gouveia et al., 2003; Pinto-Gouveia, 1997). In addition to the items mentioned, five blanks are provided for the five situations that cause the highest levels of anxiety (Gouveia et al., 2003).

TREATMENT

The National Institute for Health and Care Excellence (NICE) and the Canadian Psychiatric Association present evidence-based clinical guidelines that allow for reliable recommendations regarding approaches to be taken in various health conditions (Leichsenring & Leweke, 2017; NICE Clinical Guidelines, 2013). NICE guidelines recommend using cognitive-behavioral therapy instead of drug therapy, while the Canadian Psychiatric Association considers both first-line pharmacological and non-pharmacological treatments (Leichsenring & Leweke, 2017).

Psychotherapeutic and pharmacological interventions that are effective in treating anxiety appear to specifically alter brain activation patterns in the brain structures mentioned above (Holzschneider & Mulert, 2011; Irle et al., 2010).

Regarding the treatment of phobias, several therapeutic approaches are applied, the most used being desensitization therapy, exposure therapy in vivo, exposure therapy using virtual reality, applied relaxation, cognitive-behavioral therapy, training of social skills, cognitive restructuring, mindfulness, and drug therapy in association or not with one of the previous interventions (Arroll et al., 2017; Donker et al., 2018; Felnhofer et al., 2019; Fernández-Álvarez et al., 2020; Gebara et al., 2016; Geraets et al., 2019; Hirsch, 2018; Kampmann, Emmelkamp, & Morina, 2016; Kampmann, Emmelkamp, Hartanto, et al., 2016; Kishimoto & Ding, 2019; Leichsenring & Leweke, 2017; Lindner et al., 2017; Miloff et al., 2015; National Collaborating Centre for Mental Health, 2013; Paschali & Tsitsas, 2014; Perna et al., 2020; Serlachius et al., 2019; Wechsler et al., 2019).

As for drug therapy, it appears to have an efficacy similar to cognitive-behavioral therapy in the short-term treatment of social phobia (Leichsenring & Leweke, 2017). Several drugs have been used, the selective serotonin reuptake inhibitors (SSRIs) being considered the first line (Emmelkamp et al., 2020; Leichsenring & Leweke, 2017; Perna et al., 2020; Rose & Tadi, 2020). These drugs have a low risk of side effects and have the advantage of beneficial effects in the treatment of depression and other anxiety-related disorders, which may be coexisting with social phobia (Leichsenring & Leweke, 2017). The continued use of this therapy after short-term treatment, about 14 weeks, has been associated with lower rates of relapse (Leichsenring & Leweke, 2017). Evidence suggests that treatment should be continued for at least about 3 to 6 months after an individual responds (Leichsenring & Leweke, 2017). Thereafter, the use of the drug can be gradually decreased (Leichsenring & Leweke, 2017). Benzodiazepines, such as clonazepam and bromazepam, and beta-blockers, such as propranolol, have also been considered for treatment (Leichsenring & Leweke, 2017; Perna et al., 2020; Rose & Tadi, 2020). These drugs are used in individuals with performance anxiety (Leichsenring & Leweke, 2017). However, benzodiazepines can cause sedation and present risks of physiological dependence and withdrawal symptoms and are not considered in individuals with depression or a history of substance abuse (Leichsenring & Leweke, 2017). It is important to add that tricyclic antidepressants are not considered in the treatment of people with social phobia (Leichsenring & Leweke, 2017).

In vivo exposure consists of building a hierarchy of feared situations (from the least to the most feared) and encouraging the individual to repeatedly expose themselves to situations, starting with less anxiogenic situations and gradually moving on to situations that trigger greater anxiety and insecurity as confidence develops (Donker et al., 2018; Erin et al., 2017; National Collaborating Centre for Mental Health, 2013). Exposure exercises involve confronting real-life social situations through role-plays (National Collaborating Centre for Mental Health, 2013). It is noteworthy that this technique is based on the assumption that avoiding fearful situations promotes the maintenance of social anxiety and is one of the most effective methods for the treatment of social phobia (Donker et al., 2018; Gebara et al., 2016; Kishimoto & Ding, 2019; Lindner et al., 2017; National Collaborating Centre for Mental Health, 2013). However, the traditional aspect of this therapy has some disadvantages, namely the fact that phobic stimuli may not be easily accessible, difficult to acquire or maintain, or difficult or impossible to manipulate and control during the exposure session (Lindner et al., 2017).

As for applied relaxation, it is a specialized form of relaxation that aims to teach individuals to be able to relax in common social situations (National Collaborating Centre for Mental Health, 2013). It starts with progressive muscle relaxation training that allows a series of steps for individuals to apply relaxation in everyday anxiogenic situations (National Collaborating Centre for Mental Health, 2013). The final phase of treatment involves the intensive practice of using relaxation techniques in social situations in a real context (National Collaborating Centre for Mental Health, 2013).

Mindfulness in this pathology aims to encourage individuals to psychologically distance themselves from negative emotions and thoughts, having two aspects: stress reduction and cognitive therapy based on mindfulness (Leichsenring & Leweke, 2017; National Collaborating Centre for Mental Health, 2013). Treatment begins with therapeutic education about stress, social anxiety, and meditation techniques (Leichsenring & Leweke, 2017; National Collaborating Centre for Mental Health, 2013). Individuals must participate in therapeutic groups weekly where they learn meditation techniques, and formal meditation practice is also encouraged for at least 30 minutes daily (Leichsenring & Leweke, 2017; National Collaborating Centre for Mental Health, 2013).

In turn, social skills training is based on the assumption that people are unable to deal with anxiety in social situations, partly because they have deficits in terms of their social skills, need to improve them to regulate their emotions and behaviors in their interactions with others (National Collaborating Centre for Mental Health, 2013). This technique involves systematic training of non-verbal social skills (for example, increased eye contact, caring and friendly posture, etc.) and verbal social skills (for example, how to start a conversation, how to give positive feedback to other people, how to ask questions that promote conversation, and so on) through role-plays in sessions and homework (National Collaborating Centre for Mental Health, 2013).

Concerning cognitive-behavioral therapy (CBT), it assumes that it is not the context or the circumstances that make a person suffer emotionally, but rather the perceptions, beliefs, and assumptions about the situation (Apolinário-Hagen et al., 2020). Thus, this therapy aims to modify non-adaptive cognitions and behaviors, challenging dysfunctional thoughts and beliefs, through the use of cognitive and behavioral strategies, including cognitive restructuring and exposure, for example (Apolinário-Hagen et al., 2020; Gebara et al., 2016; Kampmann, Emmelkamp, & Morina, 2016; Kampmann, Emmelkamp, Hartanto, et al., 2016). Cognitive-behavioral therapy has been indicated as the most effective non-pharmacological approach in the treatment of social phobia, is considered a first-line treatment (Apolinário-Hagen et al., 2020; Emmelkamp et al., 2020; Erin et al., 2017; Leichsenring & Leweke, 2017; Perna et al., 2020; Rose & Tadi, 2020).

Regarding cognitive restructuring, it does not have a clear and universal definition, it is rather a set of techniques, procedures, and psychotherapeutic approaches (Cebrián et al., 2017). There is little precision regarding its definition, the most mentioned being the importance of following a procedure that must specify the when and where of its application (Cebrián et al., 2017). It is one of the most used techniques in psychological intervention in clinical practice and is commonly associated with cognitive behavioral therapy and presupposes a change in the client's thinking (Cebrián et al., 2017; Larsson et al., 2015). The literature considers a technique difficult to apply due to the lack of structure (Cebrián et al., 2017).

Systematic desensitization is a therapeutic approach based on the principle of reciprocal inhibition that comprises three stages of deep muscle relaxation training, building a hierarchy of fear and presenting the signs of anxiety, bringing them closer to the relaxation experience so that relaxation inhibits the anxiety (Janardhan Reddy et al., 2020).

Finally, in exposure therapy using virtual reality (VRET), individuals are confronted with stimuli that are generated through the computer, such as virtual social interaction, and these stimuli can cause high levels of social anxiety (Erin et al., 2017; Felnhofer et al., 2019; Kampmann, Emmelkamp, Hartanto, et al., 2016). Virtual Reality emerged as a more fascinating alternative to conventional treatment and consists of a simulation system through the use of a computer, which allows creating virtual environments and the feeling of presence in these environments, presenting an immersive visual and auditory experience (Ben-Moussa et al., 2017; Donker et al., 2018; Fernández-Álvarez et al., 2020; Kishimoto & Ding, 2019; Lindner et al., 2017). The virtual environments can be personalized and controlled, to trigger specific stimuli that allow practicing social behavior in various environments, which can be repeated to achieve therapeutic goals and the therapist can provide feedback on the same (Donker et al., 2018; Fernández-Álvarez et al., 2020; Gebara et al., 2016; Geraets et al., 2019; Kishimoto & Ding, 2019; Lindner et al., 2017). Studies have suggested that this therapy has positive effects on psychiatric illnesses, namely in the treatment of social phobia, reducing its symptoms (Donker et al., 2018; Erin et al., 2017; Felnhofer et al., 2019; Gebara et al., 2016; Geraets et al., 2019; Kampmann, Emmelkamp, & Morina, 2016; Kampmann, Emmelkamp, Hartanto, et al., 2016; Kampmann et al., 2019; H. Kim et al., 2018). This therapy associated with cognitive-behavioral therapy has the consequences of reducing social anxiety and depressive symptoms and increasing quality of life (Erin et al., 2017; Geraets et al., 2019). VRET has advantages compared to in vivo exposure, such as the possibility of performing therapy within a physical space, without having to leave, offering more flexibility as to the intensity of treatment and grading of exposure, the control of phobic stimuli, greater acceptability of exposure by individuals being treated, among others (Donker et al., 2018; Emmelkamp et al., 2020; Fernández-Álvarez et al., 2020; Lindner et al., 2017).

GAMIFICATION

Currently, special attention has been paid to computerized and mobile interventions due to their potential to reduce costs and increase treatment accessibility (Dennis & O'Toole, 2014; Miloff et al., 2015). Therefore, cognitive-behavioral interventions have been used through the computer, using virtual reality, instead of traditional techniques, which were based on imagination (Christie et al., 2019; Felnhofer et al., 2019; Kampmann, Emmelkamp, Hartanto, et al., 2016; Kishimoto & Ding, 2019; Miloff et al., 2015). According to the American Psychological Association, virtual reality would be preferable for realizing the preferences of individuals being treated, which is one of three aspects in providing adequate evidence-based practices, in addition to presenting itself as a more attractive exposure tool. compared to in vivo exposure, as previously mentioned (Fernández-Álvarez et al., 2020). In addition to this, virtual reality has shown to play an important role in treatment satisfaction (Fernández-Álvarez et al., 2020).

However, there is some difficulty in implementation due to the difficulty of access caused by the cost, the lack of specific training, technical obstacles, as well as the limited accessibility (Christie et al., 2019; Donker et al., 2018; Fernández-Álvarez et al., 2020).

The concept of gamification has been defined by several authors as the use of game design elements in non-game contexts or considered as a process of improving service with resources for gaming experiences, to support the user in creating global value (Brown et al., 2016; Cheng et al., 2019; Fleming et al., 2017; Lindner et al., 2017; Pham et al., 2016; Sánchez & Gómez Trigueros, 2019; Sardi et al., 2017). It is based on the principles of serious games, not having the purpose of having fun in the game, but working on skills that can be applied in the daily situations of the player (Cheng et al., 2019). This means that instead of creating immersive and complete games as in "serious games", gamification aims to change users' behavior and motivation through remaining gaming experiences (Brown et al., 2016; Cheng et al., 2019; Fleming et al., 2017; Lindner et al., 2017; Sardi et al., 2017). In the literature, the term "serious games" refers to games designed and created specifically for education, training, or behavioral modification (Lau et al., 2017; Zhang et al., 2018). One of the frequent uses of serious games is to solve social problems (Floryan et al., 2019).

Health-centered gamification involves the intersection of persuasive technology, serious games, and personal computing, as it requires the application of specific design principles or resources capable of inducing changes in targeted behaviors and experiences, based on intrinsically motivating qualities of well-played games simultaneously tracking individual behaviors through goal setting and feedback on individual progress (Johnson et al., 2016).

Thus, gamification aims at a double improvement, which consists of making activities more pleasant, while ensuring the involvement of people in tasks that seem demotivating (Lindner et al., 2017; Pham et al., 2016; Sardi et al., 2017; Turan et al., 2016). Also, it has emotional, cognitive, and social benefits as it stimulates various cognitive functions such as decision making and problem-solving, promotes knowledge acquisition, and develops positive social relationships (Abu-dawood, 2016; Pham et al., 2016; Sardi et al., 2017; Turan et al., 2016). Concerning the social benefits related to gamification, the main ones are to develop positive social relationships and promote a feeling of integration (Fleming et al., 2017). Social influence can also invoke a sense of competition to achieve a higher status on the leaderboard, resulting in numerous emotional competencies, such as self-satisfaction, self-esteem, and pride (Abu-dawood, 2016; Sardi et al., 2017).

In addition to what was previously mentioned, gamification also develops strategic players' skills, improving working memory, visual attention, and processing speed (Lumsden et al., 2016). Typically, the various game mechanics potentially involved in gamification are considered an anchor point for players to ensure a flow of cognitive skills, such as achieving a state of concentration, developing problem-solving skills, and acquiring a sense of goal orientation (Ruhi, 2015; Sardi et al., 2017).

As for the player's involvement, this can be explained by a motivational model derived from the theory of self-determination (Lee, 2016). This model stipulates that the satisfaction, immersion, and enjoyment of a game are mediated by how the game meets the psychological needs of autonomy, competence, and relationship (Lee, 2016).

It is also noteworthy that there are several gamification resources namely history/theme, progress, feedback, leaderboards, setting goals, rewards, challenges, badges/trophies, points, and levels or game leaders (Brown et al., 2016; Fleming et al., 2017; Lindner et al., 2017; Pham et al., 2016).

Gamification is a cognitive-behavioral technique that has been widely studied (Cheng et al., 2019). As previously mentioned, this type of intervention has been widely used in the health area, since it increases motivation and involvement in interventions (Cheng et al., 2019; Lindner et al., 2017; Linke et al., 2019; Sardi et al., 2017).

GAMIFICATION AND EXPOSURE THERAPY USING VIRTUAL REALITY

Combining gamification with VRET has advantages since gamification can reduce negative treatment experiences, gamified scenarios can be reproduced regularly, which consequently allows the individual to continue to face phobic stimuli, even after treatment (Lindner et al., 2017). The fact that it allows you to continue to face phobic stimuli after treatment can reduce the risk associated with returning to fear (Lindner et al., 2017). To ensure the effectiveness of gamification, so that it does not deviate from the therapeutic objectives outlined, the culture, gender, socioeconomic level, and age group of individuals must be considered (Lindner et al., 2017). Virtual Reality, like gamification, also allows to increase the participation and adhesion of individuals in the treatment (Cheng et al., 2019; Fernández-Álvarez et al., 2020; Lindner et al., 2017; Linke et al., 2019; Sardi et al., 2017). In this sense, the development of applications and interventions using gamification and virtual reality has been increasingly developed (Fernández-Álvarez et al., 2020).

GAMIFICATION AND SOCIAL PHOBIA

Recent studies show that gamification is commonly applied to interventions for the treatment of chronic diseases and although there are interventions to mental health, these are few (Cheng et al., 2019; Hopia & Raitio, 2016). However, although there are few studies in this regard, there is evidence that these interventions have positive effects on mental health (particularly depression and anxiety), particularly among young people, especially those who require internet access (Christie et al., 2019). In young people and young adults, in particular, gamified interventions have several advantages such as being more appealing, reducing stigma, and increasing compliance (Dennis & O'Toole, 2014). Considering the conclusions drawn from the studies presented, gamification can have positive effects on social phobia.

ARTIFICIAL INTELLIGENCE

Artificial Intelligence, it was defined as the science and engineering of making intelligent machines (Graham et al., 2019). Although intelligence is defined as a human characteristic, the associated artificial word refers to a form of computerized intelligence (Graham et al., 2019). The use of AI has been studied, particularly in mental health, despite being an area in which health professionals tend to take a more personal approach (Davenport & Kalakota, 2019; Graham et al., 2019; Weisel, 2018). Artificial Intelligence has great potential for a greater understanding of the client's status since, through this tool, it is possible to observe the client's profile and thus holistically understand their mental health (Graham et al., 2019). The positive result of the application of AI to mental health intervention is the adherence that individuals have to the use of mobile phones for this purpose (Davenport & Kalakota, 2019). The greater the involvement of individuals in their rehabilitation, the better the results, and the AI is believed to provide this involvement (Davenport & Kalakota, 2019).

OTHER STUDIES

As mentioned earlier, there are few studies on the use of virtual reality and gamification in social phobia (Emmelkamp et al., 2020). From the studies carried out, the main conclusions were that the use of virtual reality in the treatment of individuals with social phobia has positive effects (Anderson et al., 2013; Ben-Moussa et al., 2017; Kampmann, Emmelkamp, & Morina, 2016; Klinger et al., 2005; Opriş et al., 2012; Wallach et al., 2009). In a study by Klinger et al., individuals participated in virtual conversations in a meeting room and at a dinner table, and they were being analyzed and needed to assert themselves against the virtual agents (Klinger et al., 2005). The conclusions drawn were that this treatment is similarly effective compared to group CBT (Klinger et al., 2005). In turn, Wallach et al. also found similar effects to CBT in a public speaking task in a virtual reality setting (Wallach et al., 2009). In addition, another conclusion drawn was that dropout rates were lower (Wallach et al., 2009). Likewise, Anderson et al. they also concluded that there was a significant improvement in a public speaking task in a virtual reality setting and found no difference between VRET and *in vivo* (Anderson et al., 2013). In addition, they concluded that the effect is stable over 1 year after treatment (Anderson et al., 2013). Finally, Kampmann et al. reported that preliminary evidence indicates that VRET may have effects comparable to active treatments and that it has reduced the symptoms of individuals with social phobia (Kampmann, Emmelkamp, & Morina, 2016). In this study, individuals with social phobia were exposed to situations of virtual speech, job interviews, conversations with strangers, product returns in a supermarket, among others (Kampmann, Emmelkamp, & Morina, 2016). The therapist could adjust the number, gender, and gestures of the avatars, the friendliness, and, to some extent, the content of the dialogs depending on the needs of the individuals, the anxiety, and the progress of the treatment. Like Opris et al., Kampmann et al. they also concluded that VRET is just as effective as classic evidence-based interventions (Kampmann, Emmelkamp, & Morina, 2016; Opriş et al., 2012). Several studies also report that virtual social environments can be used successfully for therapeutic purposes (Emmelkamp et al., 2020; Felnhofer et al., 2019; Hartanto et al., 2014; H. Kim et al., 2018; Kishimoto & Ding, 2019; Lange & Pauli, 2019). Another study found that VRET was as effective as group CBT (Emmelkamp et al., 2020). Bouchard et al. concluded that CBT and VRET together were more effective compared to CBT and *in vivo* exposure (Bouchard et al., 2011). It is important to refer that most studies used virtual reality systems with immersive headsets (Emmelkamp et al., 2020).

Although studies carried out to date document positive effects regarding the use of virtual reality in the treatment of social phobia, most focus on the fear of public speaking, neglecting other contexts in which symptoms of social phobia may occur (Ben-Moussa et al., 2017). Besides, the majority of studies were carried out with people between 13 and 16 years old (Emmelkamp et al., 2020). Therefore, it is recommended to establish a treatment program that involves various symptoms of social phobia and that allows specific adaptations to the individual (Ben-Moussa et al., 2017; Emmelkamp et al., 2020).

PROPOSAL OF A TREATMENT PROGRAM

In this line of thought, the authors' main objective is to create a gamification program associated with the development of social skills, to bridge deficits in individuals with social phobia. In this program, each user will be able to create an avatar and there will be a table of classifications, as well as psycho-educational tips.

Individuals with social phobia have low levels of social interaction and high levels of negative affect associated with these interactions, that is, a set of negative emotions such as fear associated with social interactions (Morrison et al., 2016). Given these difficulties, it is possible to state that individuals with social phobia have unregulated empathic experiences (Morrison et al., 2016). These empathic difficulties can explain a large part of the social changes of these individuals (Morrison et al., 2016).

Regarding empathy, this is the set of cognitive and affective components, with cognitive empathy being the perception of the emotional state of the other, while emotional empathy is the response given with the same emotion, to the emotion perceived in the other (Morrison et al., 2016). These individuals show difficulties mainly in terms of cognitive empathy, showing difficulties in the theory of mind, that is, in the ability to perceive the emotions expressed by others (Morrison et al., 2016). In this sense, the literature refers that individuals with social phobia tend to perceive the verbal and non-verbal behavior of others as negative, increasing their levels of anxiety (Morrison et al., 2016).

Thus, considering the empathic deficits, it is proposed to create avatars at the beginning of the game. In this way, players will be able to express what they are feeling more clearly so that participants with social phobia can interact more efficiently and with lower levels of anxiety. This program will have a classification table in which each user can consult his classification. To be better classified in the table, extra social tasks will be available which, after completing, correspond to points which, consequently, allows the gain of more points.

To increase positive reinforcement, there will be notifications of psychoeducation that consist of providing support to each person using tips regarding their pathology and the treatment in which they are inserted. In the same sense, there will be notifications of motivational phrases with associated positive reinforcement. Each person will also be able to communicate with the therapist or with other users, through a chat, which will allow them to talk about their experience, how they felt during the sessions, or during the week, as well as about their progress/evolution. If they communicate with other users, the person can choose to send the message anonymously, to reduce their exposure.

Regarding these notifications, they must be presented as messages throughout the games and adjusted to the player's performance and needs, adopting an Artificial Intelligence (AI) system, which will be programmed for the different possible performances. This program must be associated with an application on the customer's mobile phone so that the customer can receive messages throughout the week, to keep in touch with progress and maintain involvement in rehabilitation.

It is important to note that this program will ensure the protection of each individual's data, with no sharing of personal and confidential information, both during sessions, as well as in conversations between the client and the therapist, or between the client and other players. In the same vein, the application associated with the program meets all confidentiality requirements.

Through the non-probabilistic convenience technique, as individuals voluntarily agreed to participate in the study, they would be selected according to inclusion and exclusion criteria, and to the more accessible contact. Inclusion criteria to participate in the study would be social phobia (more than 115 points on the AESDIS) and over the age of 18 years, motivation, and willingness to participate in the study. Exclusion criteria were individuals with health problems that prevented exposure to virtual reality, namely labyrinthitis, and have no smartphone.

The participation of individuals in the study would be formalized by completing the informed consent form, to ensure their rights and access to all information relevant to the decision to participate in the study. The privacy and confidentiality of the collected data would be also attested. In this study would be utilized a Clinical Interview, Demographic Characterization Questionnaire, and AESDIS. Collected data would be analyzed using the IBM SPSS Statistics 26 software. In terms of sociodemographic characterization of the participants, descriptive statistics would be used and taking into account the variables used, the mean and mode would be calculated as a measure of central tendency, the standard deviation as a measure of dispersion, and the absolute frequencies and frequency of each characteristic under analysis. Regarding the verification of significant changes before and after the implementation of the intervention protocol, inferential statistical analysis procedures would be used, assuming for all statistical tests a significance value (α) of 0.05 (Marôco, 2014; Pereira, 2008; Pestana & Gageiro, 2014).

The objective of the program is to check the impact of gamification in the treatment of social phobia. The hypotheses raised would be (1) gamification has an impact on the treatment of individuals with social phobia and (2) gamification has no impact on the treatment of individuals with social phobia.

PROGRAM

Therefore, a seven-level program was structured. In this program, the individual will have to perform various social tasks to pass the game levels, solving challenges alone and in a group.

The desensitization therapy program using gamification and virtual reality consisted of 15 sessions: an initial evaluation session, 13 biweekly exposure therapy sessions, and the last reevaluation session corresponding to a total program duration of 7 weeks. At the beginning of each session, an abdominal breathing exercise will be carried out to reduce anxiety levels. It is important to note that an initial and final evaluation will be carried out to understand the impact of the program on individuals with social phobia.

Each session, lasting approximately 50 minutes, follows a formal structure consisting of the following phases: Preparation and Warm-up of the Participant; Personalized and progressive exposure to social interaction associated with systematic desensitization games; and Relaxation and Feedback. This treatment strategy, therefore, consists of a combination of therapeutic ingredients, which includes exposure to fear-triggering stimuli, therapeutic instructions, monitoring client progress, performance feedback, and contingent performance enhancement.

The intervention focused on shaping appropriate approach behaviors through a process of successive approximations. The treatment was achieved by reducing the flight from the feared situation, assuming that the absence of consequences results in the extinction of fear, a common ingredient of exposure therapies. (Landowska et al., 2018; Verkuyl et al., 2018). The performance of approaching behaviors was facilitated by strengthening approaches and removing the negative reinforcement of avoidance. The grading of the exhibition was based on a duration of time (between 15 and 30 minutes) or several practical exhibitions with different levels of complexity and intensity.

The proposed plan involves several games, with each level gradually increasing the social interaction necessary to overcome it, making it possible to adapt the game to the difficulties presented.

The main objectives are to improve verbal communication with peers and social interaction, deal with their own emotions, understand and interpret non-verbal communication, manage anxiety and crises, reduce disruptive thoughts, decrease social isolation, encourage the use of coping strategies.

First Level

The player must be in a quiet place and must be alone. At this level, the individual must play Packman, and if he is eaten by the ghost, he must go to the supermarket to recover his life. At the end of the game, he must perform another social task, such as communicating with the employee. It is important to emphasize that in the supermarket there will be more players who will be able to communicate with him and may also express different emotions through facial expression.

Second Level

At this level, the individual must continue to play Packman, and if he is eaten by the ghost, to recover his life, the individual communicates with someone in the game, that is, he will have to talk to his virtual partner for a minute about his favorite food.

Third Level

The player will continue to play Packman, and if he is eaten by the ghost, to recover his life, have a conversation with the other person, for two minutes, without showing emotional, behavioral, and physiological symptoms inherent to the behaviors observed in social phobia (such as fear that the other person will notice that he is nervous, shortness of breath, increased sweating). You must make eye contact and be able to ask a question. It is important to note that this level will be carried out using virtual reality.

Fourth Level

The participant will continue to play Packman, and if he is eaten by the ghost, should go for coffee with the same partner on the second level, since you have already had contact with them, this will help to reduce anxiety levels, to recover his life.

Fifth Level

The individual will continue to play Packman, and if he is eaten by the ghost will have to mimic in trios, to recover his life. Therefore, the player will have to represent, through mimicry, a phrase that the other participants will have to guess. With the level increase, you will have to mimic, first, with one more person and then with 2 people, and in these cases, each element can only use one arm, the other arm being attached to the partner's arm of play.

Sixth Level

The individual will continue to play Packman, and if he is eaten by the ghost will have to participate in a quiz with a group of five people, in which you have to communicate and agree on the final answer with everyone agreeing, to recover his life.

Seventh Level

The player will continue to play Packman, and if he is eaten by the ghost, to recover his life, should perform a role play that consists of participating in a debate on a subject with another person, having to defend your point of view, presenting your arguments with the minimum of emotional, behavioral, or physiological symptoms inherent to the pathology.

Figure 1.

Nº	**Tasks**
Session 1	Task 1. Informed consent with authorization for filming Task 2. Demographic Characterization Questionnaire and Clinical Interview Task 3. Anxiety and Avoidance Scale in Performance and Social Interaction Situations Task 4. Teaching Breathing Exercise Task 6. Exposure **(adjusted to the reported level)** Task 8. *Feedback*, Scheduling Sessions
Session 2	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions
Session 3	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions
Session 4	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions
Session 5	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions
Session 6	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions
Session 7	Task 1. Breathing exercise/relaxation Task 2. Preparation for exhibition Task 3. Exposure **(adjusted to the reported level)** Task 4. *Feedback*, Scheduling Sessions.

It is important to emphasize that, since it is an individualized program and adapted to each person, the order of the levels can be changed, depending on the results obtained from the evaluation carried out in the first session through the interview and the Anxiety and Avoidance Scale in Situations of Performance and Social Interaction, that is, according to the most exacerbated difficulties of each person.

Regarding the continuation of the game, it only continues after all the social tasks corresponding to the level in question have been completed. All topics for debate, mime, and quiz will be selected by the game's program, depending on the player's rating.

SOLUTIONS AND RECOMMENDATIONS

It is important to refer that this program was not applied, so the authors don't have any solution for vies in the program.

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Chapter 10
Positive Play:
Games for Human Potential and the Yet Unexplored Case of Anorexia Nervosa

Pedro Cardoso
University of Porto, Portugal

Viviane Peçaibes
University of Porto, Portugal

Bruno Giesteira
https://orcid.org/0000-0003-4896-6659
University of Porto, Portugal

Liliana Correia de Castro
Instituto de Ciências Biomédicas de Abel Salazar

ABSTRACT

This chapter's first goal is to present the concept of Positive Play as an expression of play focused on social, psychological, and physical well-being and human potential. It presents some of its foundations in the form of eight maxims that emerged from an analysis on various games developed in the industry and in research settings. Afterwards, it demonstrates of how Positive Play can be integrated in different contexts of action, from diagnosis and intervention to contexts focused on prevention and promotion of awareness and knowledge in the scope of mental health, regarding treatment for Anorexia Nervosa, through a series of in-progress case studies in the form of game prototypes.

INTRODUCTION: IN THE AGE OF POSITIVE PLAY

Being positive and happy is the more natural state. (…) Self-improvement is a gradual process that accepts all manners of ups and downs. But it should start today. Not tomorrow because tomorrow never comes. (De Bono, 2018, p. 41)

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People's self-reports of their subjective well-being are today a focus of public debate. The Report by the Commission on the Measurement of Economic Performance and Social Progress argued that economic performance is an insufficient indicator of societal progress, and that self-reported well-being is to be considered as one of such indicators (Stiglitz et al., 2008).

According to the World Health Organization (WHO), health is defined as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. Two of the 2013-2020 WHO's mental health action plan major objectives consist of implementing strategies for strengthening information systems, evidence, and research for promoting mental health and preventing disorders. According to the Greenbook from the European Community Commission, it is mental health that allows the expression of human intellectual and emotional potential, as well as integration in school, work, and society. It is then safe to say that good mental health allows people to fully explore their human potential, to cope with the stress of life, to work productively and to contribute to their community.

Human Potential theory has emerged as an important framework for assessing individuals' well-being within an organization allowing them to develop a variety of human capabilities that foster the flow of experiences (Calvo & Peters, 2014; Peterson, 2006; Seligman & Csikszentmihalyi, 2000; Vesterinen, 2001). We can define human potential as the ability for human-beings to improve themselves through study, training, and practice. This often means working on the edge of one's abilities and competencies to improve at intrapersonal, interpersonal, and social levels, sometimes in the face of hardship and affliction.

To play is to be in the world. Playing is a form of understanding what surrounds us and who we are, and a way of engaging with others. Play is a mode of being human. (Sicart, 2017, p. 1)

The potential of games has been explored to achieve the most diverse goals in the most diverse areas of knowledge and fields of study. In the context of healthcare, many are those that aim to foster human potential and well-being, in treatment and prevention contexts and usually featuring multi-disciplinary teams. In this context, more than providing answers, this chapter aims to raise questions regarding current directions of Game Design applied to Healthcare and human potential.

The first mission of this chapter is to present a novel concept in Game Design and Game Studies we call *Positive Play*. Positive Play is a term that derives from Positive Computing (Calvo & Peters, 2014), which consists of the design and development of technology to support human potential and well-being. Positive Play takes its premise, detaches it from the design of technology and localizes it to the humanistic field of the Design of games and play. The second mission of this text is to support the concept of Positive Play with a series of case studies developed in the scope of mental health, in an yet unexplored context: that of Anorexia Nervosa.

This chapter is divided into four major sections. The first is about defining the concept of Positive Play. The second presents eight maxims that seed foundations for a future manifesto of Positive Play, presenting a series of cases in distinct contexts and across diverse fields of knowledge in which Positive Play can be witnessed. The third section explores such concepts in the scope of Healthcare presenting six games that are being developed with multidisciplinary teams, resorting to co-design methodologies to consider the feedback of clinical populations of patients with Anorexia Nervosa, researchers, clinicians, psychologists, psychiatrists, and others involved parties. Afterwards, conclusions are drawn, and future work is pinpointed.

START POSITIVE PLAY

The desire to do 'good with technology' has emerged from a shared experience that technology has a major impact on how we live, that it has the capacity not only to increase stress and suffering, but also to improve lives individually and en masse. (Calvo & Peters, 2014)

Following this line of thought, Rafael Calvo and Dorian Peters coined the term 'positive computing' as the design and development of technology to help its users achieve their potential and well-being. Positive computing is a philosophy that considers that, not only well-being in the design of technology is an achievable goal, but also that it is valuable to build digital environments able to promote resilient, happy and healthy people (Calvo & Peters, 2014). Various successful initiatives have been witnessed in recent times,[1] however, games still struggle to be recognized by many (including scientific communities) as tools with the potential to aid clinical and other societal demands. Playing is often misunderstood as a mere inconsequential distraction or a pleasurable infantile activity[2].

Games have been beside us for as long as we can be remembered by History. Even in other animals, playing is present throughout life since birth. It is usual for us to play during our infancy. It is usual for us to play when growing up. It is usual to play in adulthood, in old age. And it is usual to play with others. In sum, it is simply usual to play. This has been an evident fact in diverse societies and cultures. Play is then an ubiquitous phenomena and part of what makes us human.

This ubiquity of play gives us clues to its neurobiological richness and adaptive function namely regarding social interaction and learning, and to the fact that there is more to play than a superficial overview is able to see. The denial of the relevance of playing in certain facets of human life gave rise to a quite unexplored field of research, with insurmountable potential, and undoubtful return of investment. It is safe to say that playing games is more than to have fun. Games are able to provide playful environments that are conducive to the development of social skills and capable of working with the social dynamics between people (Bogers & Sproedt, 2012). Minina and Nikitina (2012) explain that games are attractive in this sense because the development and sharing of knowledge happens concomitantly with the emotional exchanges that are natural factors in human interaction. To play is to engage in a dialogical and dialectical relationship with other players and with the game designer through a computational system (Cardoso, 2016). To play is to understand a computational system through a humanistic perspective and to communicate through it. Therefore, to play is to communicate.

In the widely popularized hierarchy of motivation known as Maslow's pyramid (Mahadar, 2014; Maslow, 2013), self-actualization is identified at the highest level of basic human needs characterized by feelings of joy, wholeness, and fulfilment. Games are also keen on this. "Games make us happy because they are hard work that we choose for ourselves, and it turns out that almost nothing makes us happier than good, hard work." (McGonigal, 2011). In games, such "hard work" is translated into the actions players and the game system execute.

The non-trivial effort (Aarseth, 1997) exerted by players to influence the game and to experience a sense of agency (J. Murray, 2012), evidence them as action-based media (Galloway, 2006), in which without action there is no game (Lankoski & Heliö, 2002). Action is the drive for player experience and for the construction of meaning (Cardoso et al., 2019). The series of actions enacted by players and by the game system originate particular processes from which players construct meaning and learn from, in what is known as procedural rhetoric (Bogost, 2007). Procedural rhetoric is paramount in the design of serious games due to their focus besides entertainment.

As stated by Lyndsay Grace: “The play state is an exceptional mental space that allows players to focus, to be creative, and to engage differently than the everyday state.” (2019, p. 85) This means that, by their own nature, games excel at fulfilling human potential. Games are able to encourage positive changes in one’s behaviour as the playful situations they promote mobilize mental schemes that develop various aspects of personality, such as cognition, affection, socialization, motivation, and creativity (Huizinga, 1949). Games are also able to play a central role as tools to promote educational messages and to encourage positive actions to be applied in real life (Schuller et al., 2013). The premise of the design of such games is that playful behaviour can shape non-playful behaviour (Fogg, 2003; Grace, 2019). That is to say, when players feel capable of doing something in a game, they may also feel able to do that, or something analogous to that, outside of the game world (McGonigal, 2011) – e.g. to solve a problem, to overcome a challenge, to acquire, to practice or to improve a skill, or simply to be able to understand something or someone from an alternative perspective.[3]

The epithet ‘Positive Play’ is grounded on this theoretical scope. It is focused on the act of playing games designed as instruments to foster empowerment, inclusiveness, autonomy, resilience, awareness, quality of life, and life satisfaction in their players. To promote human potential in its players’ mental, physical, and social well-being is its purpose, its *raison d’être*.

In sum, Positive Play acts here. Positive Play acts in this context. Positive Play-based games follow the philosophy of Positive Computing, focusing on game action (Cardoso, 2016) as the driver for player experience to shape their procedural rhetoric (Bogost, 2007) and construct meaning for their players (Cardoso et al., 2019), and through these means to promote their human potential. Not disregarding the evident influence of technology present in games, Positive Play blooms from a humanistic worldview that is strong in Design studies.

PLAYING POSITIVELY: TOWARDS A MANIFESTO

So games are teaching us to see what really makes us happy — and how to become the best versions of ourselves. (McGonigal, 2011, p. 114)

The employment of Positive Play-based games in clinical settings is a window of opportunity to engage both caretakers, patients, and their families to better cope with mental illness and to gain insight and knowledge about mental health issues. Recent meta-analyses and literature reviews on serious games (Eichenberg & Schott, 2017; Zayeni et al., 2020) show that they can be considered innovative adjuncts or alternatives in the prevention and treatment of psychological and psychiatric disorders. As a result, today, we are witnessing games acting as effective stand-alone tools and instruments that are integrated in psychotherapeutic interventions, appealing to patients independently of age and sex (Eichenberg & Schott, 2017).[4]

In the scope of our study, we compiled a series of games for health and well-being, in order understand if and how they follow the premises of Positive Play, thus getting an overview of the phenomenon. The sample was constituted from an electronic collection in the main available databases. The Boolean descriptors used were *health, well-being,* and *wellbeing*, together with *game*, *gamification, serious game*, *video game*, *therapeutic game*, *board game, persuasive game*, and their respective plurals. After removing duplicates, the following eligibility criteria were applied: a) studies written in English; and b) descriptive studies on game design and development. Studies in other languages, studies of an exclusively clinical character, and studies that presented the term ‘game’ with the intent to characterise attitudes, behaviours, and so on, and not referring to games themselves (e.g. game of interests) were excluded. As a result, we were left with a total of 71 games in the following areas of study: Computer Science, Design, Education, Engineering, Game Design, Health Behaviour, Interactive Media, Medicine, Mental Health, Neuroscience, Nursing Science, Paediatrics, Physical Medicine and Rehabilitation, Psychiatry, Psychology, Social Science, Software Engineering, and Sports Science[5] (see Appendix 2).

Studying this sample, we realised that some games work towards common goals, defined in the next subsections as general maxims for a work-in-progress manifesto of Positive Play:

1. Make possible;
2. Follow-up;
3. Make adjustments;
4. Keep going;
5. Make headway;
6. Stay away from;
7. Hype up;
8. Have an Aha! moment.

The next eight subsections address these maxims. Each subsection is constituted by a brief description of the maxim it addresses, featuring examples of games that follow it.

Make Possible

Make possible focused games aim at interfacing players (or their caretakers or clinical staff) with whatever goals they aim or have to achieve. The onus of these games is to build bridges between them to enable, ease and/or facilitate players’ success. This can be seen in *Spaplay* (2016), a game focused on making players adopt healthy eating and physical exercise habits (Shiyko et al., 2016). The game serves as an interface between players and their goals because progress in the game depends on the activities players perform in their life outside of the game world, in which it tracks their physical activity by means of a fitness sensor.[6] It is also visible in *Shinpo* (2019), a game that promotes an active lifestyle among the elderly (Santos et al., 2019). The game encourages players to exercise by making them search for collectible cards while visiting locations in the real world. The game promotes social interaction where players can *like* the cards or the collection of other players and exchange cards with others. *Step by Step* (2018) is another example. It resorts to life stories to promote drug abstinence in its players, in which they learn from each other’s experiences (Peçaibes et al., 2018b). The game is focused on building bridges between players to help them achieve abstinence through the exchange of knowledge between patients, family members and therapists.

Follow-Up

Follow-up games are focused on inspecting players’ behaviours. Such actions can be addressed to clinicians, caretakers, teachers, etc. to inspect patients’ behaviours, or to players themselves in a logic of self-monitoring. *Echoes* (2014) is a game that does this by making players (autistic children) interact with a virtual character while informing teachers about their progress – something that wouldn’t be possible in the conventional circumstances of a classroom (Bernardini et al., 2014). *Dimmand* (2018) is focused on the identification of the nature of the learning difficulties in children with dyslexia (Sood et al., 2018). The game aims to help teachers and parents understand where the child is facing problems and what type of intervention is most suitable to help them. Both games provide information to the player's clinicians, caretakers and teachers in order to assist them in decision-making situations about the well-being of the player.

Make Adjustments

Games that follow the maxim *make adjustments* are focused on modifying or reconstructing a given routine, behaviour, or mindset already in effect. They usually aim to maximise or reduce certain aspects that can be quantified and to reorganise, to restructure, to reorient, or to adapt said behaviour, programme, or mindset. This maxim can be witnessed in *Deep* (2016). This game aims to adjust layers' breathing control in order to avoid anxiety attacks (Van Rooij et al., 2016). Although regulated breathing techniques are easy to learn, they are also prone to be performed incorrectly. This game aims at helping its players recognize and apply these techniques correctly and effectively. *Skip a Beat Heart Rate Game* (2014) encourages self-control in players (hyperactive children) by asking them to influence their own heart rate in order to be able to play.[7] The game uses players' heart rate as a means to control the playable character throughout the game world. *Antonyms* (2020) proposes adjustments to impulsive behaviour in children, by putting them in the role of a superhero that is called to save a kingdom in a game world that puts the player into conflict between what s/he is asked to accomplish and what is represented in the game world (Crepaldi et al., 2020). As such, to each situation, players are enforced to respond in a non-impulsive manner.[8]

Keep Going

The maxim *keep going* is about preserving or maintaining routines or behaviours already in effect. Games that follow this course of action are focused on helping players uphold and endure those behaviours. These games are about supporting, insisting, and nourishing. *Epic Allies* (2016) is a game to help young men with HIV keep going with their antiretroviral therapy (LeGrand et al., 2016). The game features a customisable dashboard in a daily newspaper format, that tracks players' moods and activities, such as exercise, smoking, drug use, and alcohol consumption. Along with players' personal profiles, the game features an internal social network that aims to develop a sense of community among players – according to its authors, social support is fundamental for these patients to adhere to treatment. *CliniPup* (2019) intends to serve as a means to preserve tranquillity in children that may feel anxious during preoperative occasions (Verschueren et al., 2019). It guides players through a typical day in surgery providing them with insight, adequate to their age, on the procedures about to happen. *Hope* (2018) aims to help children suffering from cancer to maintain healthy behaviours, by intertwining the actions performed in-game with those performed by players themselves, e.g. the player is solicited to jump for the playable character to jump in the game as well.[9] This allows clinicians to maintain physical exercise routines in these players' lives during treatment.

Make Headway

Make headway games foster progress, growth, and enhancement. These games are focused on expanding players' current horizons, maturing or evolving their world views, and on flourishing new insights. *OnTrack>The Game* (2019) prompts players (people with schizophrenia) to make progress by presenting them day-to-day situations they need to be able to accomplish (e.g. walk around the city with a map, visit other places around their neighbourhood, and so on), in a simulated virtual environment so that players feel confident to perform those tasks in their actual lives afterwards (Olivet et al., 2019). *Reflection Cards* (2018) intends to help players deepen a relationship with one another by fostering meaningful conversations.[10] Its cards feature questions aimed to inspire the sharing of stories and emotions, thus establishing a sense of connection, complicity, kinship, gratitude, and compassion, and promoting personal and collective growth. *Galexia* (2019) was developed to assist children with dyslexia.[11] By overcoming obstacles, enemies, solving puzzles, and exploring in-game unknown planets, they improve their reading and writing skills. The system is capable of self-adjusting to players' needs, based on their in-game results.

Stay Away From

Games that follow the *stay away from* maxim are focused on making players eschew behaviours or evading certain situations, circumstances, or venues. These games are about avoiding scenarios considered harmful or dangerous, about bypassing the latter through alternative routes, and about building awareness. *One Night Stand* (2019) is a card game that aims to help adolescents perceive risks in potentially dangerous situations and sexual partners (Hieftje et al., 2019). This game promotes the creation of a collectively created story in which the goal is to randomly choose a partner, a place and a situation, for players to realize the risks that can be predicted in each case and how to react. In *One Leaves* (2019) players take part in a horror story involving death and diseases caused by smoking.[12] Its gameplay portrays the fact that only one teenager in four abandons smoking, while the rest succumbs to addiction.[13] *Coco's Cove* (2015) is focused helping type 2 diabetic players (children) acknowledge that is important to stay away from food that may be hazardous for them.[14] In the game, players feed a character that gets grumpy and sleepy if fed with what causes them such harms, making the game harder to beat.

Hype Up

The maxim *hype up* is aimed at encouragement, inspiration, and provocation. Games focused on this maxim aims to stimulate or boost players' motivation and engagement with something considered beneficial for them. *Start the Talk* (2013) intends to stimulate and inspire parents and caretakers to talk affectionately with their alcoholic sons and/or daughters through a simulated conversation with a young alcoholic virtual person.[15] As the conversation progresses, the game indicates if players are performing well or going the wrong way. *Alpha Beat Cancer* (2017) intends to motivate and involve players (children with cancer) in their treatment, by demystifying the illness, teaching terminology and medical procedures in an adequate fashion to their age group.[16] *Physioland* (2020) aims to aid in the physical rehabilitation of children with reduced mobility as a result of neurological disease, displaying an animation of how the exercise is to be performed, at the beginning of each level (Martins et al., 2020). The game monitors players' physiotherapeutic activities through an environment with medieval narratives to motivate its players in maintaining healthy behaviours.

Have an Aha! Moment

Have an aha! moment maxim is about building the circumstances for the development of eureka moments, for moments in which one discovers something new to them. It is focused on leading players to build new discernments about something, on leading them to understandings and insights that were not covered in their initial reasonings about a particular subject. *Domestic Abuse Training Game* (2019) is focused on driving health professionals into building understandings about the impacts of domestic violence in its victims and their families.[17] The game intends players to test and develop their knowledge about key-issues, promote discussion, sharing and learning with one another. The randomness of the cards and their contents help players to rethink latent stereotypes in *Buffalo: The Name-Dropping Game* (2015). The game's mechanics are focused on raising awareness and making evident gender biases and other prejudices in their own worldviews, making players knowledgeable of a broader social diversity (Kaufman & Flanagan, 2015). *Friday Night at the ER* (2009) promotes a training experience on communication between medical teams.[18] Players perform distinct functions in a hospital in simulated critical situations. The game is, as such, based on a simulated experience that can be guided by a facilitator to construct new discernment on their players, training them for the real world. *Auti-Sim* (2013) is a metaphorical simulation of what it means to be an autistic child by manipulating the game system's outputs to the player to impede conventional socialisation with other in-game characters, e.g. when players get closer to other children in the game, audio gets distorted and louder and image gets blurred.[19]

THE YET UNEXPLORED CASE OF ANOREXIA NERVOSA

The development of therapeutic and serious games for mental health disorders is a growing field of research (Fleming et al., 2017; Lau et al., 2017). However, the field of eating disorders, and more specifically that of anorexia nervosa, is still poorly explored. In part, this is due to the complexity and difficulty associated with treatment.

Anorexia nervosa is one of the most challenging eating disorders that predominantly affects females, generally in their adolescence. Anorexia nervosa is a potentially fatal psychiatric illness and is associated with medical complications and other comorbid psychiatric disorders, such as anxiety and depression. This illness is characterized by severe weight loss and malnutrition. Generally, its course is protracted, has high morbidity (social, psychological, and physical problems), and a high mortality rate (Treasure et al., 2015).

Anorexia nervosa is one of the most difficult psychiatric illnesses to treat, bearing high personal and financial costs both for individuals and their societies (Resmark et al., 2019). Evidence-based treatment for anorexia nervosa shows mainly the benefit of family-based treatment for youth. For adults, no specific treatment demonstrates superiority. The recommended treatment is usually a combination of nourishment and psychotherapy (Watson & Bulik, 2013). It is a treatment conducted by a team of multidisciplinary specialists, and tailored according to the patients' individual, physical, psychological, and social needs. Outpatient treatment[20] of anorexia nervosa is generally privileged. However, inpatient treatment[21] is many times needed given the risks associated with poor response to ambulatory intervention or the presence of psychiatric comorbidities or medical complications (Vasquez & Martin, 2019).

Recent studies show that specialized treatments confer no advantage over comparator interventions in terms of psychological symptoms but only in weight-based anorexia symptoms at the end of treatment, not at follow-up (S. B. Murray et al., 2019). Additionally, other studies suggest that anorexia nervosa is associated with specific difficulties in the inference of emotional mental states, pointing to the importance of targeting socio-emotional processing in treatment (Brockmeyer et al., 2016). Future treatment will require a specific focus on the psychological symptoms of anorexia. Also, the importance of considering a neuropsychological understanding to develop a more individualized and personalized approach in the management of this illness is currently underlined in the literature (Kan & Treasure, 2019). Some add-on treatments[22] may be included in the inpatient's treatment with potential benefits, such as psychotherapy, psychoeducation, pharmacological treatment, and nutritional replacement (Suárez-Pinilla et al., 2015).

The involvement of family and significant others to support interventions early in the course of illness can be especially fruitful to produce sustained changes and reduce the long-term burden associated with anorexia nervosa. Positive Play can bear a role here by contributing to the development of games or ludic interventions that can complement acute-phase treatments and also target prevention. It can complement evidence-based treatment in therapeutic interventions (employed during inpatient or outpatient treatment) and in preventive interventions.

The 'Case of Anorexia Nervosa' was a chosen study because it highlights the contribution of Positive Play to mental health as a novel and promising area of intervention: 1) it straightforwardly illustrates the underlying complexity that interconnects healthcare solutions, gamification mechanisms, clinical practices and persons' idiosyncrasies; 2) there is very little to no production of games within the scope of Anorexia Nervosa; 3) the games we are developing and testing in this context are able to approach different aspects of the disorder (e.g. exploring communication among patients, therapists and families, fostering psychoeducation, promoting empathy, self-knowledge, awareness and insight), and are capable of targeting specific audiences (e.g. patients, family, friends, medical staff, and society in general). Preliminary tests conducted with some of these games help to consolidate the concept of Positive Play in the field of Game Design and to contributing to 'Solving Modern Healthcare Challenges'.

In order to discuss the application of Positive Play in the management of this complex psychiatric illness, we need to clarify how Positive Play based games and ludic interventions can be integrated and complement conventional medical and psychological treatments. With that in mind, over the next sections we demonstrate potential of Positive Play in action along seven case studies developed by us. These cases are works in progress at different development stages. They deal with different aspects of the illness and audiences and are being co-designed with a multidisciplinary specialised team. The games are being developed in the context of a communitarian residence of patients with eating disorders, with some focusing on inpatient and outpatient settings, and others on preventive interventions.

ANgame Collab

This card-based game is to be played by researchers (player 1) and mental health experts in anorexia nervosa (players 2 and onwards), such as psychologists, nutritionists, psychiatrists, in the context of focus groups or interviews.[23] It is a formative tool for researchers to build insight about a desired subject in question, designed to assist in the mapping, management, and flow of dialogue in a collaborative process. It provides visual data and decision-making resources that can contribute to increase knowledge about the disease. The goal is to discuss the subject at hand, while creating a conceptual map of the discussion/ conversation. This game has the potential to facilitate the exchange of knowledge as it provides the researcher with another way of understanding the content generated during a given session – the positioning of the cards on the table by the players creates a mental map (or a conversational map).[24]

Figure 1. ANgame Collab: Playset of the game at the top; interviewee writing on a keyword card at the bottom.

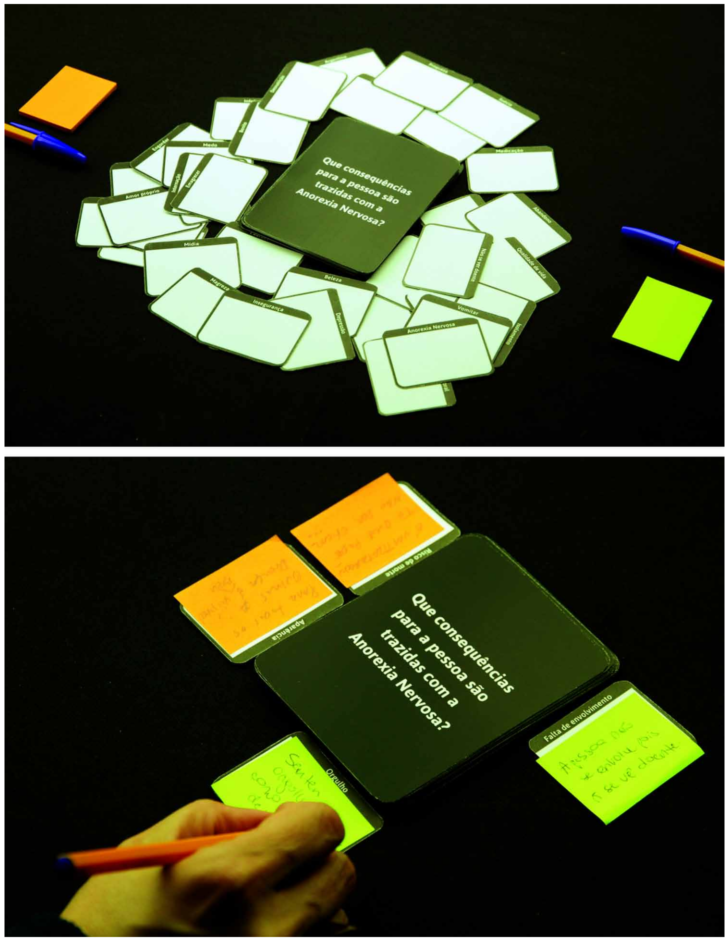


Table 1. Technical description of ANgame Collab

<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• 20 Question Cards;
• 42 Keyword Chips (30 with printed keywords, and 12 blank);
• 10 Trump Cards;
• Orange and yellow Post-its;
• 1 Instructions Card.</td><td rowspan="7">1. Player 1 possesses all the Question Cards, chooses one to place in play, wherever s/he wants, and decides what the question is about;
2. Players 2 and onwards have 2 minutes to answer the question. To answer they need to write something on a post-it (e.g. a sentence or keywords), glue it on a Answer Chip, and place that answer next to the Question Card, but wherever they choose to;
3. When the time is over, the Player 1 reads the question card aloud;
4. At this point and in turns, players must explain the reasons that drove them to such answers and why they placed their Answer Chip where they did;
5. Afterwards, another turn begins, repeating these instructions.
6. During their turn, Players 2 and onwards can play one of their the two Trump Cards they are allowed to have to go back to a previous question, or they ask Player 1 for a new Question Card;
7. There are no losers.</td></tr>
<tr><th>Players</th></tr>
<tr><td>• 1 player: researcher;
• 1 to 5 players: mental health experts.</td></tr>
<tr><th>Context of Action</th></tr>
<tr><td>• Diagnosis.</td></tr>
<tr><th>Technology Readiness Level[25]</th></tr>
<tr><td>• TRL 4 – Small scale Prototype.</td></tr>
</table>

This game follows the maxim *Follow Up*. It aims at building researchers' *insight* about anorexia nervosa by encouraging players to share knowledge and information, managing the *communication and socialization of players* and, organising the conversation and its contents into a visual map for the researcher to analyse afterwards.

ANgame Competitive

This is a card-based game focused on the psychoeducation of adolescents. It is designed to be played in the classroom by students. Psychoeducation is a type of intervention that emphasizes the education of the individual using communication and health literacy as fundamental principles. It consists on explaining health-related information about the disease in its different aspects by conveying information to the participants – it is important that individuals have access to valid information in order to be self-vigilant. The cards' contents are focused on the causes and symptoms of the disease by means of a simple and accessible discourse, on breaking taboos, on helping players perceive risky situations, and

Figure 2. ANgame Competitive: Package, Question Cards (black) and Answer Cards (white) at the top; Cards scattered around the table, ready for play, at the bottom.

on the need to seek and help others. This game aims, then, to address the promotion of well-being and to contribute to the prevention of anorexia by acting as a positive and educative experience with the potential to promote healthy behaviours.[26]

This game is linked to Positive Play's maxim *Stay Away From.* The game aims to create a favourable environment for *raising awareness* about anorexia nervosa and for learning to *maintain healthy behaviours*. When played in the classroom, it intends to create a conversational bridge between teachers and students.

Table 2. Technical description of ANgame Competitive

<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• 20 Question Cards;
• 20 Answer Cards;
• 1 Instruction Card.</td><td rowspan="7">1. Players shuffle the Question Cards and set them face down in a pile, at the center of the table. Then, they spread around the Answer Cards with their face side up;
2. A player turns over the Question Card on top of the pile. Players have 1 minute to find the corresponding Answer Card and place their choice on the side of the Question Card;
3. When time is up, players should read aloud the question, and then their chosen answers;
4. Afterwards, a player must turn over the Question Card for all to verify the correct answer;
5. Whoever answers correctly gets the Question Card for her or himself. All players return their Answer Cards to the table to continue playing. If no one answers correctly that Question Card must be removed from the game;
6. Wins whoever acquires more Question Cards.</td></tr>
<tr><td>Players</td></tr>
<tr><td>• 2 to 4 players.</td></tr>
<tr><td>Context of Action</td></tr>
<tr><td>• Promotion.</td></tr>
<tr><td>Technology Readiness Level</td></tr>
<tr><td>• TRL 4 – Small scale Prototype.</td></tr>
</table>

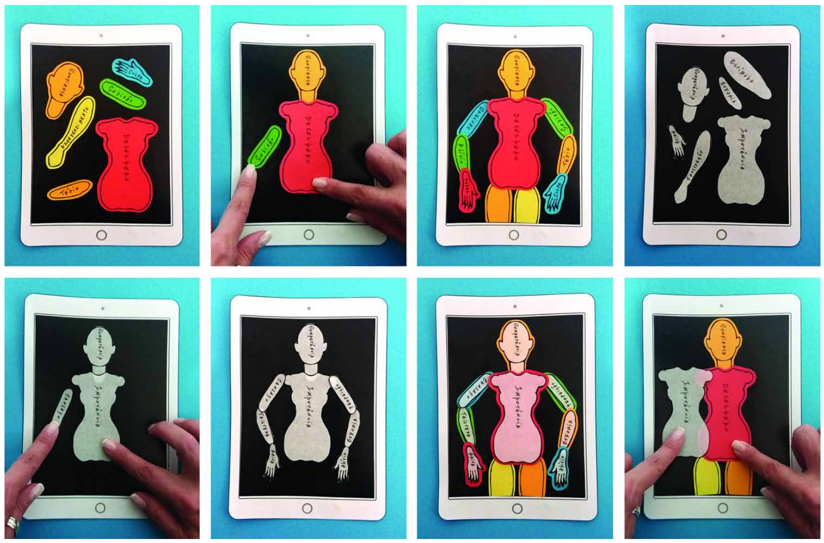
The Armour Game

One of the priority areas for intervention in eating disorders is outpatient monitoring by means of psychiatric and psychological consultations. This game's preliminary prototype was developed in this sense. The game is aimed to focus on patients' emotional aspects related to body image, identity and feelings that are associated with the experience of suffering of anorexia nervosa. It is focused on gaining insight into patients' emotional life and their illness and helping the mental health medical team obtain information about the image their patients construct about their body. The game is to be presented in the form of a digital puzzle to be played during the clinical consults and will soon undergo a series of tests with the participation of patients and their medical staff.[27]

Table 3. Technical description of The Armour Game

<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• Various visual representations of body parts (e.g. legs, arms, head);
• A list of words that refer to emotional states (e.g. comfort, anger, sadness);
• The shape button, to manipulate body forms.</td><td rowspan="7">1. Build the patient's physical body by positioning pieces in the shape of body parts.
2. After that, the patient builds the ill body.
3. Different colors and words that refer to emotional contents (e.g. comfort, anger, sadness) are added to each piece.
4. The patient can also manipulate the shape of the bodies (making them thinner, wider, shorter or taller).
5. Then, the patient must superimpose the ill body on the created physical body. (This game provides a strategy for the clinician to assist the patient in understanding unhealthy behaviours, through the metaphorical action of separating the ill body from the person's body.)</td></tr>
<tr><td>Players</td></tr>
<tr><td>• 1 player.</td></tr>
<tr><td>Context of Action</td></tr>
<tr><td>• Intervention.</td></tr>
<tr><td>Technology Readiness Level</td></tr>
<tr><td>• TRL 2 – Technology Formulation.</td></tr>
</table>

Figure 3. Paper prototype of The Armour Game: various visual representations of body parts and shape buttons to manipulate representations of body forms.



This game aims at the maxim *Have an Aha! Moment.* The game acts as a *vessel of communication* between patient and clinician as part of an intervention that aims to raise patients' *awareness and insight* on the way patients see their own body.

How do I Feel When…

There is a wide range of actors involved in the course of treatment and recovery from anorexia nervosa, namely patients, family members and the multidisciplinary healthcare team. The disease directly and indirectly affects all members of the family. In some family consultations, participants' stress and anxiety levels are high. As a result, such meetings are often dominated by the relative with the highest level of expressed emotion, which may reduce the chances for other elements to express themselves. In such settings, health professionals reinforce the importance of practicing empathy between all family members and towards the patient, working together for recovery. This game acts precisely here. *How do I Feel When…* is a card game to be played mediated by a mental health professional. It aims to create an informal environment to allow players to communicate affectively with each other and to promote empathy between them. This game is a tool for clinical intervention, allowing a better understanding and emotional clarification of the family's dynamics, aiming to improve communication among family members.

This game corresponds to the maxim *Make Possible* in the sense that it aims at *facilitating communication and socialization* between patients and their families, focused on sharing what they usually feel in particular situations. It also matches the maxim *Follow-Up* by providing doctors with *insight* into the relationships of patients' families.

Figure 4. How do I Feel When…: Playset of the game, at the top; Player revealing his card to the other players, at the bottom.

Table 4. Technical description of How do I Feel When…

<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• 60 paper cards, divided by 5 equal sets of 12 illustrated cards for each player;
•1 Instruction Card.</td><td rowspan="7">1. The decks of cards are distributed among the players. Each must have only one deck with 12 figure cards in their hand.
2. A player chooses a card from their deck and asks a question out loud based on their interpretation of the said card. The question must always start with “How do I feel when…”, such as: “How do I feel when ... I’m having family dinner?”. The player must put the selected card face down on the table next to him/her.
3. Afterwards, the other players must choose a card from their own decks that they believe represents how the former player feels, taking into account the question they heard, and place it face down on the table next to them.
4. After everyone has chosen their cards, and by turns, players must turn their card face up and justify their choice.
5. After every player has completed the last step, the first player reveals his/her card and talks about what he or she feels.
6. In the end, the mental health professional intervenes to start a new round, indicating the next family member to issue the next question.
7. The game ends when the mental health professional finds it suitable.
8. There is no loser in this game.</td></tr>
<tr><td>Players</td></tr>
<tr><td>• 2 to 5 players.</td></tr>
<tr><td>Context of Action</td></tr>
<tr><td>• Intervention.</td></tr>
<tr><td>Technology Readiness Level</td></tr>
<tr><td>• TRL 4 – Small scale Prototype.</td></tr>
</table>

Yama's Liberation

This game was developed to be played by outpatients or inpatients in residential units participating in group treatments, with the supervision of mental health professionals. The story and characters were co-designed with patients and mental health professionals. Along the adventure, all players need to overcome very particular challenges together[28] scattered throughout the game world in order to be able to face the final boss of the game. By inspecting players' involvement, discourse and actions, this game acts as a tool for the healthcare team to gain insight about their patients that could otherwise be difficult to obtain. The projective dimension implicit in the characters players create for them to play with is able to open a window to the subjective information about themselves, such as personal characteristics, past experiences, knowledge, and integration of the world. Through roleplay, players are compelled to take action to take care of themselves and of the group in the game world, to communicate with each other and to make decisions to deal with complex and spontaneous situations. Since these patients tend to be emotionally and socially inhibited and commonly show alexithymia, this aims at contributing to their subjective well-being as well.[29]

Figure 5. Yama's Liberation: Playset of the game, at the top; End of the game with stamped players, at the bottom.

This game acts in accordance with the maxim *Follow Up*. The therapeutic team is able to *get insight* on patients, by observing their actions, behaviours, and choices during the game. For patients, the game is simple entertainment. After the game is over the therapeutic team may decide to discuss the experience with the patients.

Table 5. Technical description of Yama's Liberation

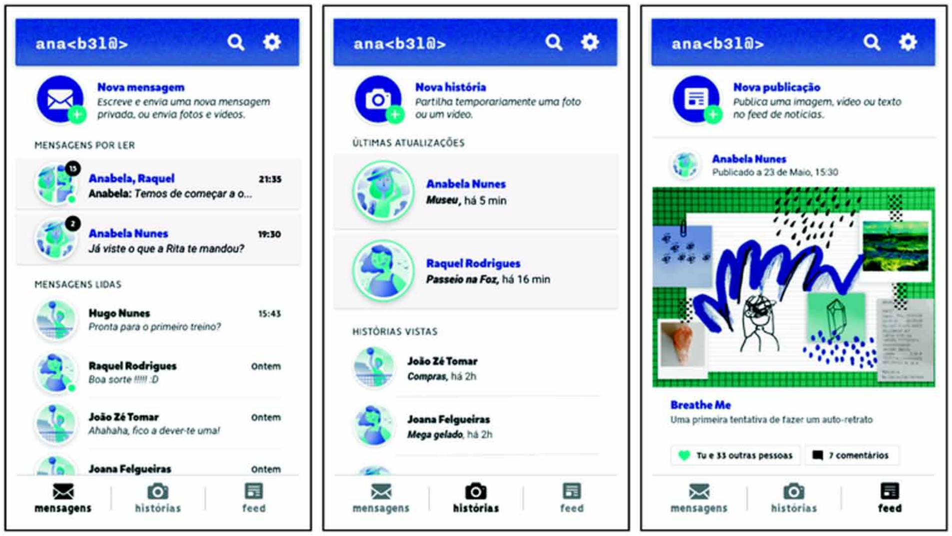
<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• 1 Board;
• 8 Action cards;
• 8 Challenge cards;
• 8 Divine gift cards;
• 2 common dice;
• 1 pawn;
• 360 colored tokens;
• 1 hourglass;
• 1 stamp.</td><td rowspan="7">1. Preparation: Each player starts with a character and its respective predetermined amount of colored pieces. To start the game, everyone must decide where in the game world they want to go. The group must always leave and return from the central square of the game world.
2. Mandatory Stop 1: The player rolls a die and according to the result he will receive a reward.
3. Divine Gift Challenge: Place the pawn in the chosen city and the challenge of that location will be read. The group will have the time determined by the hourglass to solve the challenge. If the group resolves the challenge, everyone must decide which player will receive the Divine Gift Card and the tattoo (stamp).
4. Mandatory Stop 2: A player must roll the dice to know the opponent's power. To defeat the opponent, the player can roll a dice or decide to use force or magic. If the player wins, he wins colored pieces. But if he loses, everyone loses colored pieces.
5. When players return to the town square, they always find people who need help. At this point, they should discuss how to solve the problem.
6. After that, players must decide a new location in the city to explore.
7. End of the game: The game is over when all 8 Divine Gift Challenges are unveiled, with at least 1 tattoo on each player, and Yama's Liberation is complete.</td></tr>
<tr><th>Players</th></tr>
<tr><td>• 4 to 8 players.</td></tr>
<tr><th>Context of Action</th></tr>
<tr><td>• Diagnosis.</td></tr>
<tr><th>Technology Readiness Level</th></tr>
<tr><td>• TRL 5 – Large Scale Prototype.</td></tr>
</table>

Ana<b3l@>

This game was born from the motivation to create a tool able to assist in the psychoeducation of the young people about anorexia nervosa. Patients affected with anorexia often find it difficult to identify and communicate their emotional states, whether to family members, friends or even to health care professionals. Targeting young people, frequently a pair support network (or social circle) of patients with anorexia, has the advantage of providing health and psychological related information regarding this illness. This can contribute to the indirect learning of how to better communicate and understand people suffering from anorexia nervosa, to the recognition of the illness' manifestations, and to how to interact in an effective and empathic way with these patients.

Ana<b3l@> uses a language familiar to young audiences, consisting of a digital narrative-based game that assumes the shape of a social network mobile application. The player can interact with different characters, such as the main character[30] Anabela, Hugo (brother), Vera (mother), and Raquel (friend). Each character has their own behaviour in the social network and a different way of communicating in the game. Characters' interactions simulate behaviours found in real-life people with the goal of making the player develop an understanding of the context of the main character and learn about the disease. As such, the game aims to contribute to health literacy in society and to promote support and understanding of patients with eating disorders.[31]

Figure 6. Ana<b3l@>'s Chat, Stories and Feed.



This game abides by the maxim *Stay Away From.* The game aims at promoting *insight* about anorexia nervosa, by simulating a social network in a universe that favours positive communication, and how to help a person who exhibits behaviours that lead to illness.

Table 6. Technical description of Ana<b3l@>

<table>
<tr><th>Components</th><th>Gameplay</th></tr>
<tr><td>• Chat;
• Stories;
• Feed.</td><td rowspan="8">1. Chat: The player can access notifications for conversations with Anabela and other characters in the Chat screen. By selecting a conversation, the player interacts with a character and decides the unfolding of the story. Depending on the player's choices, he or she can have a positive or negative impact on the Anabela. (The aim is to incite players to communicate more empathically.)
2. Stories: In the Stories section, the player can view the content published by Anabela, which shows a behaviour inconsistent with her feelings, as if she pretends to be emotionally happy and strong. The player can also view stories from other characters to understand the context of the story.
3. Feed: In the Feed, the player can view the content published by the characters. Anabela will publish illustrations and poems, demonstrating her true emotions in a symbolic way. (The characters' behaviours serve for the player to reflect on his own way of acting in reality and also to be able to perceive some type of unhealthy behaviour in friends and colleagues.)</td></tr>
<tr><td>Players</td></tr>
<tr><td>• 1 player.</td></tr>
<tr><td>Context of Action</td></tr>
<tr><td>• Promotion.</td></tr>
<tr><td>Technology Readiness Level</td></tr>
<tr><td>• TRL 3 – Needs Validation.</td></tr>
</table>

SUMMARY AND FUTURE WORK

This chapter defines Positive Play as an expression of play focused on social, psychological and physical well-being and human potential. Going further, it sets some of its foundations in the form of eight maxims that resulted from an analysis on various games developed in Research and in the Industry. Afterwards, we present an application of the concept of Positive Play to healthcare in the field of Psychiatry and mental health: the case of anorexia nervosa. The various games show how Positive Play can be integrated in different contexts of action, from diagnosis and intervention to contexts focused on prevention and promotion of awareness and knowledge about the disease and work as individual or as groups activities.

There is still much work to accomplish in the critical reflection and research of the concept of Positive Play. Future work includes:

1. Inspect the potential existence of other maxims. An analysis with a broader sample is required to achieve this, as well as the continuous development of concepts and prototypes of games focused on Positive Play, with multidisciplinary teams and resorting to co-design methodologies in order to integrate them in existing knowledge and practices of the clinicians, doctors and therapists.
2. Games do not need to follow a single maxim. As such, it becomes crucial to understand the dynamics created by the combinations of different maxims, and to observe its results in different contexts. This will increase knowledge in how to design games for certain contexts and in how to apply, combine or concatenate different games following different maxims to produce a certain effect or potential result.
3. It is also of extreme relevance to understand if and how certain maxims are more inclined to certain types of players or audiences. We noticed some maxims are more prone to be directed towards patients while others are more evident on the side of the therapeutic team. To understand this is to get a better grasp on how to direct and customise these games to a particular audience.
4. It is relevant to know how certain maxims work with the requirements of certain diseases or conditions. This may raise an understanding of potential incompatibilities and if new maxims or adapted versions are required.
5. Despite already showing much potential, the games for anorexia nervosa that were presented are still at their very beginning. Although there are no results from final tests yet, we got valuable qualitative feedback from the clinical team and from the patients regarding the utility of these prototypes in building a therapeutic alliance, and in facilitating emotional communication between patients and both their families and the therapeutic team. Further testing with clinical groups of patients, therapists, families and general population is required to further inspect these games, and to shape them into mature Positive Play artefacts, which, in its turn, will allow us to develop a deeper understanding of Positive Play itself.
6. It is also imperative to work on the formalisation of knowledge about Positive Play, such as the conception of frameworks, sets of good practices, design principles, patterns, and validation procedures, so that such knowledge can be more accessible to designers, educators, policy-makers, and practitioners in different fields (e.g. clinical, educational and social settings).
7. And following that line of thought, it will also become important to implement training programmes for the application of the formalised knowledge in the previous goal.

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ENDNOTES

1 E.g. Games for Change (www.gamesforchange.org), UX for Good (www.uxforgood.org), Wisdom 2.0 (www.wisdom2conference.com), Design for Good (www.aiga.org/design-for-good).

2 Games have indeed come a long way in this scope, but in some areas or contexts they are still quite dismissed.

3 We can already see this happening in some kinds of games, such as persuasive games (Bogost, 2007), games that are designed to persuade or to dissuade their players, to influence their world view and to raise social awareness on diverse subjects.

4 In fact, there has been an increasing interest in games focused on different areas of healthcare, such as prevention, therapy, assessment, and education (McCallum, 2012). In the context of mental health, for example, this may mean supporting post-traumatic treatment stress disorder, helping people deal with their anxieties or addressing challenges of people suffering from depression (Grace, 2019).

5 These games addressed issues such as addictive disorders, anxiety, autism, domestic violence, security in clinical settings, chronic diseases, depression, dyslexia, healthy lifestyle, impulsivity and hyperactivity, physical and cognitive rehabilitation, schizophrenia, and sexual risks.

6 According to the authors, the game was developed based on the Self-Determination Theory (Ryan et al., 2006) and the PENS model (Player Experience of Need Satisfaction) (Rigby & Ryan, 2007), to support the interest and involvement of players for behaviour change.

7 More info at: https://skipabeatgame.com/. Last accessed 2020/12/09.

8 It is even possible to interrupt an activity so players can think about the actions they performed and the strategies they employed with the therapist that is supervising the session.

9 More info at: https://brightdigital.pt/projetos/hope/. Last accessed 2020/12/09..

10 More info at: https://www.holstee.com/products/reflection-cards-conversation-questions. Last accessed 2020/12/09..

11 More info at: https://play.google.com/store/apps/details?id=com.PambuDev.galexia&hl=en_IE. Last accessed 2020/12/09..

12 More info at: https://www.gamesforchange.org/game/one-leaves/. Last accessed 2020/12/09..

13 According to its authors, the game was developed from real facts with the support of the FDA's Center for Tobacco Products.

14 More info at: https://mariaty.itch.io/cocos-cove. Last accessed 2020/12/09..

15 More info at: https://www.gamesforchange.org/game/start-the-talk/. Last accessed 2020/12/09..

16 More info at: https://www.gamesforchange.org/game/alpha-beat-cancer/. Last accessed 2020/12/09..

17 More info at: https://www.dvagame.co.uk/index.html. Last accessed 2020/12/09..

18 More info at: https://fridaynightattheer.com/. Last accessed 2020/12/09..

19 More info at: https://www.gamesforchange.org/game/auti-sim/. Last accessed 2020/12/09..

[20] Ambulatory treatment setting (e.g. medical and psychological consultations).
[21] Hospitalization, treatment in psychiatric/medical wards.
[22] Additional treatments to standard interventions.
[23] This game is being adapted for mental health experts to use with patients and family members. Its purpose is to promote communication during the clinical consultation.
[24] This game is the subject of the following publication (Peçaibes et al., 2019a).
[25] Adapted by CloudWATCH 2 project (CloudWATCH2, 2017).
[26] This game is the subject of the following publication (Peçaibes et al., 2018b).
[27] This game is the subject of the publication Peçaibes et al. (2019b).
[28] Challenges in this game are based on Cognitive Remediation Therapy (CRT) for anorexia nervosa. CRT acts on patients' cognitive flexibility through an interactive treatment that combines practical exercises with discussions about their relevance to the patient's daily life. The goal is to improve neurocognitive skills, such as attention, memory, flexibility, cognitive planning and executive functioning, which can lead to better psychosocial functioning (Tchanturia et al., 2007).
[29] The co-design methodology used to design this game can also be used as a framework for co-creating a new game with other groups of patients. We are currently working on its formalisation.
[30] All of the designed characters were evaluated by a health professional with experience in treating people with eating disorders.
[31] This game is the subject of the publication Peçaibes et al. (2020).
[32] All URLs were last accessed on 08/10/2020.

APPENDIX 1: LUDOGRAPHY

Alpha Beat Cancer. 2017. Mukutu Game Studio.

Antonyms. 2020. Maura Crepaldi, Vera Colombo, Stefano Mottura, Davide Baldassini, Marco Sacco, Alice Cancer, Alessandro Antonietti.

Auti-Sim. 2013. Taylan Kadayifcioglu, Matt Marshall, Krista Howarth.

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CliniPup. 2019. Sarah Verschueren, June van Aalst, Anne-Marie Bangels, Jaan Toelen, Karel Allegaert, Connor Buffel, Geert Vander Stichele.

Coco's Cove. 2015. Mariaty Inc.

Deep. 2016. Marieke van Rooij, Adam Lobel, Owen Harris, Niki Smit, Isabela Granic.

Dimmand. 2018. Mariam Sood, Annet Toornstra, Martin Sereno, Mark Boland, Daniele Filaretti, Anuj Sood.

Domestic Abuse Training Game. 2019. Parveen Ali, Focus Games.

Echoes. 2013. Sara Bernardini, Kaska Porayska-Pomsta, Tim J. Smith.

Epic Allies. 2016. Sara LeGrand, Kathryn Elizabeth Muessig, Tobias McNulty, Karina Soni, Kelly Knudtson, Alex Lemann, Nkechinyere Nwoko, Lisa B Hightow-Weidman.

Friday Night at the ER. 2019. Breakthrough Learning.

Galexia. 2019. Francisca Serrano Chica, José Francisco Bravo.

Hope. 2018. Bright Digital.

One Leaves. 2019. Oath Inc., Wahoo Studios.

One Night Stand. 2019. Kimberly Hieftje, Lindsay Duncan, Orli Florsheim, Ben Sawyer, Lynn E. Fiellin.

OnTrack>The Game. 2019. Jeffrey Olivet, Morgan Haselden, Sarah Piscitelli, Rachael Kenney, Alexander Shulman, Deborah Medoff, Lisa Dixon.

Physioland. 2020. Tiago Martins, Vítor Carvalho, Filomena Soares.

Reflection Cards. 2018. Holstee.

Shinpo. 2019. Luciano H Santos, Kazuya Okamoto, Shusuke Hiragi, Goshiro Yamamoto, Osamu Sugiyama, Tomoki Aoyama, Tomohiro Kuroda.

Skip a Beat Heart Rate Game. 2014. Happitech.

Spaplay. 2016. Mariya Shiyko, Sean Hallinan, Magy Seif El-Nasr, Shree Subramanian, Carmen Castaneda-Sceppa.

Star the Talk. 2013. Kognito.

Step by Step. 2018. Viviane Peçaibes.

APPENDIX 2

Table 7. Sample constituted from electronic collection in the main available databases.[32]

Game Title	Authors / Reference	URL	Maxim
<untitled>	Simões, M., Bernardes, M., Barros, F., & Castelo-Branco, M. (2018). Virtual Travel Training for Autism Spectrum Disorder: Proof-of-Concept Interventional Study. Jmir Serious Games, 6(1), e5.		*in analysis*
<untitled>	Gaggi, Ombretta, Claudio Enrico Palazzi, Matteo Ciman, Giorgia Galiazzo, Sandro Franceschini, Milena Ruffino, Simone Gori, and Andrea Facoetti. “Serious Games for Early Identification of Developmental Dyslexia.” Computers in Entertainment 15, no. 2 (April 4, 2017): 1–24.		*in analysis*
<untitled>	Amantini, Snsr, A A P Montilha, B C Antonelli, K T M Leite, D Rios, T Cruvinel, N Lourenco Neto, T M Oliveira, and Maam Machado. “Using Augmented Reality to Motivate Oral Hygiene Practice in Children: Protocol for the Development of a Serious Game.” Jmir Research Protocols 9, no. 1 (2020): e10987.		*in analysis*
<untitled>	Caglio, M., Latini-Corazzini, L., D’Agata, F., Cauda, F., Sacco, K., Monteverdi, S., Zettin, M., Duca, S., & Geminiani, G. (2009). Video game play changes spatial and verbal memory: Rehabilitation of a single case with traumatic brain injury. Cognitive Processing, 10(SUPPL. 2), 195–197.		*in analysis*
<untitled>	Amado, I, L Brenugat-Herne, E Orriols, C Desombre, M Dos Santos, Z Prost, M O Krebs, and P Piolino. “A Serious Game to Improve Cognitive Functions in Schizophrenia: A Pilot Study.” Frontiers in Psychiatry 7 (2016): 64.		*in analysis*
A Plus	Ta-Te Wu	https://www.kickstarter.com/projects/tatewu/a-plus-a-game-for-children-with-autism?ref=discovery_category	*in analysis*
Alcohol Alert	Jander, A., Crutzen, R., Mercken, L., Candel, M., & de Vries, H. (2016). Effects of a Web-Based Computer-Tailored Game to Reduce Binge Drinking Among Dutch Adolescents: A Cluster Randomized Controlled Trial. Journal of Medical Internet Research, 18(2), e29.	https://www.c4tbh.org/program-review/alcohol-alert/	*in analysis*
Alpha Beat Cancer	Mukutu Game Studio	https://www.gamesforchange.org/game/alpha-beat-cancer/	Hype Up
Antonyms	Crepaldi, M., Colombo, V., Mottura, S., Baldassini, D., Sacco, M., Cancer, A., & Antonietti, A. (2020). Antonyms: A Computer Game to Improve Inhibitory Control of Impulsivity in Children with Attention Deficit/Hyperactivity Disorder (ADHD). Information, 11(4), 230.		Make Adjustments
Auti-Sim	Taylan Kadayifcioglu, Matt Marshall, Krista Howarth	https://www.gamesforchange.org/game/auti-sim/	Have an Aha! Moment

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Table 7. Continued

Game Title	Authors / Reference	URL	Maxim
Buffalo: The Name-Dropping Game	Kaufman, G., & Flanagan, M. (2015). "A psychologically "embedded" approach to designing games for prosocial causes." Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 9(3), article 1. doi: 10.5817/CP2015-3-5		Have an Aha! Moment
Cards of Calm	Stuart Fitzwilliam	https://cardsforcalm.com/	*in analysis*
CliniPup	Verschueren, S., van Aalst, J., Bangels, A. M., Toelen, J., Allegaert, K., Buffel, C., & Stichele, G. Vander. (2019). Development of CliniPup, a serious game aimed at reducing perioperative anxiety and pain in children: Mixed methods study. Journal of Medical Internet Research, 21(6), 1–16.	http://mindbytes.be/project/seres-clinipup/	Keep Going
Coco's Cove	Mariaty Inc.	https://play.google.com/store/apps/details?id=com.Mariaty.CocosCove&hl=en https://www.diabeteshealth.com/diabetes-health-in-the-news-products-cocos-cove/	Stay Away From
Critical Core	Game to Grow	https://www.kickstarter.com/projects/gametogrow/critical-core?ref=discovery_category	*in analysis*
Deep	Van Rooij, M., Lobel, A., Harris, O., Smit, N., & Granic, I. (2016). DEEP: A biofeedback virtual reality game for children at-risk for anxiety. Conference on Human Factors in Computing Systems - Proceedings, 07-12-May-2016, 1989–1997.	https://www.exploredeep.com/#about-deep	Make Adjustments
Depression Quest	Zoe Quinn, Patrick Lindsey and Isaac Schankler	https://www.gamesforchange.org/game/depression-quest/ http://www.depressionquest.com/#top-section	*in analysis*
Dimmand	Sood, M. R., A. Toornstra, M. I. Sereno, M. Boland, D. Filaretti, and A. Sood. "A Digital App to Aid Detection, Monitoring, and Management of Dyslexia in Young Children (Dimmand): Protocol for a Digital Health and Education Solution." JMIR Res Protoc 7, no. 5 (May 17 2018): e135.	https://www.festoon.studio/dimmand	Follow-up
Dojo	Schuurmans, A. A. T., Nijhof, K. S., Vermaes, I. P. R., Engels, R. C. M. E., & Granic, I. (2015). A Pilot Study Evaluating "dojo," a Videogame Intervention for Youths with Externalizing and Anxiety Problems. Games for Health Journal, 4(5), 401–408.		*in analysis*
Domestic Abuse Training Game	Parveen Ali/Focus Games	https://www.dvagame.co.uk/index.html https://www.sheffield.ac.uk/news/nr/board-game-to-help-students-support-victims-of-domestic-violence-1.860095	Have an Aha! Moment

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Table 7. Continued

Game Title	Authors / Reference	URL	Maxim
Dr. Fill	Bukowski, M., Kuhn, M., Zhao, X., Bettermann, R., & Jonas, S. (2016). Gamification of Clinical Routine: The Dr. Fill Approach. Stud Health Technol Inform, 225, 262–266.		*in analysis*
DV in Clinical Settings	Mason, R., & Turner, L. (2018). Serious gaming: A tool to educate health care providers about domestic violence. Health Care Women Int, 1–13.		*in analysis*
Dytective	Rello, L., Williams, K., Ali, A., White, N. C., & Bigham, J. P. (2016, April 11). Dytective: Towards detecting dyslexia across languages using an online game. W4A 2016 - 13th Web for All Conference.	https://www.changedyslexia.org/	*in analysis*
Echoes	Bernardini, S., Porayska-Pomsta, K., & Smith, T. J. (2014). ECHOES: An intelligent serious game for fostering social communication in children with autism. Information Sciences, 264, 41–60.	https://www.ucl.ac.uk/ioe/research-projects/2018/oct/echoes-project	Follow-up
Emotiplay	Fridenson-Hayo, S., Berggren, S., Lassalle, A., Tal, S., Pigat, D., Meir-Goren, N., O'Reilly, H., Ben-Zur, S., Bolte, S., Baron-Cohen, S., & Golan, O. (2017). "Emotiplay": a serious game for learning about emotions in children with autism: results of a cross-cultural evaluation. Eur Child Adolesc Psychiatry, 26(8), 979–992.	https://emotiplay.com/	*in analysis*
Epic Allies	LeGrand, S., Muessig, K. E., McNulty, T., Soni, K., Knudtson, K., Lemann, A., Nwoko, N., & Hightow-Weidman, L. B. (2016). Epic Allies: Development of a Gaming App to Improve Antiretroviral Therapy Adherence Among Young HIV-Positive Men Who Have Sex with Men. Jmir Serious Games, 4(1), e6.		Keep Going
Flowy	Pham, Q., Khatib, Y., Stansfeld, S., Fox, S., & Green, T. (2016). Feasibility and Efficacy of an mHealth Game for Managing Anxiety: "Flowy" Randomized Controlled Pilot Trial and Design Evaluation. Games for Health Journal, 5(1), 50–67.	https://www.youtube.com/watch?v=l_bOmGmYECE	*in analysis*
Friday Night at the ER	McIntyre, L., & Yeoman, A. (2015). How board games can be used to improve safety. Nursing Times, 111(25), 14–16.		Have an Aha! Moment
Fume	Parisod, H., Pakarinen, A., Axelin, A., Danielsson-Ojala, R., Smed, J., & Salanterä, S. (2017). Designing a Health-Game Intervention Supporting Health Literacy and a Tobacco-Free Life in Early Adolescence. Games for Health Journal, 6(4), 187–199.		in analysis
Galexia	Francisca Serrano Chica & José Francisco Bravo	https://www.evolving-science.com/health/galexia-game-designed-children-dyslexia-0098 https://play.google.com/store/apps/details?id=com.PambuDev.galexia&hl=en_IE	Make Headway
Glooveth	Macias, E, O Garcia, P Moreno, M M Presno, and T Forrest. "Glooveth: Healthy Living, Fun and Serious Gaming." Stud Health Technol Inform 172 (2012): 180–84.		*in analysis*

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Table 7. Continued

Game Title	Authors / Reference	URL	Maxim
Gomins	Alava Reyes	https://www.gomins.es/home/	in analysis
GraphoGame	GraphoGroup	https://www.graphogame.com/	in analysis
HapHop-Physio	Rico-Olarte, C., Lopez, D. M., Narvaez, S., Farinango, C. D., & Pharow, P. S. (2017). HapHop-Physio: a computer game to support cognitive therapies in children. Psychol Res Behav Manag, 10, 209–217.		*in analysis*
Hope	Bright Digital	https://brightdigital.pt/projetos/hope/	Keep Going
iManage Cancer	Hoffmann, S., & Wilson, S. (2018). The role of serious games in the iManageCancer project. E cancer medical science, 12, 850.	http://imanagecancer.eu/	*in analysis*
Life is Game	Alves, S., Marques, A., Queiros, C., & Orvalho, V. (2013). Life is game: A Serious Game About Emotions for Children with Autism Spectrum Disorders. Impact 2013: International Psychological Applications Conference and Trends, 323-323.	https://sigarra.up.pt/fcup/pt/noticias_geral.ver_noticia?p_nr=4350	*in analysis*
Maya	Carrasco, A. E. (2016). Acceptability of an adventure video game in the treatment of female adolescents with symptoms of depression. Research in Psychotherapy-Psychopathology Process and Outcome, 19(1), 10-18.		*in analysis*
Michael's Game	Khazaal, Y., J. Favrod, S. Azoulay, S. C. Finot, M. Bernabotto, S. Raffard, J. Libbrecht, et al. “”Michael's Game,” a Card Game for the Treatment of Psychotic Symptoms.” Patient Educ Couns 83, no. 2 (May 2011): 210-6.		*in analysis*
Mission: Schweinehund	Höchsmann, C., Infanger, D., Klenk, C., Königstein, K., Walz, S. P., & Schmidt-Trucksäss, A. (2019). Effectiveness of a Behavior Change Technique–Based Smartphone Game to Improve Intrinsic Motivation and Physical Activity Adherence in Patients with Type 2 Diabetes: Randomized Controlled Trial. JMIR Serious Games, 7(1), e11444.	http://www.geelab.eu/content/novartis-%E2%80%93-mission-schweinehund	*in analysis*
Mood Jumper	Baghaei, N., Hach, S., Liang, H. N., & Brucker, M. (2019). MoodJumper: An Exploration of Game Interface Preferences in Users With/Out Mood Disorder. Frontiers in Public Health, 7, 220.		*in analysis*
One Leaves	Oath Inc. and Wahoo Studios	https://www.gamesforchange.org/game/one-leaves/	Stay Away From
One Night Stand	Hieftje, K., Duncan, L., Florsheim, O., Sawyer, B., & Fiellin, L. E. (2019). One Night Stan: Feasibility Study of an HIV Prevention and Sexual Risk Reduction Social Card Game for Young Black Women. Games for Health Journal, 8(2), 112–120.		Stay Away From
OnTrack> The Game	Olivet, J, M Haselden, S Piscitelli, R Kenney, A Shulman, D Medoff, and L Dixon. “Results from a Pilot Study of a Computer-Based Role-Playing Game for Young People with Psychosis.” Early Interv Psychiatry 13, no. 4 (2019): 767–72.		Make Headway
Orbit	Scholes, L., Jones, C., Stieler-Hunt, C., & Rolfe, B. (2014). Serious games for learning: games-based child sexual abuse prevention in schools. International Journal of Inclusive Education, 18(9), 934–956.	http://orbit.ht.dstier2.com/csa/the-orbit-approach/	*in analysis*

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Table 7. Continued

Game Title	Authors / Reference	URL	Maxim
Physioland	Martins, T., Carvalho, V., & Soares, F. (2020). Physioland – A serious game for physical rehabilitation of patients with neurological diseases. Entertainment Computing, 34(July 2019), 100356.		Hype Up
Please Knock on my door	Levall Games	https://www.gamesforchange.org/game/please-knock-on-my-door/	*in analysis*
POD Adventures	Gonsalves, P. P., Hodgson, E. S., Kumar, A., Aurora, T., Chandak, Y., Sharma, R., Michelson, D., & Patel, V. (2019). Design and Development of the "POD Adventures" Smartphone Game: A Blended Problem-Solving Intervention for Adolescent Mental Health in India. Frontiers in Public Health, 7.		*in analysis*
Ponder: The Socratic Way	Life Care Sim	https://lifecaresim.com/	*in analysis*
Pure Rush	Stapinski, L. A., Reda, B., Newton, N. C., Lawler, S., Rodriguez, D., Chapman, C., & Teesson, M. (2018). Development and evaluation of "Pure Rush": An online serious game for drug education. Drug and Alcohol Review, 37 Suppl 1, S420–S428.	https://positivechoices.org.au/teachers/pure-rush-drug-education-game	*in analysis*
Recover Rapids	Maung, D., Crawfis, R., Gauthier, L. V., Worthen-Chaudhari, L. C., Gauthier, L. V, Worthen-Chaudhari, L., Lowes, L. P., Borstad, A., Mcpherson, R. J., Grealy, J., & Adams, J. (2014). Development of Recovery Rapids-A Game for Cost Effective Stroke Therapy. Conference: Foundations of Digital Games, April.	http://www.citherapy.net/	*in analysis*
Reflection Cards	Holstee	https://www.holstee.com/products/reflection-cards-conversation-questions	Make Headway
Re-Mission	Realtime Associates Inc.	https://www.gamesforchange.org/game/re-mission/	*in analysis*
SeCZ TaLK	van der Stege, H. A., van Staa, A., Hilberink, S. R., & Visser, A. P. (2010). Using the new board game SeCZ TaLK to stimulate the communication on sexual health for adolescents with chronic conditions. Patient Education and Counseling, 81(3), 324–331.	https://www.rotterdamuas.com/research/projects-and-publications/innovations-in-care/selfmanagement-and-participation/finished-projects/secz-talk/project/#flex	*in analysis*
Shinpo	Santos, L H, K Okamoto, S Hiragi, G Yamamoto, O Sugiyama, T Aoyama, and T Kuroda. "Pervasive Game Design to Evaluate Social Interaction Effects on Levels of Physical Activity among Older Adults." J Rehabil Assist Technol Eng 6 (2019): 2055668319844443.		Make Possible
Skip a Beat Heart Rate Game	Happitech	https://skipabeatgame.com/	Make Adjustments
SpaPlay	Shiyko, M, S Hallinan, M Seif El-Nasr, S Subramanian, and C Castaneda-Sceppa. "Effects of Playing a Serious Computer Game on Body Mass Index and Nutrition Knowledge in Women." Jmir Serious Games 4, no. 1 (2016): e8.		Make Possible

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Table 7. Continued

Game Title	Authors / Reference	URL	Maxim
SPARX	Merry, S. N., Stasiak, K., Shepherd, M., Frampton, C., Fleming, T., & Lucassen, M. F. G. (2012). The effectiveness of SPARX, a computerised self-help intervention for adolescents seeking help for depression: Randomised controlled non-inferiority trial. BMJ (Online), 344(7857), 1–16.	https://www.sparx.org.nz/home	*in analysis*
Start the Talk	Kognito	https://www.gamesforchange.org/game/start-the-talk/	Hype Up
Step by Step	Peçaibes, V., Tonetto, L. M., & Andretta, I. (2018). “Step by step”: the development of a therapeutic game to assist in the treatment of drug use. Cien Saude Colet, 0430/2018(ISSN 1678-4561).		Make Possible
SuperBetter	Roepke, A. M., Jaffee, S. R., Riffle, O. M., McGonigal, J., Broome, R., & Maxwell, B. (2015). Randomized Controlled Trial of SuperBetter, a Smartphone-Based/Internet-Based Self-Help Tool to Reduce Depressive Symptoms. Games for Health Journal, 4(3), 235–246.	https://www.superbetter.com/	*in analysis*
SuperSight	Preloaded	https://www.gamesforchange.org/game/supersight/	*in analysis*
Tell Tall Tales	Prerna Magon	https://www.sciencenewsforstudents.org/blog/eureka-lab/isef-2019-game-may-help-rid-people-biases	*in analysis*
The Empathy Game	BIS publishers / Saskia Herrmann & Jorik Elferink	https://www.bispublishers.com/the-empathy-game.html	*in analysis*
The Fling	Boendermaker, W. J., Veltkamp, R. C., & Peeters, M. (2017). Training Behavioral Control in Adolescents Using a Serious Game. Games for Health Journal, 6(6), 351–357.		*in analysis*
The impulse control game	Tonia Caselman / Franklin Learning Systems	https://www.amazon.com/Franklin-Learning-Impulse-Control-Board/dp/B002P8LK90	*in analysis*
The secret of seven stones	Dube, S., Ceglio, L., Song, H., Markham, C., Santa Maria, D., Peskin, M., McLaughlin, J., Lahiri, C., Wilkerson, J., Emery, S. T., & Shegog, R. (2015). Secret of Seven Stones: A Game to Prevent Youth Hiv/Stis and Pregnancy by Parent-Youth Communication. Annals of Behavioral Medicine, 49, S33–S33.		*in analysis*
We4Fit	Pereira, C V, G Figueiredo, M G P Esteves, and J M de Souza. “We4Fit: A Game with a Purpose for Behavior Change.” Proceedings of the 2014 Ieee 18th International Conference on Computer Supported Cooperative Work in Design (Cscwd), 2014, 83–88.	https://we4fit.wordpress.com/	*in analysis*
Wizard	Cambridge University	https://www.cam.ac.uk/research/news/brain-training-app-may-improve-memory-and-daily-functioning-in-schizophrenia	*in analysis*
Yummi Tricks	Ingles-Camats, G, M M Presno-Rivas, M Antonijoan, O Garcia-Panella, and T Forrest. “Yummy Tricks: A Serious Game for Learning Healthy Eating Habits.” Stud Health Technol Inform 172 (2012): 185–90.		*in analysis*
Zombie Run!	Six to start	https://www.gamesforchange.org/game/zombies-run/	*in analysis*

Chapter 11
mHealth for Illness Self-Management for People With Schizophrenia:
Opportunities and Implications in Gamification

Raquel Simões de Almeida
School of Health, Polytechnic of Porto, Portugal

ABSTRACT

People with schizophrenia and other related disorders experience great difficulties in getting the appropriate treatment regarding not only the type of interventions available but also the conditions that required for a proper treatment, mainly cost, locale, and frequency. The use of gamified mHealth applications for this population is a proven way to provide a set of tools that may help patients to manage their condition using applications on mobile devices, like smartphones, that implement game-like strategies and elements that transform unpleasant tasks into virtual challenges. This chapter addresses the impact and implications that the use of gamified mHealth applications have for people with schizophrenia, a comprehensive guide of recommendations and standards used by the industry on the development of gamified applications and provides a literature review on the subject.

INTRODUCTION

According to the World Health Organization (WHO, 2016) chronic diseases can be defined as long-term and generally slow-progressing diseases, which result in disability. The provision of care in chronic diseases must include, among others, the identification of the patient's needs, the modification of risk behaviours and the use of systems that allow the monitoring of results. In addition, it is essential to control the symptoms and the possible implications that they may trigger in the patient's life, thus making it essential to develop intervention strategies focused on self-management (Gale & Skouteris, 2013).

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The concept of self-management was initially used by Thomas Creer, in the mid-1960s, while studying children with asthma (Padilha, 2013). It was also during the second half of the twentieth century that industrialized countries began to develop health programs, which were based on the belief that chronic disease self-management played a key role in controlling diseases such as asthma, heart disease and diabetes (Bastos, 2013). Self-management is recognized as an essential component of health care in chronic diseases, being a multidimensional and complex phenomenon, which can be defined as an action oriented towards the active involvement of the individual in the management of the disease and, simultaneously, to promote their global health (Cunha, Chibante & André, 2014; Kimberly, 2011; Padilha, 2013; Schulman-Green et al, 2012). More recently, a new definition of self-management was proposed by Van de Velde and colleagues (2019): "*Self-management is the intrinsically controlled ability of an active, responsible, informed and autonomous individual to live with the medical, role and emotional consequences of his chronic condition(s) in partnership with his social network and the healthcare provider(s)"*.

With the development of technologies on the field of mobile devices and the proliferation of software applications for these platforms, a wide range of opportunities were opened for the development of tools that are designed to help people with chronic diseases. With the illness self-management in mind, multiple tools and applications were developed to help patients to carry on with their lives while taking care of their own condition. Some of these tools apply elements, patterns and principles that are more probable to be found on video-games - this is known as gamification. With no surprise, gamification is being used as serious approach to engage users to all kinds of platforms and provide satisfactory user experience while guiding the user to perform a series of tasks and activities that are crucial to the good management of their condition. Mobile health applications, which include applications aimed for patients with schizophrenia, are among the most gamified tools available in the various application marketplaces with very positive impacts on the lives of their users (Chandrashekar, 2018; Cheng, Davenport, Johnson, Vella, & Hickie, 2019).

BACKGROUND

Mental health problems have a great impact on affected individuals and society, being one of the main causes of disability. According to the Global Burden of Disease study (2018), 792 million people lived in 2017 with a mental health problem, a prevalence rate of 10.7%, however the access to rehabilitation programs and psychological intervention is still scarce, which has a negative impact on the functionality, quality of life and social inclusion of these people.

Mental health problems are thus a growing global concern and recent evidence supports the need for additional treatments and the implementation of practices that favour the patient's self-management of the disease (Buchanan et al., 2009), concomitantly with taking medication prescribed (Mueser, Deavers, Penn, & Cassisi, 2013).

The way in which mental illnesses are conceptualized today and the responses that are developed to improve the functionality, quality and life satisfaction of people with experience of mental illness and their effective social inclusion, result from dynamic and evolutionary processes that have undergone profound changes across different societies. For many years the conventional wisdom in the field of mental health assumed that mental illness, in particular schizophrenia, inevitably resulted in progressive deterioration (Farkas, 2007). Professional practice was essentially focused on the management of psychopathology and its symptoms, neglecting all other aspects nowadays recognized as essential in rehabilitation, that is, the nuclear response found to deal with severe mental illness, in different formats and concepts, has always been imprisonment or internment, the withdrawal of these people from community life, depriving them of their active participation and the ability to self-determine, which hindered and delayed the adoption of recovery-centred practices.

Schizophrenia, along with other psychotic disorders, is characterized by several psychopathological domains, each with distinctive courses, treatment-response patterns and prognostic implications. The relative severity of these symptom dimensions varies in all people diagnosed, as well as through different stages of the disease. Measuring the relative severity of these dimensions of symptoms during the course of the illness in the context of treatment can provide clinicians with useful information about the nature of it in a particular person and in assessing the specific impact of treatment on different aspects of the illness as well. Schizophrenia is the most prevalent and incapacitating psychotic disorder (Chaudhury, Deka, & Chetia, 2006), being characterized as a mental health problem that causes cognitive disruption and emotional, with repercussions on social and occupational functioning (Chien, Wong, Leung, & Yeung, 2013; Tandon et al., 2013).

Regarding the criteria for the diagnosis of schizophrenia, it is necessary to present at least two of the following items, each present for a significant amount, during the period of one month: delusions, hallucinations, disorganized speech, grossly disorganized behaviour and negative symptoms. In addition, in order to diagnose this pathology, it is necessary to have a change in social and occupational functioning in one or more areas, such as work, social participation or activities of daily living, during a significant period of time, since the beginning of the disorder. The duration of symptoms should still be present for at least six months. It should also be noted that schizophrenia can be attributed to the physiological effects of a substance (drug of abuse or medication) or to another medical condition (APA – American Psychological Association, 2013; Tandon et al., 2013).

With regard to symptoms, schizophrenia presents positive and negative symptoms that result from changes in several domains of mental function (APA, 2013; Erjavec et al., 2017). Positive symptoms include delusions, hallucinations, disorganized thinking and grossly disorganized or abnormal behaviour (Shin et al., 2017; Yang et al., 2017). Delusions are fixed beliefs that cannot be changed and their content can include a variety of themes that justify their classification, namely persecutory delusions, delusions of greatness, nihilistic delusions, erotomaniac delusions and somatic delusions (APA, 2013; Weinberger, & Harrison, 2011). Regarding hallucinations, these are characterized by abnormal sensory experiences, where there are new perceptions that arise in the absence of an external stimulus (APA, 2013; Weinberger, & Harrison, 2011). Regarding changes in thinking, these are visible during speech, with tangentiality, word salad, blocking of thought, flight of ideas, circumstantiality and verbal perseverance being more prevalent. Grossly disorganized or abnormal motor behaviour is manifested by inappropriate motor behaviour and unpredictable agitation, behaviours that are observable when performing daily activities (APA, 2013).

With regard to negative symptoms, these are defined as the absence or decrease of normal behaviours and functions (Buchanan, 2007), encompassing the emotional dullness, the alogia, the anhedonia, the social isolation, the emotion and the apathy (APA, 2013; Horan et al., 2011; Weinberger, & Harrison, 2011).

Still regarding symptoms, it should be noted that positive symptoms have a greater variation, compared to negative ones, over the course of the disease (Weinberger, & Harrison, 2011). However, both have a significant impact on the individual's occupational functionality and performance (Weinberger, & Harrison, 2011). This impairment is closely related to neurocognitive changes, namely in terms of social cognition, memory, attention, processing speed and executive functions (Bora, 2016; McCleery & Nuechterlein, 2019) which are usually present even before the appearance of the pathology (Larson, Walker, & Compton, 2010).

With the development of schizophrenia, comorbidities may arise, which may be disorders related to substance use, anxiety disorders, obsessive-compulsive disorders, depression, schizotypal or paranoid personality disorders. Regardless of these characteristics, the paradigm in recent years has been centred on the recovery of people with schizophrenia, namely on their empowerment so that they have the tools and skills necessary for them to be able to make decisions about their life and autonomously manage their condition.

SELF-MANAGEMENT

Good self-management is understood as the individual's ability to monitor the disease and develop and use cognitive, behavioural and emotional strategies, in order to minimize the functional limitations that arise from chronic diseases (Siantz & Aranda, 2014; Schulman-Green et al, 2012). As a result of good self-management, increased independence, greater therapeutic adherence and changes in the patient's lifestyles and risky behaviours are achieved, which translates, in the medium and long term, into increased well-being. being in greater stress management and, consequently, improving their quality of life (Kimberly, 2011; Panattoni et al, 2017; Strong, Lemaire & Murphy, 2017). In turn, some indicators, such as readmissions, seeking medical appointments and the presence of complications from the disease, are the result of ineffective self-management (Bastos, 2013).

The effectiveness of self-management encompasses two aspects: volition, the process according to which the individual creates a mental model, according to his opinions and orientations, in order to make choices: and cognition - a process that allows decision making, considering individual judgment regarding options (Bastos, 2013; Cook et al, 2012).

Regarding mental illness, it was only in recent years that self-management programs began to be developed, with the first publication in 2006 (Lorig et al, 2014; Siantz & Aranda, 2014), perhaps due to the growing commitment to recovery in mental health in recent years in many countries. Alongside this interest in recovery, there has been an increasing emphasis on personal responsibility, education, hope, self-advocacy and support, through self-directed interventions for people with mental health problems, as opposed to traditional paradigms.

In practical terms, self-management requires an assertive application of the concept of recovery, allowing people to take responsibility for their lives and collaborate with health professionals in a symmetrical relationship. However, moving from a disease-based to a recovery-based structure requires a transformation in the way a person with a mental health problem is viewed, requiring changes in treatment goals, user-health professional relationships and intervention approaches.

The Illness Management and Recovery program is one of the most interesting programs for its level of evidence (Mueser et al., 2006). This program has a psychoeducational approach (education about the disease and effective use of medication), as well as disease management and recovery (training for the development of various skills and subjective/ objective recovery). It is complemented with a book organized in the following modules: recovery strategies, practical facts about mental illness, stress vulnerability model, building a social support network, effective use of medication, alcohol and drug consumption, relapse prevention, strategies coping to cope with stress and persistent symptoms, and self-harm in the mental health system (Beentjes et al., 2016; Whitley, Gingerich, Lutz, & Mueser, 2009). It is the combination of these factors that will allow the person with a mental health problem to perform their significant roles and occupations, which promotes their functionality and participation.

Over the years, the way in which each self-management intervention has been made available to people with mental health problems has been changing. Recently, the potential of Information and Communication Technologies (ICT) to facilitate and support the change in health behaviours and the self-management of chronic conditions has been evident. Examples of this are the use of websites, mobile applications, social networking tools or online games that offer flexibility to provide health information and resources at a time and place chosen by the individual, thus being consistent with the person-centred approach.

MHEALTH AS A PROMISING TOOL

The concept of eHealth (electronic health) can be defined as the use of ICT through online and offline applications in wired electronic devices (Blaya, Fraser, & Holt, 2010; Kampmeijer, Pavlova, Tambor, Golinowska, & Groot, 2016; Smeets, Martin, Zijlstra-Vlasveld, & Boon, 2014). The main objective of ICT in the health field is to support the care provided by traditional services, converging information technology combined with medicine and public health (Blaya et al., 2010; Høstgaard, Bertelsen, & Nøhr, 2017; Smeets et al., 2014).

The use of eHealth services must consider aspects such as the efficiency and improvement of the quality of healthcare, the empowerment of the user, the incentive to create a new therapeutic relationship, the education of technicians and users about the functioning of the applications, the sharing of information between health establishments, the expansion of care provision, interventions supported by evidence, ethics and equity, and technologies must be accessible to all users regardless of their skills and socioeconomic status (Beentjes, Gaal, Goossens, & Schoonhoven, 2016). EHealth resources consider four areas of service provision: information sharing; selection, evaluation and monitoring; intervention; and social support (Lal & Adair, 2014). Then, the concept of mHealth appeared. The definition of mHealth is "wireless communication technologies that transform health, healthcare and public health" (Steinhubl, Muse, & Topol, 2013). The price, the portability of mHealth systems and the ubiquity of the mobile network are the main factors that guarantee the success of this field of computer science with evident benefits for its users.

Smartphones, as the most common mobile devices used around the world, have come to stand out as interesting platforms for illness self-management because of their ubiquity and their ability to connect to the Internet. Some of these features allow its users to better manage their condition by issuing appointment notices, reminders to take their medication and providing coping and problem-solving strategies to deal with the symptoms and specific everyday situations.

In the area of mental health, most of the applications developed are aimed at depression, generalized anxiety disorder, panic attacks, phobias and stress management (Rotondi et al., 2015; Stjernswärd & Östman, 2007). These electronic applications are based on Cognitive and Behavioural Therapy (CBT), mainly in programs aimed at generalized anxiety disorder, panic attacks and depression. Psychoeducation is the second most used approach in programs aimed at depression and stress (Christensen & Petrie, 2013; Moock, 2014; Musiat & Tarrier, 2014). Studies are not consensual regarding the effectiveness of this type of approach in mental illness, although for depression and anxiety disorders, some interventions demonstrate efficacy in early trials (Beentjes et al., 2016). With regard to depression, only online self-help guides proved to be as effective as the standard intervention (O'Dea et al., 2014; Smeets et al., 2014). Also, e-mental health interventions for young people have been shown to have an effect, with a decrease in depressive symptoms as well as in anxiogenic symptoms (Smeets et al., 2014). It should also be noted that pilot studies carried out with children with symptoms of mood disturbance revealed a reduction in depressive symptoms after a month of intervention using e-mental health (Smeets et al., 2014). For anxiety disorders, the evidence from programs using ICT is less (Smeets et al., 2014), although some studies show an equivalent effectiveness of e-mental Health for panic attacks and social phobia when compared to the standard intervention (O'Dea et al., 2014).

The advantages of mHealth services are the increase of the user's responsibility and feeling of empowerment, improvement of the self-management of the illness and self-efficacy, stimulation of the user's participation, adaptation of the services to the user's needs and skills, promotion of an extension of interventions beyond the therapeutic context, improvement of the efficiency of the health service, decrease of costs inherent in the provision of services, the promotion of accessibility and equity in health care assistance, minimization of impact on the functionality of people who experience a mental health problem found on waiting lists, decrease of medical errors, as well as promotion of anonymity. With regard to the intervention, it can be classified according to the phase (promotion, prevention, early intervention, active treatment and prevention of relapses), type of relationship and type of intervention. Most interventions consider a continuum of care and use only a single format. However, some incorporate several types of approaches, such as using the Internet in a self-help logic in conjunction with establishing contact via email with the therapist. Social support in mental health occurs through several formats, including discussion groups, chat rooms, blogs and social networks (Lal & Adair, 2014).

Applications aimed for people with psychotic disorders, namely schizophrenia, are still scarce compared to other health issues. The implementation of mHealth applications has encountered barriers, with the resistance of professionals and users being the most prominent. In addition, the users' low level of education, the low competence on ICT, the user's lack of insight and confidence in this service, possible cognitive, sensory and motor deficits, were also mentioned as barriers. But also, the socio-economic context of users, the lack of financial support for the development of applications, the difficulty in recruiting experienced staff, technical knowledge, the high initial costs inherent in the development of the application, the lack of awareness of the importance of eHealth resources, scepticism about the effectiveness of applications, concerns about privacy and security and legal barriers, such as bureaucracies inherent in the patent.

Studies (Gay, Torous, Joseph, Pandya, & Duckworth, 2016; Simões de Almeida, Sousa, Marques, & Queirós, 2018) carried out in Europe and in the United States of America have found evidence that counter the apparent scepticism of these technologies by people with psychotic disorders, highlighting the fact that these people are highly motivated and are able to get involved in the use of these types of technologies, especially the young.

The European Union's General Data Protection Regulation (GDPR) has triggered further interest in privacy and data protection, not only for health care organizations but also for mobile technologies (Hoofnagle, van der Sloot, & Borgesius (2019).

It should be emphasized that the provision of services through mHealth is not intended to replace or reduce existing standard interventions, namely pharmacological and psychosocial interventions, since they are an extension of health care that aims to maximize the provision of services and increase the user's involvement in their therapeutic process. In addition, the effective management of psychiatric illness requires collaboration between the patient and the professional, so that problems can be identified, goals defined, incorporate the most effective self-management strategies and monitor the user's progress.

HABITS AND ATTITUDES TOWARDS GAMES AND ICT USAGE IN PEOPLE WITH SCHIZOPHRENIA

We tend to have the misconception that people with schizophrenia use technology on a smaller scale than people without mental illness, but the studies carried out show us a different reality.

In 2016, it was conducted in the United States a survey on technology usage among those self-identifying as having schizophrenia (Gay et al., 2016). The main findings pointed out that 90% of the respondents owned more than one digital device and many respondents stated that they used ICT to help identify coping strategies to deal with voices or for medication management. A cross-sectional survey was made in Hong Kong to explore the habits and attitudes of video gaming and information technology use in people with schizophrenia (Choi et al., 2020) and the results showed high internet rate use (90% had access to the internet). Also, more than 30% used the internet to play web-based games and 80% had played a video game in the past year, having positive perceptions regarding it. Another study reported that 86% of participants used a mobile phone, identifying some factors that can interfere with this: age, illness stage, income and neurocognitive functioning (Young et al., 2020).

However, it must not be forgotten that many of these studies are carried out online, which can create a response bias (these participants are likely to be more technology savvy).

FEATURES OF SCHIZOPHRENIA AND OTHER PSYCHOTIC DISORDERS APPS

There are a few good examples of mobile applications aimed to the self-management of schizophrenia that are widely used, in special the following. One of the pioneering applications was FOCUS which intervention modules consist of brief skills training, practical exercises, and encouragement to use illness management techniques related to medication adherence, mood regulation, sleep, social functioning, and coping with auditory hallucinations (Ben-Zeev et al., 2016). App4Independence (A4i) which is a multi-feature app that uses feed, scheduling, and text-based functions co-designed with service users to enhance illness self-management (Kidd al. 2019). WeCope that targets coping with voices, problem solving, goals setting and stress management, and also has a feature that allows the exchange of messages between user and therapist (Simões de Almeida et al., 2019). MindFrame, a tool that foster power in the everyday management of living with their illness (Terp et al., 2018). m-RESIST (Huerta-Ramos et al., 2017) is a mHealth solution that address the following intervention modules: psychoeducation, monitoring, treatment, and illness self-management. PRIME, a mobile-based digital health intervention designed to improve motivation and quality of life and for that reason it can also boost self-management (Schlosser et al., 2018), lets users set daily goals based on their individual needs. There are challenges to try and users can see their progress tracked getting points and rewards for their achievements. Also, whenever users need help, there are coaches available to help them.

A recent systematic review (Chivilgina, Wangmo, Elger, Heinrich, & Jotterand, 2020) showed that mobile health applications for schizophrenia and related disorders were designed with multiple purposes: monitoring of symptoms, including applications able to predict psychological conditions; Promoting medication adherence and/or monitoring side-effects; Prevention or therapy of psychosis or auditory verbal hallucinations, which includes cognitive behavioural therapy (CBT) interventions, violence monitoring and a game for coping with auditory verbal hallucinations; Targeting deficits: cognitive training, decision-making support, improving anhedonia, social skills training and wayfinding; lifestyle goals:

smoking cessation, coping skills, supporting at work, promoting healthy lifestyle, sleep improvement, music therapy, mindfulness and assisted caregiving; and also general purposes, when the program represented a combined intervention targeting several functions.

According to Chandrashekar (2018) these apps try to accomplish three goals. First of all, high user engagement. Most of the users use apps on their own time without clinical oversight and they must be intrinsically motivated to engage with the app. Evidence from the literature suggest that patient engagement can be improved through: (1) real-time engagement; (2) usage reminders; (3) gamified interactions. Second one, simple user interface and experience. Models of technology-based behaviour change emphasize the importance of simple, intuitive user interfaces for driving faster behaviour change through reduced cognitive demands. For people with schizophrenia or other psychotic disorders, working memory is often impaired. Apps serving these population must be designed to generate a low cognitive load and a simple interface reduces cognitive load and increases capacity for learning. Features that reduce cognitive load include: (1) the use of pictures rather than text; (2) reduced sentence lengths; (3) inclusive, nonclinical language (Bakker et al., 2016). Third, app-based features that enable users to self-monitor their mood by periodically reporting their thoughts, behaviours, and actions can increase emotional self-awareness (defined as the ability to identify and understand one's own emotions, has been shown to reduce symptoms of mental illness and improve coping skills). That is rather important since psychological disorders are highly comorbid, however, few mental health apps explicitly harness transdiagnostic methods to treat symptoms shared among disorders. Since interventions for comorbid disorders are typically similar in delivery and content, transdiagnostic apps can increase patient engagement and treatment efficacy by reducing the commitment needed to interact with multiple apps for comorbid disorders.

Nevertheless, there are factors that can contribute to the adoption of health services through mobile technologies, such as the perception of ease of use and self-efficacy (mobile applications must be easily learned and used) and the fact of providing this tool with an appropriate service price. People with psychotic disorders can be positively affected in their acceptance behaviours, not only by their peers, but also by professionals' attitudes towards mobile technologies (Sun, Wang, Guo, & Peng, 2013).

MHEALTH FROM DESIGN TO IMPLEMENTATION

A very common methodology used during the development and implementation of these technologies start with the development of low-tech prototypes, which serve to communicate the goal and ideas behind the technology, essentially a proof of concept. The most important characteristics of the idea must be present in the prototype to be evaluated by users, specialists or other interested parties. This can be done with a paper and pencil scheme or something more complex like creating mock-ups. Only at a later stage the development of digital interfaces and the most concrete possibility of testing the usability of the technological tool take place. This iterative process allows to produce an ideal product using constant feedback at each stage of the development.

Later in the development process, usability tests are performed. In general terms, there are two forms of usability testing: expert-based assessments and user-based assessments. The former must have in-depth knowledge of both the technology and the health problem in question, while the latter must belong to the target group for which the tool is intended.

Usability assessment is at the moment considered critical to the success of mobile healthcare applications. However, the wide range of usability inspection and testing methods available can make it difficult to decide on a usability assessment plan. The choice of using methods is often related to resource issues. User-centred approaches are particularly important in the development of technological systems for people with psychotic disorders, as they often have a set of unique characteristics (for example, the presence of positive and negative symptoms) that can significantly affect how they can get involved in technology-based services.

Moreover, the end-user should be involved as a participant in the design decisions. In short, it is important to understand how mHealth interventions should be designed and built. User Centred Design or Human Centred Design, as the name implies, involves considering what the user needs at all stages of the design process, representing a systematic process that is essential to ensure that applications are focused on the person (Polhemus et al., 2020).

A few years ago, a system approach called "P5 medicine" was proposed (Gorini and Pravettoni, 2011), and the five Ps referred to Predictive, Personalized, Preventive, Participatory and Psycho-cognitive aspects; this allows to assertively consider the user's needs and contexts from the very first steps of design and implementation and could be exploited in the future to design advanced mHealth resources (Gorini et al., 2018).

This reflection is extremely important for designing technologies for health, but it is even more important when it comes to people with mental health problems. As an emerging area with a unique sets of design constraints and concerns, guidelines are beginning to be established that organize the knowledge gained from existing development projects. There are some theoretical models that can orientate the design of effective and sustainable behavioural health interventions, but when it relates to people with mental health problems the use of those principles has received reduced consideration. It should also be noted that the simplicity of the interface and the ease of navigation of a program significantly influence how users perceive the quality of online interventions for mental health. User satisfaction and the credibility of the program directly influence involvement and therapeutic benefit.

USE OF GAMIFICATION ON MHEALTH

There are several definitions for "Serious games" and "gamification", but they use game elements to educate and change behaviours (Fleming et al., 2017). Gamification consists in using some specific game elements to non-game contexts, namely healthcare (Fleming et al., 2017).

Gamification is a technique which motivates app users to engage with the application to earn rewards. It is a subtle psychological way to motivate users to keep playing and engaging with an application. This is a great way to encourage users to stay on track with their mental health and wellbeing goals (giving users visual feedback on their progress or maybe points for following their recommendations every day) and even suggest improvements to their lifestyle which is also a good way to plug in-app purchase.

Game-based approaches for mental health are still gaining traction, but already present some benefits in terms of symptomatic control and in behavioural and psychological improvements (Fleming et al., 2017). A recent review found that gamification has a greater maturity in the areas of fitness, changing lifestyles and managing chronic diseases such as diabetes, but is still at a very early stage in terms of mental illness management (Cheng et al., 2019). This fact can be explained because it could be considered unreasonable to apply game-like elements (points, rewards, achievements, social comparison, and competition) to people experience mental health distress, especially in circumstances where users are in an acute phase (Cheng et al., 2019).

The use of gamification is a way to improve illness self-management applications using the self-determination theory framework. According to this theory, motivation is a force that energizes and directs behaviour, continuously regulating the subject's interaction with his environment. It is a critical condition for change, entry into therapy, adherence and the results of therapy. However, people with mental health problems, namely psychotic disorders, usually present a pattern of demotivation, reflected in their behaviours, emotions and cognitions (Gard, et al., 2014).

There are several mechanisms through which motivation influences learning and achievement, namely: choice of activities and selection of environments, which, through the skills, values and interests they stimulate, influence learning and development; effort (intensity); use of strategies; and the willingness to persist in time (Lai, 2011). In addition, the belief and perception of one's own ability to perform a task successfully has to do with expectations, self-concept and self-efficacy, with the belief that challenging tasks presuppose greater motivation, considering the type of value they bring (intrinsic interest, importance, utility, cost). For people with mental health problems it is essential to define goals, since they are the ones that give meaning to the behaviour and organize the internal and external resources, because the objectives configure different patterns of cognition, affection and behaviour, relating to more positive results. or less functional, adapted and well-being (Lai, 2011).

The Self-Determination Theory also provides a model for understanding motivation deficits in schizophrenia, underlining that behaviour results from three factors or types of motivation: intrinsic, facilitated by the need for autonomy, competence and relationship; extrinsic, which consists of reward or punishment; and internalized, which describes the involvement in activities that are not intrinsically interesting, but productive and accommodating to the social world (Gard et al., 2014). These motivational processes are impaired in most mental illnesses and failures in internalization imply less effective functioning and vulnerability to psychopathology (Barch & Dowd, 2010). The integration of values and regulatory processes in the self is the basis for the self-determination of extrinsically motivated activities, so it must be a work developed with these people (Ryan & Deci, 2000).

A difficulty also present in psychotic disorders is the regulation of behaviour, which can take on different styles: external, with behaviours regulated by expected extrinsic contingencies, anticipation of social or tangible reinforcements; introjected, with behaviours regulated by self-approval or disapproval; identified, when previously external regulation is experienced as its own value or objective, the behaviour is experienced as self-determined; or integrated, when the various identifications or values are integrated in a coherent hierarchy, without different objectives interfering or competing with each other (Livingstone, Harper, & Gillanders, 2009).

The Theory of Self-Determination also highlights the basic psychological needs that are subdivided into three needs: competence, which refers to the feeling of effectiveness and leads to the search for challenges and the attempt to overcome them; autonomy, which refers to the feeling of being the author of one's own behaviour; and relationship, which refers to the feeling of connection and belonging. This aspect is essential, since support for autonomy refers to the amount of freedom given to the person to determine their behaviour. The attitudes that support autonomy are: allowing choices; recognize the subject's will when limits are established; to highlight, for the subject, the relations between the activities and their interests; minimize external rewards, control and pressure (Gagné & Deci, 2014).

SOLUTIONS AND RECOMMENDATIONS

Because schizophrenia is by definition a chronic condition, the use of technologies for a long time could be a good asset. However, many Internet based interventions have high rates of drop-out mainly due to user loss of interest. Applying gamification may not be the always the best or most effective solution per se, but specific game design elements have specific psychological effects (Sailer, Hense, Mayr, & Mandl, 2017). Moreover, user engagement strategies should be included in the app itself. For example, the onboarding moment. The onboarding experience of an app is the first conversation with the user. This first step should cause the best and most positive impact possible in order to engage the user from the get-go.

With onboarding, the goal should be to bring people in and get them used to using the app. The user should be guided through the features of the app during the onboarding process, but the focus should be on getting users to experience the benefits of using your app as soon as possible. As with all user engagement strategies, the sooner the user gets engaged, the more likely they will be to continue using the app. Another aspect is push notifications. If the app goes quiet for long periods of time, users will forget about it and eventually delete it but this does not mean that the app should annoy users with massive notifications.

The usage of incentives and rewards is the golden point of gamification. Although many apps offer points, badges, or other reward systems, not all of them do it well. The human brain is complex. An incentive that works today may not continue to work months down the road. One type of incentive might work really well on a certain demographic, but not at all on a different demographic.

Cognitive flow, positive reinforcement, simplicity, and autonomy all play important roles in gamification user engagement strategies. Personalization is key, if a user feels that the information being provided is generic, he may get the feeling that he could get the information elsewhere and dismiss the app, regardless of the other benefits it provides. Developers and healthcare professionals need to make sure that the mobile application automatically keeps track of relevant personal information and offers information that is tailored and customized for each user. Also, brainstorm other features that individual users might be interested in using and offer those as incentives for increased engagement. Also important is the connection to real life consequences. Beyond offering incentives and rewards within the app itself, the application developers have to make sure that the application connects positive health changes to real life consequences.

Although it does not offer scoring or recommendations of specific apps, the American Psychiatric Association App Evaluation Model provides a framework to guide discussion and informed decision-making about apps (Torous, et al. 2018) including context and background of the app, risk assessing for harm, evidence potential for benefit, usability and adherence and interoperability (meaningful data use and sharing).

A systematic review (Cheng, Davenport, Johnson, Vella, & Hickie, 2019) screened about 50 apps and technologies and observed that the most relevant gamification elements were "*levels or progress feedback, points or scoring, rewards or prizes, narrative or theme, personalization, and customization; the least commonly observed elements were artificial assistance, unlockable content, social cooperation, exploratory or open-world approach, artificial challenge, and randomness*" (p. 2). The two major goals for using gamification to improve mental health and well-being are promoting user engagement and enhancing the effects of a given intervention (Cheng et al., 2019). These authors place some reservations on the widespread use of gamification as they argued that many developers and researchers use gamification disconnected with the theories of behavioural change and its own mechanisms.

The findings from another recent scoping review (Williams, Farhall, Fossey, & Thomas, 2019) indicate that when Internet-based interventions are well-integrated into practice, they can support service users' involvement in their care, promote a sense of working in partnership, and support recovery-oriented practices. The authors of this study stated that it is necessary to clarify expectations about using the tool in advance and integrate these tools in the systems, giving human support whenever is needed (Williams et al., 2019).

People who experience schizophrenia and other psychotic disorders can engage in protective or risky behaviours every day, but emerging technologies can help them change their behaviours and serve as the key scaffold to implementing effective practices in a scalable, personalized, and sustainable manner (Ben-Zeev et al., 2019).

The application of behavioural economics principles in healthcare has been transformed through the use of technology and recently the advent of video gaming concepts, or gamification, to modify patient behaviours. The role of practitioners in the era of gamification has not been well established, but it is possible that the need has arisen for development of clinical practice guidelines and the "digital practitioner" - one who specializes in healthcare apps, accepts referrals from other practitioners, identifies the best programs to meet individual patient needs, and consults to assess whether game apps might improve clinical outcomes.

In addition, data security and the privacy of the person with mental illness is an essential requirement during the development of these services and applications. Mechanisms that guarantee the correct authentications and authorization of access to data and resources is fundamental.

FUTURE RESEARCH DIRECTIONS

Today the focus on the use of technologies in the health area is to develop applications that promote the autonomy, health and well-being of most people. There have been improvements of using gamification to help respond to that call, however there is a need to reflect and define guidelines in order to implement these techniques safely and effectively, and in order to respond pragmatically to the needs that arise.

Psychotic disorders are a chronic condition, implying the need to illness self-manage, essential for people with these diagnoses to be able to deal with the symptoms and live a functional and satisfactory life. Self-management is a dynamic and daily process that involves taking informed choices and decisions, an aspect that is consistent with the recovery paradigm. Evidence-based psychological interventions are recommended for people who experience severe mental health problems such as psychosis. However, factors including the costs of in-person therapy, lack of trained staff, and time and caseload pressures mean that timely access to support is not always available.

Digital technologies offer new opportunities for improving psychological interventions in an engaging and tailored setup, as well as providing novel therapeutic contexts within which core psychological processes can be targeted in real time with immediate feedback. In recent times, several technologies emerged and support this approach by advocating the active role of the person in the recovery.

The use of eHealth services must consider aspects such as the efficiency and improvement of the quality of healthcare, the empowerment of the user, the incentive to create a new therapeutic relationship, the education of technicians and users about the functioning of the applications, the sharing of information between health establishments, the expansion of care provision, interventions supported by evidence, ethics and equity, and technologies must be accessible to all users regardless of their skills and socioeconomic status. Still, for mobile app prescription to be a reality, it is essential to test them and present results that demonstrate that they do not cause harm and that they are useful and motivating for users (Byambasuren et al., 2018).

CONCLUSION

In the recent past, a series of applications and services taking advantage of this technological environment have emerged to help the practice of medicine and public health using mobile devices. These mobile applications and services are classified as mHealth, a subset of eHealth solutions - healthcare practices supported by electronic processes. This may empower patients to stay on track with their illness, thus in control of it. This also indicates the potential of smartphone-based care being capable of aiding this specific population to more confidently manage their new life situation.

Solving modern healthcare challenges with gamification technology is indeed well-poised to transform how mental health treatment is delivered and accessed, but this transformation requires the combined mobilization of science, regulation, and design. Also, if we think about the future, digital natives - individuals who grew up in the internet and smartphone era - are fully capable of using technologies for self-help and personal healthcare.

Use of mobile health technology for empowerment of people with schizophrenia is an emerging way to answer the needs that are not covered by the lack of professionals, the costs and even stigma, and it can address almost every problem of the user. But approaches are diverse and every app has its own properties and functionalities. There are many apps on the market, but only few of them are adequately designed, reviewed and certified by authorities. Therefore, their quality is questionable. But many studies showed, mHealth is effective and even cost-effective, though more research is needed. The future applications should be more personally oriented, improved regarding usability and accessibility, and based on accepted clinical guidelines.

Regarding gamification, it is essential to have more comprehensive and explicit guidelines on how researchers, developers and clinicians could use it in order to create mHealth approaches that respond to the needs of its users, without causing harm, and be a proposal to complement existing services.

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ADDITIONAL READING

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KEY TERMS AND DEFINITIONS

eHealth: Use of digital technologies to facilitate health improvement and health care services.

Gamification: Use of game-design elements and principles in non-game contexts such as healthcare, education, and so on._

Illness Self-Management: Decisions and behaviours that people with chronic illness engage in that can affect their health – hopefully in a positive note.

mHealth: General term for the use of mobile phones and other wireless devices for healthcare purposes.

Recovery: Not focus on symptom reduction but on a personal process of rediscovering a new feeling of identity, self-determination, and personal empowerment to live, participate, and contribute to the community.

Self-Determination Theory: Framework conceptualizing motivation and personality which explains the choices people make based on their needs for autonomy, acquire skills and have positive relationships.

User-Centered Design: Iterative design process in which developers and researchers focus on the users and their needs in each phase of the process.

Section 3

Gamification in Health Promotion and Physical Rehabilitation

Chapter 12
Carnival Play:
eHealth Solution to Evaluate, Rehabilitate, and Monitor Dexterity and Manual Strength

Bruno Giesteira
https://orcid.org/0000-0003-4896-6659
University of Porto, Portugal

Joana Silva
University of Porto, Portugal

Teresa Sarmento
University of Porto, Portugal

Paulo Abreu
https://orcid.org/0000-0002-2745-6951
LAETA-INEGI, Faculdade de Engenharia, Universidade do Porto, Portugal

Maria Teresa Restivo
University of Porto, Faculty of Engineering

ABSTRACT

Developed within the scope of a SciTech research project, this chapter records in a procedural way the design centred on senior users for a set of three serious games for the eHealth field, designated by the authors as "Carnival." The chapter, having as its leitmotif the project aforementioned, looking at its motivation, breaks down the systems augmented feedback interfaces—BodyGrip and SHaRe—to evaluate, rehabilitate, and monitor dexterity and manual strength. Topics related to empathy and well-being in the user experience design process, namely guidelines for empathy in different project phases, participatory design, inclusiveness, and amusement are identified. Withal listed the development phases of three games dynamics inherent to the "Carnival" set —"High Striker," "Claw Machine," "HotDog Sauce"—punctuating with the discussion and contributions to the e-health area describing its potential for Evaluate, rehabilitate, and monitor dexterity and manual strength.

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INTRODUCTION

In this chapter, the authors played seriously. Presently, healthcare and well-being demand for Serious Games playing and, since this is no playful matter, there is no problem about how slow the progression is, as long as it continues. Similar to the recovery process that is about evolution, not perfection, side by side, games and technology can engage users in playful, as well as significant experiences, prompting the delight of each human cell. Empathy starts with the ability of one placing himself in another person shoes, seeing with other eyes, feeling with another heart. An echo from another perspective into ourselves, ripping apart the human ego sphere. Belonging to a greater sphere, more inclusive, where everyone feels as equals since every human being has the right to unite to a society. There is a need to optimize technology, to overcome these struggles, as the next step towards a society that will shape different values for the future. Implying that technology is at peoples service, is the same as saying that it is available for them hence it must behave like a respectful, generous and helpful character, that cares for people delight, inclusiveness and amusement.

Framing a work plan for the Interaction and Serious Game design, in an eHealth context, the authors developed “Carnival” a game set comprising three games dynamics: “High Striker”, “Claw Machine” and “HotDog Sauce”. These were conceived in parallel within two perspectives: (i) the digital Interface Design (UI), as a mediator of game dynamics, and (ii) the User Experience Design (UX). Focusing on promoting the player’s engagement in the performance of repetitive tasks, the authors aim to defeat the rehabilitation or training process monotony. “Carnival” intends to ensure good communication, providing stimuli for the players to go forward in their performances. Facing this situation, the authors unfolded the chapter into four main titles. The first defining the Motivation for this design, with a central purpose of evaluating and reformulate the Interaction Design, and User Experience applied to two instrumented systems already conceived and built: BodyGrip and SHaRe (hardware devices and its corresponding interactive software applications), where previously were specified the Social Context. The second defines the State-of-the-Art, prospecting the concept of Empathy for Well-Being, where notions such as Positive Computing and eHealth, Guidelines for Empathy’ Stages, Co-Designing Healthcare and Inclusivity and Amusement, were explored aiming to reinforce the contributions of play systems for eHealth, Occupational Therapy and Rehabilitation contexts. The third title declares solution development, step by step, where the game “Carnival” gains life, converging its user experience research to its user interface ideation. Finally, the authors close the chapter offering an overview of this project Discussion and Future Research Directions, aiming to trace the current and future usage of games for health on diagnosis, prediction and monitoring namely in the context of musculoskeletal pathologies describing the potential of the BodyGrip and SHaRe systems to evaluate, rehabilitate and monitor dexterity and manual Strength.

MOTIVATION

Social Context

Technological evolution has transformed human living irreversibly since the XX century, changing how people live, think, perform their daily activities, connect with the world and with others. It is undeniable that these changes have a direct impact on society, being able to bring many social benefits; since man knows how to use them. In parallel with technological development, there are significant changes in the demographic profile of the world population, demonstrating the need to a user-centered approach in technological innovations, considering who will be the people who will use these technologies: an ageing population. Considering ageing as a process that occurs throughout life the search for active and healthy ageing brings contributions not only for the elderly but consequently for everyone (United Nations, 2017). It is necessary to create age-friendly environments (World Health Organization, 2015). Solutions that encompass memory, perception, language and motor stimulus are crucial for longevity, agile cognition and consequently an increased quality of life.

"Carnival" play system allowed instigating opportunities for remote therapy, meeting the player's needs and expectations. Every minute, the elderly population increases, thus, there's a need to thrive in design for rehabilitation programs.

HCI4D has proven to be among the fast-growing fields in which key goals have been the contextualization of HCI to fit the application needs, therefore considering eHealth context, there is a huge demand for research and consequently innovation (Devezas & Giesteira, 2015).

Prospecting an average life expectancy progressively higher is the result of scientific evolution, technology and more qualified health care. Some deficits can limit a person's ability to perform daily tasks, consequently affecting and reducing social participation (Karwowski, 2001). Despite its effectiveness in motor recovery, individuals often cite repetitive exercises as monotonous tasks. Besides, the repetitions per session, it's usually insufficient, contributing to an economically infeasible solution, as well to a non-recurring activity in privately owned contexts (Brox, Fernandez-Luque, Evertsen, & González-Hernández, 2011; Proffitt, Sevick, Chang, & Lange, 2015). Furthermore, the elderly population is a valuable piece of the puzzle, due to their physical and psychological decay process, as well as their cognitive changes. Ageing itself presents a gradual decline in language, perception and motor skills functions (Fisk, Rogers, Charness, Czaja, & Sharit, 2009). Memory loss is prominent, as it compromises some daily life activities, later associated with personal discomfort, loss of autonomy and social problems. Therefore, maintaining an agile cognition is crucial for the quality of life and longevity.

Consequently, there is a need to promote new approaches in the areas of rehabilitation, especially considering these target users (Magalhaes et al., 2019), to delay motor limitations, as well as other adversities. Often, professionals in institutions especially prepared for this purpose (Levy-Storms, 2013) adopt these treatments typology. However, the tools and methods are applied systematically demanding repetitive actions with a succinct focus on users motivation and consequent engagement. Some devices' purposes include the diagnosis, prediction and treatment monitoring of musculoskeletal pathologies, as rheumatoid arthritis, tendonitis and carpal tunnel syndrome (Magalhães, C. et al. 2019).

The assessment with this kind of devices is possible through the use of dynamometers, a portable, easy to use and low-cost tool. Depending on the type, dynamometers may be able to force, measuring torque and power (Gdula M, et al.. 2018; Mathissen M, et al.. 2018). Apart from leased muscle tissue, blood circulation is also altered upon muscular mal-function (Manson JJ, et.al., 2014).

However, other recent studies show that the design of games as psycho-educational and research ludic tools can be used to increase elderly's motivation to engage in physical exercise, and maintain their cognitive abilities (Ma, 2017; Brox et al., 2011). Furthermore, they enable the assessment and rehabilitation of the elderly with mild cognitive impairment, Alzheimer's disease and related disorders (Manera et al., 2015).

Although motivation is inherent to individual interests, some drives are considered universal to the human being beyond any particular constraint, like memory loss or cultural differences. Additionally, many games carry natural human motivation – like seeking patterns in visual information, collecting things and resolving cognitive dissonance (Calvo & Peters, 2014).

BodyGrip and SHaRe Devices

Within the present research, the authors' focus embraced the design of digital games interfaces for instrumented devices used in hand rehabilitation-training phase. The study considered the User Experience with games dynamics fostering the engagement in the treatment.

These were possible throughout the creation of positive stimuli, which enhanced the perception of motor manipulation via a physical and a digital medium.

The devices interfaces promote the simulation of physical gestures and reproduce with augmented visual feedback the user interaction with the instrumented devices.

The HanGrip and SHaRe are both instrumented devices: (i) BodyGrip, is a dynamometer that measures grip strength used for assessment, monitoring and prediction. Includes the ability to be seen as a training device in different contexts of interaction, through game dynamics that require their use. (ii) SHaRe, the System for Hand Rehabilitation in dexterous manipulation of daily objects, focuses on hands rehabilitation. Assists in the recovery of motor, cognitive and sensory functionalities, through game dynamics that motivate users to perform numerous tasks that are part of the rehabilitation universe.

BodyGrip, the device presented in Figure 1, enables the assessment and allows to predict features based on the grip strength exerted during the interaction with it (Guerra et al., 2017). Apart from measuring compression forces (up to 1000 N) exerted by one or various muscle group, it can estimate the amount of energy spent in the process. The grip force (F[N]) is measured and registered along a predefined time interval using a sampling rate of 10 ms. The BodyGrip device allows assessing, monitoring and training hand grip strength, through dynamics that promote the use of the device as a joystick. This training feature comes from the ability to be seen and explored as a playful object, speculative in nature.

Figure 1. BodyGrip, muscle strength and energy measuring device

SHaRe, the device presented in Figure 2, is used in rehabilitation aiming to help in the recovery of motor, cognitive and sensory functionalities throughout game dynamics that focus on re-learning fine movements control, stability and hand dexterity. SHaRe promotes the rehabilitation of individuals with little or no hand strength, and those lacking strength control, endowing them to adapt to the cognitive process of relearning strength control abilities. The device instrumented with force and orientation sensors allows the user to learn how to control the grasp force suitable for performing a given task. The orientation sensors (IMU) provide the use of dynamic behaviour in reproducing hand movement. This improves the game engagement and allows augmented vision feedback during hand movements and training. All these aspects are relevant to be used with patients that suffered a stroke, in a dementia process, or for general upper limbs rehabilitation in individuals with prostheses (Carneiro, Tavares, Rodrigues, Abreu, & Restivo, 2018).

With the device, it is possible to record, process and measure grasp force and spatial orientation. The user can visualise in a computer his performance while directly interacting with the device. Combining force, orientation and sounding provides the base of ludic games that makes the rehabilitation process less monotonous, improving the rehabilitation process. Therefore, the games developed so far comprise virtual environments, using augmented feedback (Carneiro et al., 2018).

Figure 2. SHaRe, System for hand rehabilitation in dexterous manipulation of daily objects

These features motivate the users to perform repetitive exercises, aiming to restore hand movement control, within an Occupational Therapy context, further intended to adapt to a broad generational spectrum, in different contexts of use (Vardasca, Abreu, Mendes, & Restivo, 2018; Silva, Vardasca, Mendes, & Restivo, 2018). On the other hand, SHaRe with its glass-shaped form, a familiar daily used object, is suitable for precision grip training, fine movements control and cognition dynamics. This approach is in line with other works (Lohse, Shirzad, Verster, Hodges, & H. F. Machiel Van Der Loos, 2013), where to enhance the player's in-treatment motivation, engagement and immersion, the repetitiveness of the rehabilitation process was outstrip, converting monotonous tasks into ludic ones.

Additional advantages of device are to monitor progress and to evaluate treatment efficiency (Carneiro, Tavares, Abreu, & Restivo, 2017). Both the BodyGrip and SHaRe have been used in different health, rehabilitation and occupational contexts, taking advantages of the referred capabilities of data storage to monitor, evaluate and follow up patients' evolution (Magalhaes et al., 2019). More details of the devices are available on Restivo et al., 2020a & Restivo et al., 2020b.

Behavioural experiments have shown that the combination of auditory and visual stimulation is more powerful than unisensory stimulation. Thus rhythmically synchronous cues, temporally repetitive, provide substantial advantages to control attention over perceptual selection enabling a more quick and fuller recovery. These cues, support the patient in learn how to control attention, due to the fact that the brain is constantly searching for correlations between the neurons pattern. When repeatedly activated, together will bond and form new synaptic connections (Janssen et al., 2017). Initial studies to introduce the use of sound in these instrumented devices were conducted (Rui Torres, Sonificação de dispositivos instrumentados utilizados em reabilitação, MSc dissertation, FEUP, 2019)

EMPATHY FOR WELL-BEING

Positive Computing and eHealth

There is an increasing interest in games focused on different areas of healthcare: from preventive to therapeutic and for assessment or educational purposes (McCallum, 2012). Positive Computing, a term coined by Rafael Calvo and Dorian Peters in 2014, expresses the desire to "do good with technology" improving the wellbeing of individuals, society and the sustainability of the planet. A manifesto that stands for technology as an agent of positive change, revealing a crucial impact on one's life far beyond the stress of daily routines, assuming the relevant role in the political decisions, human relationships, social and emotional, lives.

Costly chronic diseases and ageing populations are making more and more demands on healthcare services, insurers, and governments. Recently, health policy has encouraged a transversal focus across a person's lifespan, rather than an episodic view, where healthcare procedures are carried out only to address sickness. As Rafael Calvo and Dorian Peters (2014) clearly explain that motivation and engagement walk side by side, and, for the engagement design, one needs the active participation of the potential users throughout the process.

Implies the need for a stronger focus on health promotion and disease prevention, as well as knowledge, skills and tools to achieve this. To address this dilemma were explored, new approaches that take advantage of the availability of increasingly affordable and ubiquitous computing power and related information communications technologies.

The authors have seen events emerge, such as Games for Change, UX for Good and Design for Good. This last motto was even the leitmotiv for the 2018 World Usability Day, where Giesteira argues about "The Evilness of the Design of Everyday Things" having reflected about the wide spreading of IoT technologies and its impacts in the inclusivity of Human-Computer Interaction. Considering being connected and sharing information between devices and humans, and how the interface design is addressed through an accessibility point of view by the letting drop question: "Are we not overly dazzled by technology at the expense of more inclusive and user-centered design?" (Ccg, 2018). These technologies, including wearable sensor networks, mobile computing and telemedicine, allow patients to bring healthcare closer to their daily life.

Beyond motivating health behaviours, engaging players in positive experiences, can directly contribute to their well-being, due to the basic psychological need of satisfaction, positive emotions, engagement, relationships, meaning and accomplishment (Johnson et al., 2016).

Guidelines on Empathy' Stages

According to Calvo & Peters (2014), some empathy design interventions will remain low tech. It is knowledgeable that through playful strategies, it is possible to facilitate learning, develop personal, social and cultural improvement, and collaborate for good mental health. Pleasurable situations not only mobilize cognitive schemes but also contribute to the development of various aspects of personality, such as cognition, affectivity, motivation and creativity (Huizinga, 1949; Flanagan, 2018). Studies show that games enhance cooperation, promote positive social interactions, favour selfless and self-controlling behaviour (Rauterberg, 2004). Currently, in the health area, project contexts are commonly related to designing games that promote knowledge about diseases, facilitating diagnosis, monitoring and treatment (Peçaibes, Tonetto, & Andretta, 2020).

Fisk et al., (2009) cover all the basic principles of design for and with the older user at the centre of the process. This extent of work finds it difficult to define "older adults" especially given the changing profile of older people. They suggested that designing for senior individuals should be focused on similarities with all segments that allow them to optimize it, considering biological, psychological, cognitive, and social dimensions. However, these authors refer, as well, to older adults as having unique usability constraints compared to younger adults, being these usability issues often shared among other age groups. However, to contribute to the future development of game dynamics in eHealth, it is central to consider principles, guidelines and standards for the development of rehabilitation interfaces for seniors. Previously done research developed guidelines for interactive content, namely language or illiteracy barriers this way bridging not only cultural gaps but also supporting the interaction design process. From these studies, we can, for instance, assume that individuals with literacy difficulties have distinct methods to organize and search for information (Giesteira & Pereira, 2018).

The use of qualitative research is deeply relevant for achieving a broad understanding, from groundbreaking works to those developed for particularly targeted users (Denzin & Lincoln, 2005). The main virtues of these approaches in HCI4D are (i) to make visible the context of system use, social practices of interactions and communities' sensibilities, which might not otherwise be encountered (Isomursu, Ervasti, Kinnula, & Isomursu, 2011; Sarmento & Patrício, 2010), and (ii) to provide explanatory frameworks for whatever is observed that offer new ways of imagining the relationship between people and technology. Moreover when designing interactions, specifically entailing the senior population, ethical and affective issues are fundamental and therefore, beyond simple data monitoring, qualitative studies are an essential and a very rich contribution of information (Sanches et al., 2019).

Co-Designing Healthcare

That said, the importance of Co-Design, in other words, collaborative and, or participatory design, implies the creation of a system with the contribution of potential users, hint to achieve their goals (Brandt, Binder, & Sanders, 2012). This group provides relevant information that is useful for the validation of design solutions, thus contributing to a reformulation suiting patient's needs and goals within a functional, accessible and engaging experience (Rodgers, 2017). The user experience (UX) design involves the entire process of acquiring and integrating the user needs and requirements, including aspects of interface, usability and functionality (Preece, Rogers, & Sharp, 2018). Within this methodology, several techniques can be applied such as task analysis, at an initial step of development or usability tests and heuristic evaluation in a more advanced stage.

Deep social interaction can promote co-designing outcomes essential to document the process keeping into account what works and what doesn't — This process focuses more on identifying specific user's challenges at a high level of detail. Involves a good understanding of the cognitive processes, being very rewardful when working with the elderly and specifically for the healthcare contexts. The authors used several other processes considering this co-design and user-centered approach, which will be described more in-depth throughout the Carnival eHealth Solution title.

Game designing therapy sessions include its dynamics as triggers to physical and cognitive behavioural patterns, essential for neurological recovery. By reducing the gap between therapists and game designers, defines a valuable potential for specific games, where therapists improve the intensity and quality of the therapy, and game designers focus on the players motivation, engagement and amusement, which leads to an increased intensity of training (Janssen et al., 2017).

Inclusivity and Amusement

Games provide a playful environment and are conducive to the development of social skills capable of working with the social dynamics between people. Social interaction is the basis for the construction of the subject since it is in the context of social relations that language, cognitive development and knowledge of oneself and others flourish. With social interaction, we witness cultural diversity, and cultures or groups of people not being better or worse than others, just being different. For social inclusion to take place and cultural diversity to be an objective concluded, empathy turns out to be a path to follow. The empathic quality in UX-related procedures can help to understand different types of human experiences and so help to be slightly more aware of other beliefs, communities and cultures, aiming not only to value people's cultural differences but also to promote social inclusion, empathy and social interaction between people. Increase social interactions in a future release as cooperative, competitive and intergenerational dynamics.

Under the main topic of UX, this work had two main drivers: User's Accessibility and their Amusement. This way, all the design process involved the valuable contribution of potential users, from exploratory moments until a prototyping stage (Sarmento, 2013). This participatory approach helps to better understand real circumstances of inherent use, because provoked unexpected questions, challenges or constraints, thus inspiring the search for new ideas (Peçaibes, Cardoso, & Giesteira, 2018). Moreover, a speculative design empowered new perspectives, as well as, created spaces for discussion and debate with all the participants, acting as a catalyst to collectively redefine new solutions (Peçaibes, Cardoso, & Giesteira, 2018).

Withal instigating the elderly support, means optimizing their quality of life, thus delaying motor limitations, through a well-defined experience reinforced by positive visual stimuli, that enhances motor control perception, denoting that observable results no longer take too long to be watchable, thus prompting physical exercise adherence within a virtual environment as an escape from real-life reality and negative feelings (Schifferstein & Hekkert, 2009).

Fun experiences have a special sparkle of excitement and pleasure, involving surprises as the root of entertainment, strategy and problem-solving. The pleasure centre is triggered, in our brains, when an individual is hardwired by delightful or even unpleasant surprises (Norman, 2002).

"Carnival, the name by which the project became known, embraced a research stage to collect, compile and assay literature, seeking to support and validate design solutions. Within the following domains, Design, Serious Games and eHealth unfolded into fields such as Interaction Design and Game Design, aiming to develop for both training and rehabilitation contexts, allowing to gain access to remote health services. With this in mind, and considering Exergames, helped structure ludic research, addressing the Interface Design development, within a Player-Centered Design methodology. The design solution inferred knowledge within Gamification, Engagement and Immersion scopes, as groundwork for the game design. Besides the Technology Acceptance, aspired to understand players' perceived ease of use and perceived usefulness (Venkatesh, Moris, Davis, & Davis, 2003), when interacting with a digital game, debriefing the evaluation of the design solutions.

In physical rehabilitation, videogames define characteristics of attractiveness, motivation and engagement, however, as an intervention they don't guarantee therapeutic effectiveness. Notwithstanding, these are important for individuals therapy, due to their capability to reward-related dopaminergic systems in the brain, known to facilitate learning through long-term potentiation of neural connections (Janssen et al., 2017). The immersion and reward games are developed to include context-relate, engagement and motivational factors, related to multisensory therapy, defining a player who is immersed in a non-reality world, but feels as immersed as in real life. This plays an important role in the players' attention and focus in rehabilitation tasks, preventing distractions (Janssen et al., 2017). Rewards facilitate dopamine releases, that favors neuronal plasticity and learning, and enables to manipulate behaviour, influencing a positive therapy focus (Janssen et al., 2017). Also, it influences depression and other negative social-emotional factors.

CARNIVAL EHEALTH SOLUTION

The Challenge

Regarding players whose motor disabilities impair their ability to interact with a play system, "Carnival" kicked-off with a problem striving to be solved. The project worked towards the understanding of the player's engagement during the interaction with both BodyGrip and SHaRe devices. The researchers tried to answer the following question:

How to motivate and engage players (which may include individuals with motor, cognitive, sensory and affective deficits), in rehabilitation and/or training procedures, thus, eliminating the countless tasks process monotony, providing them with useful, satisfactory and delightful game experience, hence encouraging a recurrent and systematic use of the devices?

Being digital interfaces the investigation core, the researchers aimed to endow positive stimuli to facilitate in-treatment evolution and perception, welcoming design solutions that fulfil those players demands. The urge to outstrip these obstacles, hence the progressively higher life expectancy, due to science and technology improvements, has a significant role in facilitating daily life contexts. Thereby, thriving in rehabilitation and training fields by re-thinking tools and methods that focus on the players' motivation, defines an opportunity to frame the aforementioned devices, that can both remotely communicate a players' physical interaction, as an input device.

This project states several stages for the game design development, considering two paths, the Interface Design (UI) and the User Experience Design (UX). Hence, the four project phases establish an Exploration Stage, an Ideation Stage, a Building Stage and an Assessments Stage. The Exploration Stage emphasized a User Experience procedure, by investigating potential users, throughout a Player Research and concluding with Mind Mapping of interactions between Players, Tasks and Contexts. The Ideation Stage sustained the information collected before and helped materialize the game interface look and feel, as well as the player's experience, throughout paper prototyping and game design framework conception. Based on previous results, the interface was built, throughout various levels of graphic fidelity, within the Building Stage. At the same time, those "wireframes" were under formative evaluations, within the Assessments Stage, with potential players, fostering to meet their needs, constraints and expectations. Initially, the researchers also conducted a Heuristic Evaluation on previously developed games and BodyGrip and SHaRe devices interfaces. The project ended with two MVPs developed in Unity, aimed to play with the BodyGrip. One, "High Striker" was summatively evaluated, within a Usability Test to assess the interface and user experience usability, accessibility and engagement.

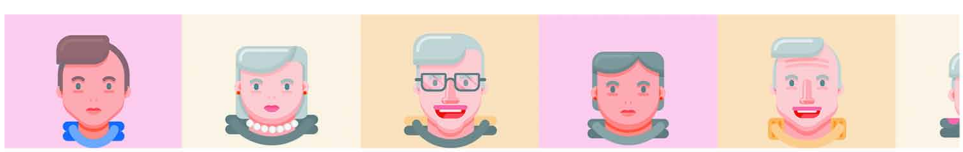
As previously disclosed in the above section, performing enjoyable and fun exercises suggests a greater likelihood for the player's engagement. As the interactive system focuses on their recovery process perception and immersion, in addition to entertainment, should provide visible feedback, namely a game's world response, from the player's direct device manipulation.

Exploration Stage

User Research

To explore and understand the concept of fun in games, we must understand the player's experience (Davis & Carini, 2004). Hereupon and supported by a Player-Centred Design methodology, the project researchers featured a data collection plan, portraying an evaluation flow to conduct a User Research. Planning for interviewing participants within an institutional context, as well as their caregivers, and other associates, each presence enabled a truthful observation of their daily environment. Researchers intended to assess players motivations, aptitudes, background or previous knowledge, as well as behaviours and their technology acceptance. The authors conducted this study at Foz do Douro Social Centre — Porto, Portugal — an institution that granted the opportunity to work with seven wonderful and available people, pictured in Figure 3, who were very enthusiastic with this experience.

Figure 3. Foz do Douro Social Centre participants



To answer the project research question, the researchers sustained the study on a Player-Centered Design methodology, an iterative process that placed the players at the centre of all design decisions, hence meeting their needs and providing an easy achievement of their goals. This procedure summed engagement to usability, provided to stimulate the gameplay, encountering attributes players bring to task performance, along with the way they perceive and successfully perform those tasks. The research focused on observing, listening and talking directly with participants, understanding their activities, behaviours or reactions associated with motor, sensory, cognitive and affective features. Regarding the participants' context, their relationship with caregivers and other users, hence the way they interact with their surroundings and the way the surroundings affect their daily life. Focusing on observing activities they execute with their hands, as well as a pastime and/or entertainment activities, in or out the day centre, accordingly activities promote physical and cognitive stimulation.

Ludic Moodboard

The game design supported principles for interface design, as well as emotional design (Norman, 2005), that strived to correspond to eHealth guidelines, due to the need to understand and empathise with players, recognising their constraints and decision-making personality. Increasingly was a need to attend to Credibility and Trust concepts applied to eHealth services, prospecting a new relationship between users and health professionals (Sousa, 2017). Notwithstanding, these systems don't replace professionals, hence they better mediate information about health status, allowing to overcome physical contexts limitation. Having in mind eHealth services connection to health, outline that all actions users perform are directly related to their decision making, considering health prevention (Sousa, 2017). The presence of real people, or person-like machines, emotionally designed, corroborates for a good relationship between the information mediator credibility, and the message receiver acceptance (Fogg, 2003).

Furthermore, fields such as designing for the elderly and cognition (Norman, 1980) helped understand even more about the player's needs. The Ludic Moodboard assembled a set of play and/or interactive systems, within several of the following domains:

(i) *Exergames*, are games that instigate players' physical activity within mechanics that deliberately persuade them to change attitudes and behaviours (Brox et al., 2011). For instance, PhysioPlay (Santos, Carvalho, & Bressan, 2012) is a Serious Game for physical rehabilitation aiming to educate or re-educate posture and balance within a ludic way. Integrating motor and sensory functions captured by a sensor, it enhances motor abilities and promotes focus as part of the tridimensional world gameplay. Others like MoVer (Sousa Junior, 2013) and DanceTown (Brox et al., 2011), assists the quality of life recovery or maintenance, offering a new perspective about health, through an enjoyable and stimulating game environment scenario, as well as a pleasant experience. Others like Fish 'n' Steps (Lin, Mamykina, Delajoux, & Strub, 2006), Flowie (Albaina, Visser, Mast, & Vastenburg, 2009) and UbiFit Garden (Consolvo et al., 2008), focus on the player's evolution displaying visual feedback within the gameplay and scenario game's flow progression (Csikszentmihalyi, 1996). For example, UbiFit Garden's interface displays a garden scenario among fauna and flora that increases its density as the player exercises. Although, if the player doesn't exercise at all, the interface exhibits a garden only with grass and a blue sky, thus reinforcing positive behaviours (Brox et al., 2011);

(ii) Other domains such as *traditional board games*, due to their popularity in the elderly and the young population, like *Dominoes* (Unknown, 18th Century) and *Qwirkle* (Ross, 2006);
(iii) *Arcade games* such as *Pong* (Atari & Alcorn, 1972) and *Tetris* (AcademySoft & Pajitnov, 1984), whose familiar look, as well as the abstract aesthetics, provides a straightforward interface appearance, fostering an immersive gameplay.
(iv) *Cognitive games* and *Games for Health*, for example, *Big Brain Academy* (Nintendo, 2005a), consists of a set of mini-games divided into five categories: Identity, Memorize, Analyse, Computing and

Visualise, that allows the player to assess and measure, through a fictitious brain weight metaphor, his brain density. Though, *Brain Age: Training Your Brain in Minutes a Day* (Nintendo, 2005b), for instance, was developed to be played a little every day, as a training tool.

(v) *Guitar Hero* (Harmonix, 2005), was important due to the remote input device, a *guitar*, as well as the playing music theme. And the list goes on, thus this ludic study was always selected, taking into account the player's meaningful experiences.

To endorse aesthetically this moodboard, the authors gathered graphic inspiration references, such as João Machado, a designer and illustrator, that was dedicated to graphic arts, from Pop Art to Japanese culture influences, as the ability to uniquely combine chromatism and composition. Hence developed for four decades posters for "*Cinanima"*, an animation film festival. Other inspirations included references to Lisbon's first Funfair, traditional American fairs and amusement parks, emotional states, colours schemes and flat design shapes.

Sampling

Researchers observed and interviewed seven senior users, supporting to trace a set of standards capable of portraying their expectations, motivations and constraints. Upon applying a triangulation strategy for data collection, results provided more rigorous and defensive conclusions (Bryman, 2012). They have conducted a Demographic Survey acquiring knowledge regarding participants age, civil status, education and household. To supplement this information were also conducted a Mini-Mental State Examination (Folstein, Folstein, & Mchugh, 1975), providing a brief thirty points questionnaire for the identification of cognitive severity constraints (Appendix 1), whom participants could not specify.

As a qualitative source of data, the researchers conducted a field observation study of participants behaviour and other specific details. For example, one participant had tremors in her left hand when she evoked an episode of: "A very big faint". Furthermore, observing participants performing daily tasks, and therefore assessing how the day centre surroundings affected their performance. The semi-structured interviews allowed to establish physical, cognitive and affective impairments, complementing quantitative data, ensuring that players limitations were met, by assuming the way they adapted to their new life, more or less, independently (Faria, Martins, Schoeller, & Matos, 2017). For example, one participant that had a stroke (Cerebrovascular Accident), got her right side of the body paralysed. Still, with one hand, she can peel an orange better than a non-impaired person, due to her need to outstrip her daily challenges. Most participants had motor limitations, as well as sensory impairments, however proprioception, for example, enables the realisation of individuals perception of their location, position and orientation of their body in space, as well as strength recognition, and joints movements without using the visual sense. The participant aforementioned had no strength or movement perception without looking at her arm due to its paralysis. Hence she couldn't control her hand strength. Another participant, due to a Carpal Tunnel surgery, lost her touch sensing ability, now she's not able to detect which objects grabbed, as well as the amount of BodyGrip strength she makes.

UX Project Procedure

Conducting this research was very rewardful, thus being challenging, but also fun. For instance, it was challenging to communicate with a person with aphasia, that never had contact with the researchers, thus being the first interviewee. Yet, the "show must go on", and despite these limitations, they learned to communicate through gestures and three sounds she emitted, “Yes”, “No” and “More”. Another participant, at the age of ninety, and despite his severe visual and hearing impairments, expressed his love for playing the drum, which enhanced his tactile sense. Another, whose session lasted one and a half hours of storytelling and drawings, was long but important for the project. Though, due to his low ability to focus and his off-the-topic speech, he couldn’t stay too long doing the same task, thus requiring several different stimuli. Additionally interviewing caregivers’ complemented the previous information introducing the researchers to a set of game dynamics they’ve created in the centre, to adapt to most of the users. Aiming to assist cognitive stimulation, entertainment, attention and focus, within multiplayer games, it has been accomplished to help caregivers manage time dedication, through a fellowship experience.

Conclusively, these methods allowed the researchers to analyse participant’s tasks, activities and behaviours, that they perform daily within a specific environment, with specific tools. Also, their background and previous knowledge experience provided the understanding of their roots, such as language and geographic place. Also, their physical, cognitive and affective, obstacles and limitations, allowed projecting their needs and expectations, answered by the game, as well as their goals, motivations and triggers, bringing them closer to the game. In short, they’ve shown that they need, and thrive, for anything new and different from their usual routine, matching with people tired from rehabilitation and/or training routines. Participant’s visceral goals such as feelings of achievement and success, while performing an activity without pain or tiredness, also sustain behavioural goals for being active, entertained and motivated, thus being able to do more than an ordinary routine. Hence, their reflective goals focused on remembering what they used to be, in other words, the energy they used to have, and helping each other achieve the same goals (Norman, 2013).

Mind Mapping Interactions

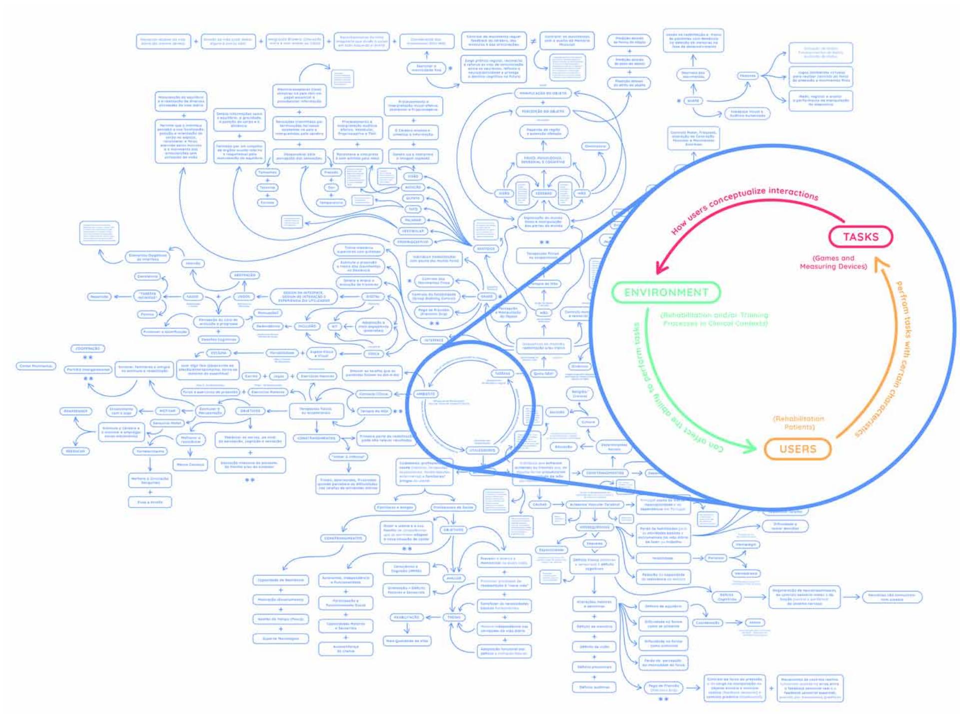
Researchers assembled and designed mind maps, shaping data collected from previous phases. Fostering the identification of opportunities and interaction purposes was intended to triangulate the interplay between three interaction characters, the Players, the Tasks and the Contexts. The brainstorm, materialises micro and macro connections, of Players, individuals requiring motor functions recovery, whose impairments drawn to their Tasks performance, within digital games and measuring devices, in private or clinical Contexts.

Players

Players describe two groups. The first acknowledges individuals who suffered accidents or traumas that harmed their hand functionality (Dobkin, 2009). Although this group doesn’t sustain every situation, accordingly, the BodyGrip can be performed by users without apparent function problems. The second group admitted every caregiver, from health professionals to friends and family, that usually struggle with time, motivation and technology constraints.

Consequently, to fulfil both groups requirements, the authors aimed to develop a tool that would assist players, as well as teammates or helpmates. Additionally, the Players’ group, for the BodyGrip describe individuals striving to train BodyGrip strength, throughout a visual solution of their motor evolution. Thus, SHaRe players groups evoke candidates to hand therapy who suffered injuries, scars, burns, fractures, or even fingers, hand or arms amputations. Others might include individuals who suffer from Carpal Tunnel Syndrome, as well as chronicle problems that can affect hand function, such as Arthrosis,

Figure 4. Mind mapping the triangulation between Players, Tasks and Contexts



neurological disorders or autoimmune diseases (Proffitt et al., 2015). Most situations imply some levels of dependency, meaning the player's expectations thrive to re-discover the world, with high motivation for out of routine tasks. Nevertheless, they're also highly susceptible to situations they don't appreciate.

Tasks

Tasks describe what players can perform with the system, aiming to identify the main focus of interaction, in other words, the players' mental models necessary to understand their physical and psychological context, knowledge and experience that will influence their task performance. Focusing on rehabilitation and training measuring devices support those tasks' accomplishment, within a goal-oriented approach. Goal-oriented activities fostered hand and cognitive functions, as well as visual and spatial perception, visual-motor coordination, attention and focus, and also self-expression (Son, Bang, Hwang, & Oh, 2017). Task-oriented activities are a strategy for specialised goal-oriented tasks, therefore giving the player a purpose, instead of doing simple and repetitive tasks.

Tasks were selected based on players' characteristics, fostering focus, reasoning ability and social behaviour, aiming to increase execution skills and trigger cognitive operations. From an Occupational Therapy point of view, activities of daily living (ADL), are a set of ordinary tasks that people perform autonomously and routinely in their day-to-day (Son et al., 2017). Hands are responsible for 30% of all brain activities, thus through touch and direct exploitation, lots of information is being sent to the brain. And besides stimulating and taking advantage of brain functions, hands also play an essential role in social interactions as a medium of expression, for example (Flanagan, 2018).

Contexts

Despite existing a whole of Contexts, such as clinical, hospitals or therapy centres, institutional, for instance, day centres or sports academy, and privately owned contexts, for example, at home. The game contexts comprise the upper mentioned day centre, notwithstanding the devices will be tested, in clinical or institutional contexts, where the player will always start with an instructors' help.

In short, these three characters established design requirements, allowing to analyse the way the players express themselves in terms of goals, actions and environment, privileging their games' achievements, behaviours and interactions. Due to players' physical constraints, such as motor disabilities can limit movement, as well as perception as personal differences. Hence, cultural differences, such as language problems, like using different terms to refer to the same thing, due to training, culture, vocabulary, generation and geographic reasons. Summing, the intention was to help players achieve their desires, respecting these specific conditions.

Ideation Stage

"Sketches": Paper Prototyping

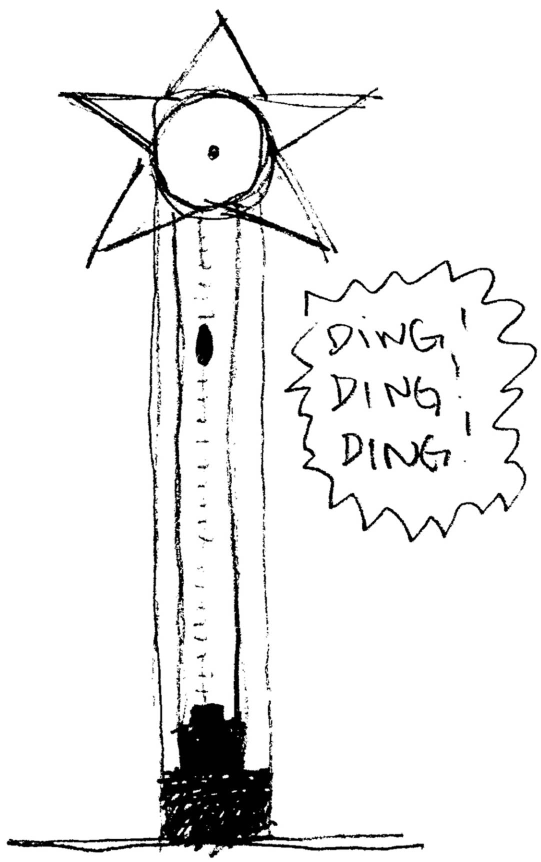
Sketching as a method to stimulate idea generation, shouldered the speculation of possible games solutions, thus welcoming an Ideation Stage, turning the previous knowledge insights into tangible ideas. Sketches allowed rapid communication of design solutions, aiming to establish a design framework, outlining the game experience skeleton, such as general behaviours, macro interactions, navigation and ambience. Paper prototyping valued representation, thus promoting the overall layout and ideas, highlighting the primary concepts and definitions of the game's posture, establishing the stories, the steps and the context, crucial for a pleasant experience.

Hence, the authors started to unveil the purpose beyond entertainment applied to Serious Game within eHealth contexts, further included in an Exergame segment, alongside with a Goal-Oriented Task dynamic. The game experience is described by the interface's appearance, bounding two-dimensional elements, alongside with the sound, and the direct manipulation of measuring devices. Consequently, goal-oriented tasks are fast to learn, suggesting the player analyses game affordances, furnishing interactive or informative elements detection, and easily perceives what tasks' to perform. Hence, the game must demand the player to be concentrated, implying dedication to the performance of the exercises not just for fun. Yet inserted in a concept of fun, it allows to remove burdens from the player, nurturing a more relaxed and pleasurable environment (Norman, 2002). Intending to achieve a better physical performance, through the fulfilment of increasingly more difficult challenges, the design of positive stimuli in a recovery process, fosters in-game immersion as an essential part repetitive tasks performance, while suppressing player's monotony. Aiming to re-think repetitive movements, into a fun, playful, motivating and engaging experience, while applying similar mechanics to different purposes, each mini-game goal was enhanced and tried to meet meaningful experiences with a positive impact. Thus, easy to use ensured a low spend of cognitive resources, by reducing player's interaction anxiety levels, conveying security and trust feelings (Norman, 2002).

Regardless of the challenges of design for two different artefacts, BodyGrip and SHaRe, the sketches developed for both measuring devices, with distinctive goals and players' archetypes, uncovering a solution that reduces the functionality distance between them, incorporating both into similar situations and play spaces.

Within a Funfair game theme, the BodyGrip seed identified "Strength" as a game dynamic, visually illustrated in Figure 5, to assess the BodyGrip strength. Every BodyGrip sketch belongs to the same universe and is playable with the same mechanic — applying force to the device. Hence, the designers considered competitive games, such as an "Iron Arm", a dynamic for two players, who compete to assess the strongest.

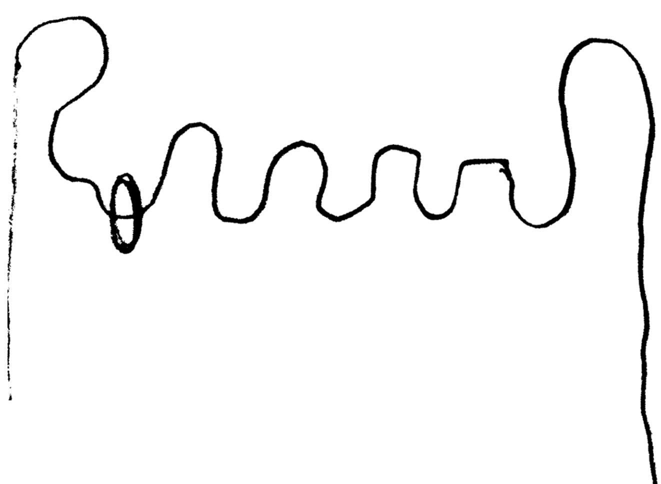
Figure 5. BodyGrip, "Strength" seed dynamic



SHaRe seed is identified as "Cooperation or Competition", illustrated in Figure 6, since it's proven that exercise performed in a group is more encouraging, due to concepts of fellowship, connection and simultaneity, among collective support. Forward, like competitive games, cooperative games are intended for multi-players, thus portraying financial constraints, due to the expense of a single device. Buying many at the same time, is economically infeasible, for single individuals and/or small institutions, being the solution to develop for single-use contexts. With this in mind, SHaRe seed turned out to be its focal purpose, "Fine Movement Control", featured in Figure 7. Associated with tasks of daily living, such dynamics and mechanics of precision, direction, position, strength, focus and attention, allows endorsing motor and cognitive capabilities, while progressively increasing with the game levels. For an instant, the designers also defined different interaction styles to manipulate the device, such as using it faced down.

Figure 6. SHaRe, "Cooperation or Competition" seed dynamic

Figure 7. SHaRe, "Fine Movement Control" seed dynamic



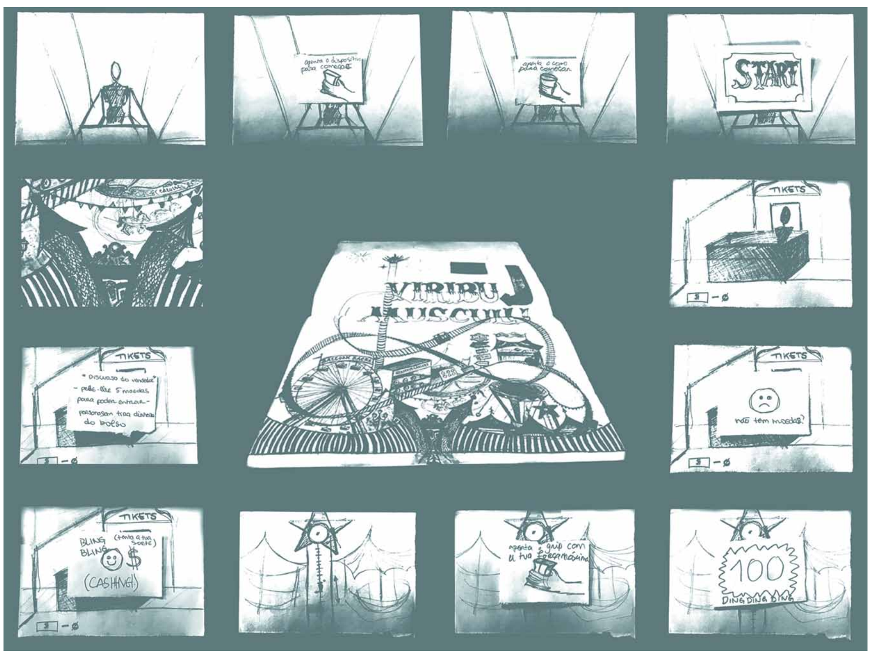
Briefly, and besides the ideas that were generated, was sensed the need to define a game's personality, mixing three characters, a personal trainer, with a motivational tone, a fair salesman, with a fun and amusing dialogue, and a therapist, with a credible speech. If the system thrives to communicate as "a person", the player won't feel it like a machine (Fogg, 2003). Additionally, engagement features fostering treatment immersion, such as a monetisation system, "pay-as-you-go", hence the funfair metaphor, allows the player to enjoy multiple activities, conquering more tickets to be able to play more games, therefore experience more playful moments.

Storyboards and Wireflows

“Storyboards” and “Wireflows” were assembled, ensuring an amplified vision of the player’s interaction flow through the various screens sequences, as well as the respective display content, data input, output and navigation. Within an Ideation Stage, the authors aimed to emphasize the essential elements for the experience, thus describing basic interaction processes.

As a cinema sketching tool, to preview movements and interaction sequences, Storyboards, illustrated in Figure 8, have layers of meaning to communicate the game’s emotional engagement, the situations players will encounter, as well as the environment, allowing to materialise the game’s story cycle. Wireflows, as abstract information diagrams, described the detailed structure of the game’s interaction key-path, aiming to prototype more refined wireframes, thus promoting vertical prototyping of each mini-game.

Figure 8. Storyboard “Carnival” entrance and “High Striker” dynamic



Also, the game’s context of use scenario, sets interactive environments, reflecting the devices as an extension of the player’s bodies, that when physically manipulated, that action is extended, to a digital universe, through visual feedback provided by the game elements, enhancing it as a communication medium. Two sets of usage were designer, the first the player interacts with a computer, in a seated position, and the second the players interact with the television, with one or multiple devices, connected via Bluetooth or USB, allowing more people to observe and play, similar to Wii remote controls. For more details, the authors provide a storyboard video possible to view on Storyboard (2020).

Game Design Framework

According to Macklin and Sharp (2016), the authors defined restrictions to the game's development path, accomplishing iterations closer to the game's goals. The Funfair theme universe scenario, corresponded to the player's mental model of a fun, happy and friendly environment, fostering his immersion due to the potential of all the activities to explore. Thus a simulated reality facilitates in-game immersion, as an abstraction from reality, that allows the player to enter the "magic circle" (Adams & Rollings, 2007). Aim to train and/or rehabilitate the hand the game flow channel intends to be personalised for each player, noting that difficulty levels increase according to his task success completeness. Additionally, the dynamic Action-Reaction, means that every action decision has reaction feedback, as a stimulus to decision-making, instigating information visualisation and Emotional Design. The direct actions and interactions describe the grip reaction strength and fine movements control, when interacting with the devices, thus, preventing players from doing wrong actions, within a health perspective, as the main game restriction.

Mechanics, Dynamics & Aesthetics Framework

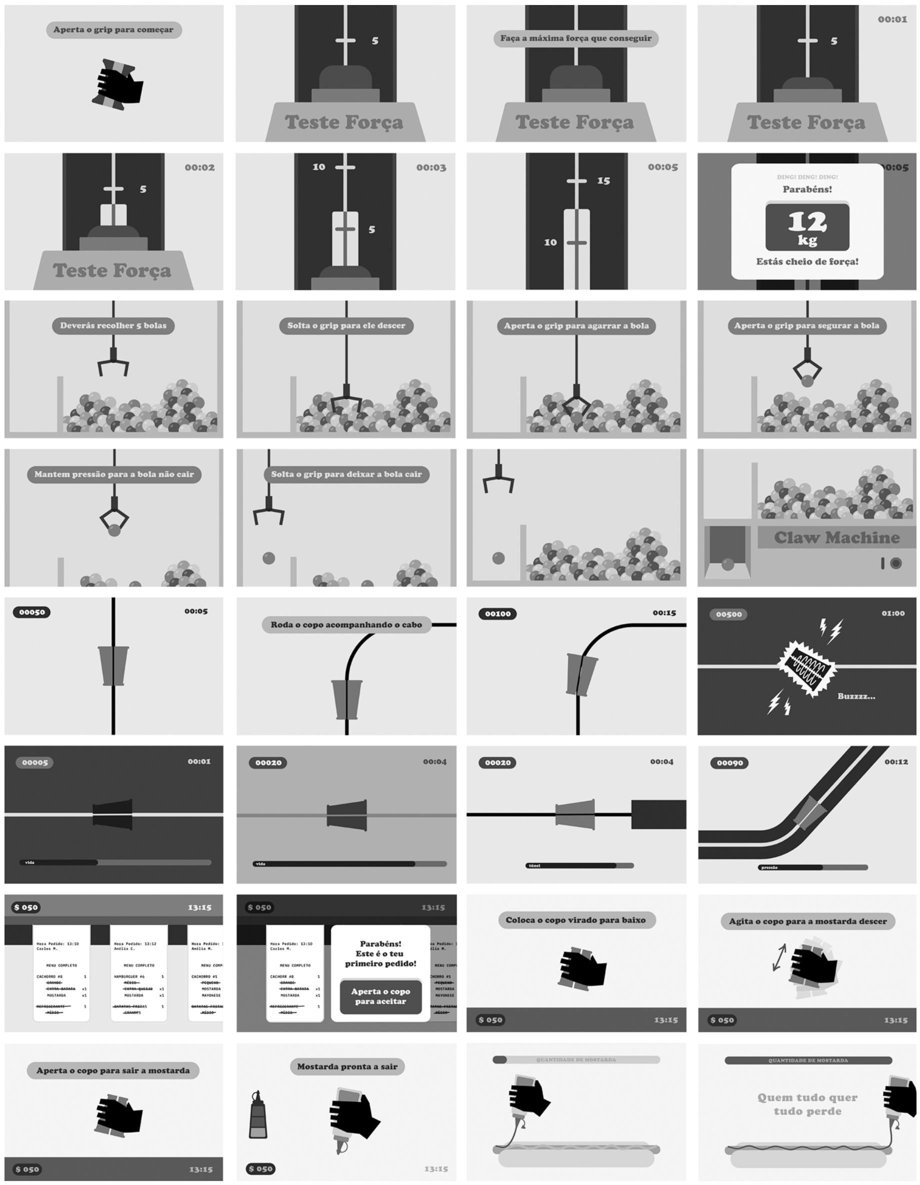
The framework of the Game Mechanics, Dynamics and Aesthetics defined the approach for the development of the game design, expected to outline a pleasant and enjoyable play experience (Hunicke, Leblanc, & Zubek, 2004). Included in the Ideation Stage, the authors defined this framework to describe the players' behaviour and steps to achieve his goals. The Aesthetics furnishes the game entertainment aspect, within a meaningful experience, resulting from the players' response, entitled Aesthetic Experiences (Hunicke et al., 2004). "Carnival" aimed to exhibit aesthetic experiences such as Sensation, Challenge and Submission, yet, further, in the future, it should also include "Fellowship", that defines the game as a social framework, so that "Carnival" could become more engaging, thus enhancing longer play cycles.

Building Stage

Medium-Fidelity Prototyping

The authors built a medium-fidelity "wireframes" prototype, to test design solutions with the game's potential players, assessing usability and accessibility issues, intending to establish pleasing elements to provide value to the game, thus enhancing its experience. Sustained by a medium-fidelity prototyping tool and relying on shades of grey to distinguish interface components, eight mini-games wireframing sequences, were produced, accordingly "High Striker" (Figure 9), "Claw Machine" (Figure 9), "Spin the Wheel" and "Target Shooting", planned for the BodyGrip device. And "Buzz Wire" (Figure 9), "HotDog Sauce" (Figure 9), "Flying PopCorn" and "Space Cleaner", established for SHaRe. Later these results were introduced to the stakeholders, who admitted all, yet due to time constraints, turned out to be impossible to prototype and implement, each of them. Notwithstanding, this prototypes aimed to support in-game mechanics and dynamics, granted advantages such as, understanding which interface elements are essential to perceive an action, as well as the best definition, or symbol, to represent an action, hence which infographics will represent a specific content, and consequently which content is confusing or irrelevant to the experience.

Figure 9. "High Striker", "Claw Machine", "Buzz Wire" and "HotDog Sauce" prototype sequences



High-Fidelity Prototyping

High-fidelity prototyping strengthened a more refined final design, thus promoting and facilitating its implementation. Within the Building Stage and developed along with Formative Assessments, sustaining a player-centred design process, allowed to validate a set of crucial interfaces elements, thus increasingly refine previous ones, both in terms of functionality and layout. The authors now present Carnival, a game that fulfils two purposes for different people, with two devices, BodyGrip and SHaRe, enhancing each devices' mechanics, within a world with similar dynamics and aesthetics, assembling multiple mini-games.

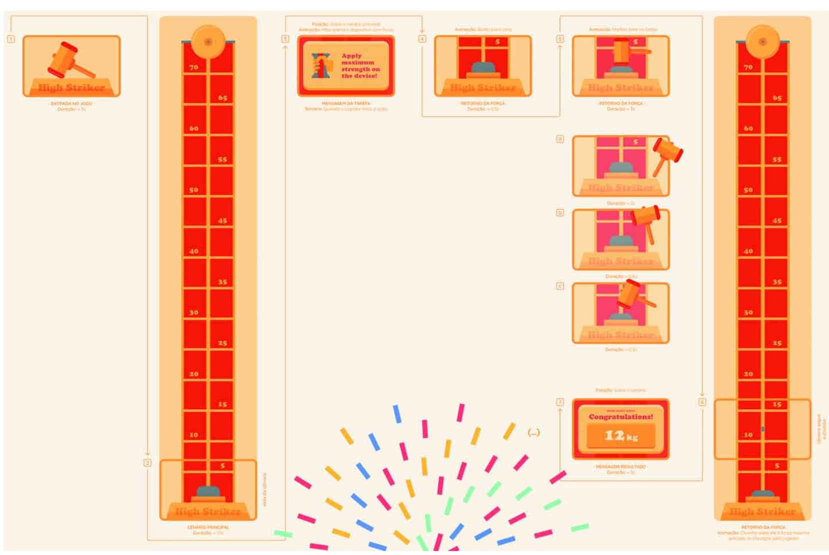
The other major obstacle was the Play History, allowing the player to access his evolutive path, within a funfair tickets representation model, as a way to enter each mini-game. Throughout the game, the player has several tickets and every time he completes a task, loses one, thus getting closer to the end of his training or rehabilitation treatment.

Additionally, the authors developed the game's sequence systems, to articulate the communication of the features and their connections, to the developer, regarding the game's aspect ratio, action-centred camera perspective, as well as its colour codification. Additionally, it was essential to describe the game's format and interface elements position, from three components: information elements, decorative elements and interactive elements. Hence, this Design System will assist future game dynamics hypothesis development, based on "Carnival's" mini-games.

High Striker

"High Striker" developed as a game system, was designed for the assessment of BodyGrip strength, aiming to materialize force dynamics, as an analogy to the game presence in funfairs. In Figure 10, the sequence illustrates as first BodyGrip dynamics, that allows the player to assess his BodyGrip strength, and customizing the remaining games accordingly, so that it is neither too difficult nor too easy.

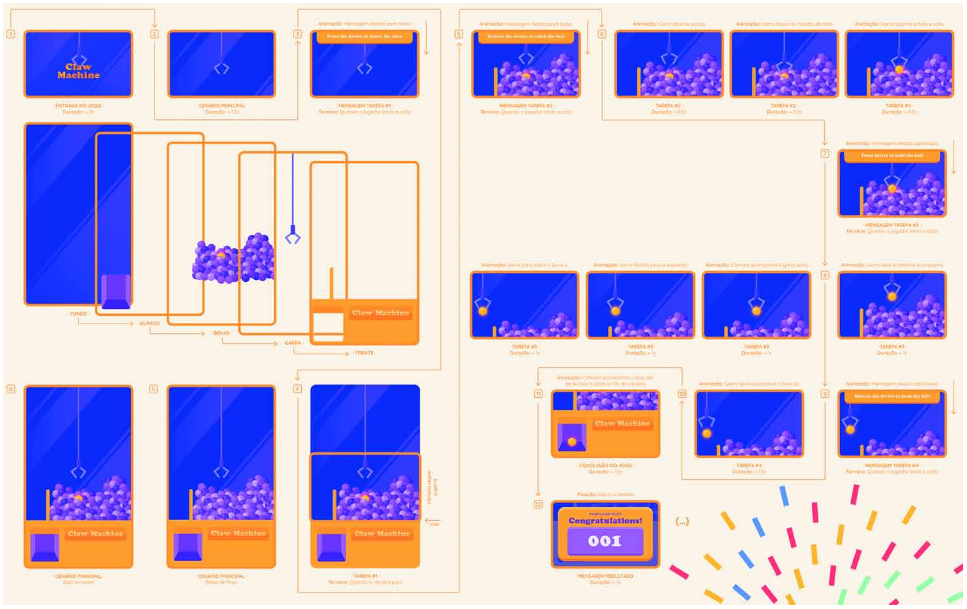
Figure 10. "High Striker" game logic sequence



Claw Machine

"Claw Machine", defines a game system, illustrated in Figure 11, designed to train BodyGrip strength. It can apply to two dynamics, the first in which the player will have to go through a set of instructions, to progressively collect, in an incremental way, more and more balls. The second dynamic involves catching balls with different weights, causing the player to exert an amount of force specified by the ball in question.

Figure 11. "Claw Machine" game logic sequence



HotDog Sauce

"HotDog Sauce" is a game system, illustrated in Figure 12 sequence, intended to be applied to SHaRe, aiming to rehabilitate and/or train fine hand movements, as well as grip strength. It also consists of dynamics that allow to stimulate cognitive abilities, through the set of instructions by which the players are guided to achieve the final goal, namely to serve the hot dog, exactly like the client asked.

Figure 12. "HotDog Sauce" game logic sequence

Assessments Stage

Analytics Assessments

Initially and parallel to the Exploration Stage, the researchers conducted Heuristic Evaluations (Appendix 2) for both physical and digital interfaces, of already existing prototypes, evaluating usability, throughout an Analytic Assessments phase. Encompassing the Assessments Stage, the researchers assessed the device's interface, as objects that players physically manipulate, culminating as a reaction in a digital interface, also under evaluation. Briefly, the researchers noticed thirty-seven problems in both interfaces, for both BodyGrip and SHaRe devices, resulting in the average severity of 2.62 within a spectrum of low and high levels of priority to solve.

Summing, both digital and physical systems exhibited inconsistencies in communicating ordinary concepts, with a player. Employing unique terminology, can confuse and increase players' cognitive load, thus forcing them to add new information to their mental models. For instance, SHaRe's interactive dynamic, representing a glass that the player guides to a bigger one and rotate to adapt its position. The representation model could illustrate an ocean metaphor, where a fish needs guidance to eat small fishes. The perception of the fish getting big, each time it consumes would help the player perceive his evolution (Restivo, 2020b). Additionally, other interface problems established that almost all elements turned out to be unnoticed, irrelevant or unnecessary, meaning that every extra unit of information, competes with relevant sections, decreasing its overall visibility. "Less is more" meaning, less to learn, to misunderstand and to distract, presenting useful visible content towards player's needs, prospecting to minimize cognitive effort (Molich & Nielsen, 1990).

Formative Assessments

Parallel to the Building Stage, the researchers conducted an interface Formative Assessments, employed by game's potential players, fostering an iterative development of the game's prototypes. Sustaining the Assessments Stage, the researchers attended at Foz do Douro Social Centre, carrying out two evaluation sessions. First, the researchers used a Card Sorting method, illustrated by Figure 13, to assess participants' perspectives related to three components: Labels, Typography and Sounds. For example, asking: "What do you call to this, BodyGrip? It's a "device", an "appliance", a "machine" or a "mechanism"?" — briefly, most of them answered "device", thus being the word adopted for its labelling. Further, most participants had difficulties choosing the typeface they liked the most. Some said that they all look alike. Hence, their contrast and bold look showed within a distance, was decisive due to the role it plays in readability. Additionally, the sounds expressed through our voice, or with words, such as onomatopoeias. To find out participants onomatopoeia mental model the researcher asked them: "Tell me what a bell sounds like", and second, showed the cards and asked: "Which of these best represents the sound a bell does".

Furthermore, the second evaluation employed a Usability Test to assess devices usability metrics, applying semi-structured interviews and performance observation, the last conducted by students from the Master in Product and Industrial Design (Faculty of Engineering & Faculty of Fine Arts University of Porto. Participants were presented with various message screens, drawn in the building stage, intending to be observed and analysed, to accurately perform the action: "Press the device with your maximum strength!", captured in Figure 14. Briefly, participants didn't express much difficulty, manipulating the BodyGrip, due to its well-adapted shape to the hand. The challenge centred on how to communicate the exact action for them to perform. They often performed wrong actions, perhaps due to lack of context, images or assistance, for example, “Rotate the device”, most participants, as shown in the bottom of Figure 13, spun the device around itself, like twirling a top.

Working with an audience from an extremity of the age spectrum, it is a challenge yet it is also rewardful, that due to their spontaneous personality the session plan got punctured, thus allowing researchers to learn much more than they have planned.

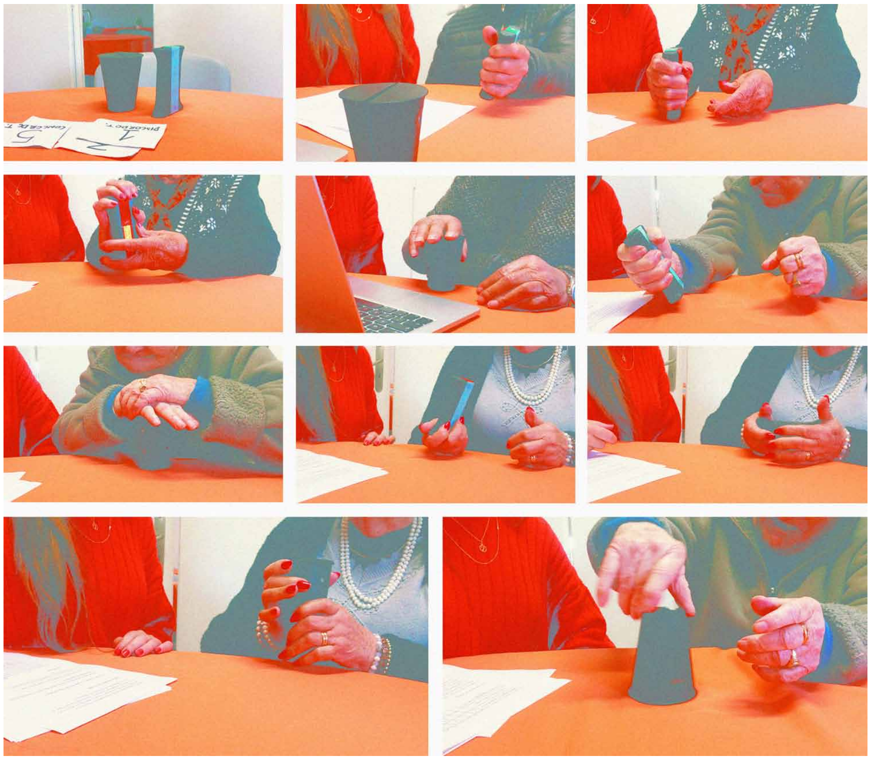
Figure 13. Card sorting method used in formative assessments

MVPs Implementation and Summative Assessments

With the support of MVPs implementation and Summative Assessments, evaluating the game usefulness, ease of use and pleasure, defined by its interface and play experience. Implying to make this game concept real, as well as validating the solution applied to the playtester’s context. The authors designed a gameplay screen transitions, defining each screen duration, restrictions, animations and endings. Despite taking part in the same universe and considering a 2D game scenario, each mini-game had subtle differences, taking into account when developed in Unity software. For instance, “High Striker” included the “Hammer” animation steps, as well as camera movements. “Claw Machine” included its layered building scenarios in Unity, such as the background, the hole, the balls, the claw and the front, offering also two dynamics, the first one “*Catch the yellow ball*”, and the second one “*Catch a ball with a specific weight”*.

During the fellowship, the developer generated two MVPs, “High Striker” and “Claw Machine”. The “High Striker”, was taken to an INEGI Conference, as a demo on a coffee break, with a lot of participant’s adherence that wanted to know, if their strength was within normal standards, and what was the average strength of INEGI’s participants, especially for men. If the researchers had this previous knowledge, they tried to solve those problems, by taking an average mean of normal standards (for man and woman) and placing that panel with spaces to write participant’s names and their respective strength, thus implying a competitive dynamic.

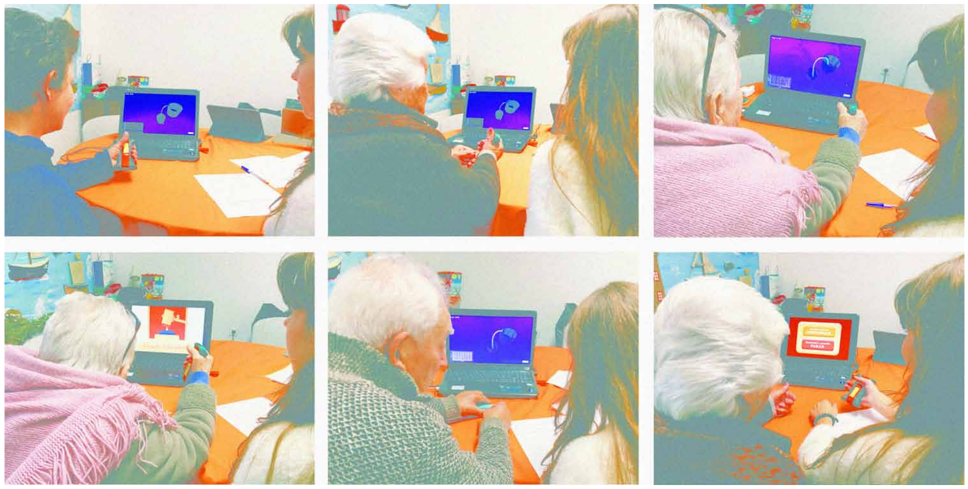
Figure 14. Devices usability test, performing: "press the device" & "rotate the device"



The Assessments Stage implied usability, accessibility and engagement evaluation, denoting a first step of planning the session to conduct six participants who interacted with two BodyGrip game dynamics, the "High Striker" and the "Water Pump". Along with success, ease of task understanding, time, effort and errors metrics, as well as, satisfaction, engagement and accessibility, allowed the researcher to test, initially the "Water Pump" dynamic, captured in Figure 15. Some participants didn't understand the dynamic's goal, yet when they heard the sound of the water, they stayed more focused and engaged. Additionally, most of them had difficulties using the laptop mouse, due to the motor, sensory and technologic impairments. Despite seeing only 45% from one eye, it was the only participant that best performed the task, notwithstanding his difficulties seeing the button intended to be press.

Subsequently, the researchers tested the "High Striker", thus revealing a more fluid and less insecure interaction. Though, the Exit Menu was the most complicated feature, considering that the Continue button had to be press only once, hence most pressed it for too long, in turn, pressing the Stop button. Nevertheless, everyone managed, even though they stopped the game, to interact with the menus with the BodyGrip, as an interactive remote input method. Despite these errors, one participant, with ninety-six years old, said that she would always go to the fair, for good hammering, before going to her home, meaning that she recognised the game, plus wanted to play for long. For more details, the authors provide a "High Striker" MPV video on High Striker, 2020.

Figure 15. Summative assessment conducting a usability testing on “Water Pump” and “High Striker”



Alongside with the Usability Test, were employed a System Usability Scale (SUS) (Brooke, 1986) (Appendix 3), a set of negative and positive questions, linked with an agreement scale from one to five. Yet, participants struggled to understand how the scale worked, answering most of the time, “yes”, “no” or “maybe”, as well as problems in distinguishing the content of the question. Despite all that, it was allowed to assess that most participants liked both dynamics, overtaking the number sixty, thus meaning good usability. For them, the dynamics due to its out-of-the routine context were fun and motivating. However, most revealed difficulties interacting with the Water Pump, due to game flow and interaction, as well as the interface elements.

DISCUSSION AND CONTRIBUTIONS

As initially disclaimed, several research areas like the study and observation of maximum force, average force, accumulated work have been working on device’s solutions to perform with established BodyGrip exercises. The used devices for this study - BodyGrip and Share - have already some research work related to biofeedback concerning their relationship between the thermal variables and the mechanical work involved. However this gamified experience of Physiotherapy and exercise contributes not only to a more regular and resilient performance as to elicit other kinds of interaction and feedback.

Moreover the present research contributes with a real solution for play systems for eHealth, Occupational Therapy and Rehabilitation contexts and specifically neurorehabilitation processes where the aim is nervous system recovery, and to minimize any functional alterations resulting from it. The use of assessment and intervention in recovering therapies and motor learning, is reinforced with more meaningful activities within a ludic context.

Finally the combination of auditory and visual stimulation has proved to contribute to an unisensory stimulation, synchronous cues, providing substantial advantages on focus and perceptual selection, and potentially to enable a faster recovery, supporting the user to learn, to control attention with a less monotonous approach.

Corroborating with several studies previously mentioned, we confirm that the use of technology itself doesn't replace therapists. Hence, it promotes more intensive training, establishing more frequent treatment sessions, and turning sometimes time consuming and expensive treatments into a more accessible solution.

Furthermore, the main contributions of the "Carnival" study are three-dimensional:

(i) under Design scope in its collaborative process, co-designing with the caregivers, potential users and elderly people for their therapy, considered several design stages as empathy' stages. Friends and family are essential for dependent individuals, hence living alone revealed to be more self-sufficient, and thus more depressive, some enjoyed more to be in the day centre. This kind of data is considered in the task analysis, as well as the activities they've performed daily. Caregivers contributed too to the design solutions, improving the intensity and quality of the therapy and feedback on topics like cognition, attention, adaption, entertainment or multi-player environments. Games and devices allowed, as triggers to physical and cognitive behavioural patterns, essential for neurological recovery. Hence, auditory and visual stimulation provide substantial advantages to control attention enabling a quicker and fuller recovery, possibilitating a next level of rehabilitation, enhancing the player's neurologic recovery, and thereby their learning capacity.

(ii) Serious Games under the digital environments within Exergames typology contribute to eHealth, due to their potential on fitness reinforcement. As a tool for older adults, Exergames have the potential to motivate physical adherence, perceived as a fun commitment. Moreover, the social factor is relevant, since most participants prefered social interaction, rather than being alone. "Carnival" applied as a supplement in training sessions, considers the evidence that playing this kind of digital games can enhance the social interaction between the players. Engaging in positive experiences, directly contributes to their well-being, satisfaction, positive emotions, engagement, relationships, meaning and accomplishment. Due to the Funfair theme, it promotes amusement and demands inclusivity, mostly contributing to an intergenerational relationship, between different generations that share the same imagetic scope.

(iii) Achieving physical, psychological and social well-being, are significant determinants for ageing successfully. Beyond the role as a physical promotor "Carnival" fosters cognitive functioning and social interaction, due to its ludic dynamics between players, triggering physical and cognitive behavioural patterns, essential for neurological recovery. Consequently, the game mechanics, for these potential users and clinical contexts, should be carefully attended to the empathy on single and multiplayer platforms, due to the evidence that exercising in groups is more motivating than alone.

Additionally due to devices' capability to collect data, enabling it evaluation, diagnosis and storage, enhancing the perception of physical recovery, along with the visualization of results mediated by a digital interface. The simulation of environments, portraying daily activities, along with momentary action feedback, contributes to the rehabilitation of individuals with physical limitations. The immediate responses that the players receive, assist the direct observation of their performance, thus motivating them to become more engaged in their progress. Through a motivating experience, "Carnival" allows players to learn, stimulate and improve motor abilities, of the hand functionality, so increasing their physical, social, professional and familiar participation. Encouraging positive changes in one's behaviour games mobilize new mental schemes developing various aspects of personality, such as cognition, affection, socialization, motivation and creativity, meaning that design playful behaviours can shape non-playful behaviours, hence when players feel capable of doing something in a game, they may also feel able to do that or something analogous to that outside of the game world.

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KEY TERMS AND DEFINITIONS

Co-Design Empathy for Well-Being: Empathy is the process development request, that needs to be even more collaborative, throughout co-designing methods. Furthermore, it is possible to highlight the well-being as the final goal, preserving dimensions like physical, mental, and affective, as the path that should follow human beings during different life stages. Concerning the older adults, as the leitmotiv of the authors in this chapter.

Gamification to Rehabilitation: Ludify processes that involve specific mechanics that enhance patient's engagement, in different rehabilitation treatments—most of the time repetitive and monotonous methods to performance—thus promoting motivation and resilience.

APPENDIX 1

Mini-Mental State Examination Results

Table 1. Player research cognitive assessment results

MMSE	P#1	P#2	P#3	P#4	P#5	P#6	vP#7
Orientation (Time)	5	5	5	4	4	4	4
Orientation (Space)	5	3	5	4	5	4	5
Registration	2	3	3	3	3	3	2
Attention & Calculation	0	5	5	2	5	4	5
Recall	0	2	3	3	2	3	2
Language (Name)	2	2	2	2	1	2	2
Language (Repeat)	1	1	1	1	1	1	1
Language (Command)	3	3	3	3	3	3	3
Language (Reading)	1	0	1	1	1	1	1
Language (Writing)	1	0	1	1	1	0	1
Language (Copy)	1	1	1	1	1	1	1
Total	**20**	**24**	**29**	**23**	**23**	**25**	**26**

Mini-Mental State Examination Results Interpretation

Table 2. Mini-Mental State Examination results interpretation

Method	Punctuation	Interpretation
Single Cutoff	< 24	Abnormal
Range	< 21	Increased Odds of Dementia
	> 25	Decreased Odds of Dementia
Education	21	Abnormal for 8th Grade Education
	< 23	Abnormal for High School Education
	< 24	Abnormal for College Education
Severity	24 – 23	No Cognitive Impairment
	18 – 23	Mild Cognitive Impairment
	0 – 17	Severe Cognitive Impairment

APPENDIX 2

In 1994, Nielsen & Molich, established a ten Usability Heuristics set, that allowed the researchers to improve games and devices user experience. Hence, games have a non-practical purpose, rather than entertainment (Nielsen, 1994), however, this heuristic evaluation allowed to perceive observed inconsistencies, thus identifying usability problems, and recognising what didn't succeed, fostering possible solutions to improve those flaws.

Usability Problems and Respective Level of Severity

Table 3. Heuristic evaluation exposing usability problems and their relative severity level

Usability Heuristics / Severity Levels	0	1	2	3	4	Total
H1. Visibility of system status			2	3		
H2. Match between system and the real world		1	3	3	1	
H3. User control and freedom						
H4. Consistency and standards				2		
H5. Error prevention			1	1		
H6. Recognition rather than recall			2	4		
H7. Flexibility and efficiency of use						
H8. Aesthetic and minimalist design			2	4	1	
H9. Help users recognize, diagnose, and recover from errors			2	1		
H10. Help and documentation			2	2		
Total	0	1	14	20	2	**37**

APPENDIX 3

System Usability Scale (SUS) is a questionnaire that contains 10 questions, on which the participants assigned a value from 1 to 5, according to the statement presented. This agreement scale defines 1 as completely disagree and 5 declares as fully agree.

System Usability Scale (SUS) Results "High Striker"

Table 4. System Usability Scale results from the usability test on "High Striker"

Statements / Participants	P#1	P#2	P#3	P#4	P#5	P#6	Mean
1. I think that I would like to use this system frequently	3	3	4	2	4	3	
2. I found the system unnecessary complex	1	2	4	2	4	4	
3. I thought the system was easy to use	2	4	4	4	4	4	
4. I think that I would need the support of a technical person to be able to use the system	4	3	4	4	1	0	
5. I found the various functions in this system were well integrated	3	4	4	4	4	4	
6. I thought there was too much inconsistency in this system	4	3	4	4	4	4	
7. I would imagine that most people would learn to use this system very quickly	4	4	4	4	4	0	
8. I found the system very cumbersome to use	4	4	4	4	4	4	
9. I felt very confident using the system	4	4	4	4	4	4	
10. I needed to learn a lot of things before I could get going with this system	4	3	4	4	4	2	
Total	33	34	40	36	37	29	
x2.5	**82.5**	**85**	**100**	**90**	**92.5**	**72.5**	**87.1**

System Usability Scale (SUS) Results "Water Pump"

Table 5. System Usability Scale results from the usability test on "Water Pump"

Statements / Participants	P#1	P#2	P#3	P#4	P#5	P#6	Mean
1. I think that I would like to use this system frequently	4	0	3	4	4	4	
2. I found the system unnecessary complex	4	0	4	4	1	2	
3. I thought the system was easy to use	0	2	4	4	4	4	
4. I think that I would need the support of a technical person to be able to use the system	2	4	1	4	1	0	
5. I found the various functions in this system were well integrated	4	4	4	4	4	4	
6. I thought there was too much inconsistency in this system	4	0	4	4	4	1	
7. I would imagine that most people would learn to use this system very quickly	4	4	4	4	3	0	
8. I found the system very cumbersome to use	4	4	4	4	4	4	
9. I felt very confident using the system	4	4	4	4	4	4	
10. I needed to learn a lot of things before I could get going with this system	4	4	4	4	3	1	
Total	34	26	36	40	32	24	
x2.5	**85**	**65**	**90**	**100**	**80**	**60**	**80**

Chapter 13
Gamification as Upper Limb Rehabilitation Process

Vitor Simões-Silva
https://orcid.org/0000-0003-2831-9729
School of Health, Polytechnic of Porto, Portugal

Ana Filipa Duarte Mesquita
School of Health, Polytechnic of Porto, Portugal

Karla Lígia Santos Da Silva
School of Health, Polytechnic of Porto, Portugal

Vanessa Solange Arouca Quental
School of Health, Polytechnic of Porto, Portugal

António Marques
https://orcid.org/0000-0002-8656-5023
School of Health, Polytechnic of Porto, Portugal

ABSTRACT

In our modern life world, health and well-being strongly depend on the individual's health behaviours. Motivation is a major factor of health behaviour change, and intrinsically motivated behaviour change is desirable as it is both sustained and directly contributes to well-being. This raises the immediate question what kind of interventions are best positioned to intrinsically motivate health behaviour change. The current state of evidence supports that gamification can have a positive impact in health and wellbeing. In recent years, games and game technology have been used quite widely to investigate if they can help make rehabilitation more engaging for users. The underlying hypothesis is that the motivating qualities of games may be harnessed and embedded into a game-based rehabilitation system to improve the quality of user participation.

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HOW CAN GAMIFICATION BE A PROCESS OF REHABILITATION OF UPPER LIMBS?

Synthesis of Investigations in the Area

In the last decades the gamification concept comes up as different and original way of society to relate with several performances into different subjects and it has been increasingly defended that gaming does not only have to be relating as something pleasurable or as amusements. According to Huizinga (2012) cited in Assunção (2018), gaming is something that belongs to the individual and reveals an important role into cognitive, behavioural and social development.

Consequently, according to Deterding (2011) cited in Assunção (2018), gaming can be defined as the use of game components on occasions not associated with any situation of gaming, but its function is increasing people's involvement in to promote certain behaviours.

Considering game as a belong to a human being and from its culture, it is understood that the mechanisms of games are present in the way of living and relating since the beginning of civilization. Its survival could be considered as a way to play with life and, therefore, could not be understood gaming as something new (Navarro, 2013).

Motivation as a motor of movement:

In our modern world, health and well-being strongly depend on individual health behaviours. Motivation is a major factor of health behaviour change, and intrinsically motivated behaviour changes are desirable as it is both sustained and directly contributes to well-being. This raises immediately the question of what kind of interventions are in a better position to intrinsically motivates health behaviour changes. The current state of evidence supports that gamification can have a positive impact in health and wellbeing (Johnson et al., 2016).

Motivation is understood as a strength that emerges, measures and supports attitudes of each human, it is a joint process that reaches the beginning of an activity and its maintenance with firmness and vigour over time.

Besides, motivation should not be considered as a feature relatively stable of human behaviour because it can change due to others features that the individual may be exposed to (Pansera et al., 2016).

People are motivated to perform by different kinds of factors that might be as activity by its own or other external force. When the individual is only motivated by the activity and not by external factors is designated as intrinsic motivation. This kind of motivation is related with better learning, high performance and well-being as well and, therefore, it is essential to study the conditions that enhance it.

Autonomy is important for intrinsic motivation, and some studies prove this need by revealing that actions such as rewards, threats, assessments and deadlines reduce intrinsic motivation and decreasing autonomy.

The results of an experiment prepared by Zuckerman and collaborators (1978) has shown that people's motivation it is high when they have higher control upon on its involvement because having the freedom of choice, about what they will do or either how they will going to do, the individuals tend to have intrinsic motivation raised than people that performs same actions but not have elected it by themselves (Marins, 2013).

When we mention motivation, we are also referring to Martins (2018) who define this as being psychologic energy, directed to a specific object, however, many behaviour's theories about behaviour's orientation do not explain where came from the same kind of energy that encourages to act as well. Taking into account the theory, the origin of this energy comes from intrinsic or extrinsic motivations, the first being the most desired motivational state, within the scope of gamification, is defined as the desire or the tendency to perform certain behaviour related to gamification, is defined as the will or tendency to perform a certain task by itself, due to its interesting character, challenging of what is shown to us on a certain occasion, that is, the reasons for the accomplishment are in the task itself .

Nevertheless, the authors Ryan & Deci (2000) cit in Martins (2018) already revealed that intrinsic motivation has origin in external factors of the individual or the tasks by itself, being the person motivated by reward with additional value-added into a simple pleasure to do the task (Martins, 2018).

Usefulness in the upper limb rehabilitation process:

Applications and research have mainly targeted physical activity, nutrition, and stroke rehabilitation, with an about equal share of: "exergames" or "active video games" directly requiring physical activity as input; behavioural games focusing specific behaviours; rehabilitation games guiding rehabilitative movements, and educational games targeting belief and attitude change as a precondition to behaviour change (Johnson et al., 2016; Sardi et al., 2017).

In upper limb rehabilitation discourse, both commercial and bespoke video games are attractive perspective tools. Their application has been explored since the arrival of 'exergames' in the 1980s39 and the consequent and exponential creation of games without entertainment as the primary focus often termed as 'serious games'. In games for rehabilitation, ecologically relevant functional movements can be masked within the context of the game and presented as steps to accomplish an objective (Barrett et al., 2016).

In the chronic phase after stroke, most people still have motor problems, leading to difficulties in performing activities of daily living (ADL). Good arm and hand motor function are essential to perform ADL independently. Therefore, restoration of arm and hand function is a major objective in stroke rehabilitation. Research into motor relearning and cortical reorganization after stroke has provided a neurophysiological basis for those aspects that are important to stimulate restoration of arm function: functional exercises, at high intensity and with the active involvement of the patient within a motivating environment (Nijenhuis et al., 2015).

Gamification of health:

Proponents of gamification for health and wellbeing have seven potential advantages of gamification: supporting intrinsic motivation (as games have been shown to motivate intrinsically); wide accessibility through mobile technology and ubiquitous sensors; broad appeal across audiences (as gaming has become mainstream); broad applicability across health and wellbeing risks and factors; cost-benefit efficiency of enhancing existing systems (versus building bespoke games); everyday's life fits (reorganising existing activity rather than adding additional demands to people's lives); direct wellbeing support (by providing positive experiences) (Johnson et al., 2016).

In recent years, games and game technology have been used quite widely to investigate if they can help make rehabilitation more engaging for users (Sardi et al., 2017). The underlying hypothesis is that the motivating qualities of games may be harnessed and embedded into a game-based rehabilitation system to improve the quality of user participation (Charles & McDonough, 2014; Karashanov et al., 2016; Nijenhuis et al., 2015).

These games can be divided by two groups: the serious games, which has the aim to offer virtual reality's environment for rehabilitation of the individuals, contributing for the motivation to perform repetitive moves related to the rehabilitation process, that the other way this performance can become monotonous and uninteresting. The other category are "exergames" (exercises games) that seek to awaken an active lifestyle tailored to a certain standard, one physiological and one psychological, directed to the needs of people with disabilities (Webster & Celik, 2014).

However, it is important to underline that gamification is directly related to an individual's motivation. In several situations, it is used to give rewards to the users, in the way that motivates them extrinsically for something, but these extrinsic rewards can be used as incentive way with strong motivation called intrinsic (Marins, 2013).

In the rehabilitation context, "serious games" play one of the most important roles, according to several authors, allows the patients to maximise their chances of recovery. In the meantime, for the serious games to be effective, it should be followed by three main rules aiming to generate interest and maintain the motivation of patients:

- The exercises must be proposed in stimulating, dynamic, changeable and fun interactive environments. The authors also cite that the exercises must be provided with competitive stimuli, such as specific mechanisms or scoring mechanisms;
- Professionals who are going to apply the game must be able to calmly select the rehabilitation exercises according to the needs of the users. Since throughout the rehabilitation process, the increased difficulty is attributed to the continuous maintenance of gain in the exercise parameters, about the progress of the patients. Also, one must be aware that each patient has his individuality and may require a unique set of interactions, parameters and goals;
- Quantitative mechanisms that can measure patients' performance during therapies are also needed. Since, different professionals may have different opinions about patients' progress, especially when they are imperceptible to human eyes (Marques, 2019).

Appealing to established theories of intrinsic motivation, gamified systems commonly employ motivational features like immediate success feedback, continuous progress feedback, or goal-setting through interface elements like point scores, badges, levels, or challenges and competitions; relatedness support, social feedback, recognition, and comparison through leaderboards, teams, or communication functions; and autonomy support through customizable avatars and environments, user choice in goals and activities, or narratives providing emotional and value-based rationales for an activity (Edwards et al., 2016; Johnson et al., 2016).

The use of technology-based neurorehabilitation approaches has increased to face high demands due to the increasing numbers of stroke victims as it provides rich controllable multi-modal simulation and the possibility for Placidi (2018) several studies showed evidence of the positive benefits of such systems in the rehabilitation of the paretic upper limb after stroke (C. Cameirão et al., 2011; Placidi et al., 2018).

The results of these studies suggest that many elements of the interactive games have tremendous potential as rehabilitation tools, using miniature motion tracking sensor (Szturm et al., 2008); integration of an instrumented hand rehabilitation device (Carneiro et al., 2018); leap motion systems (Karashanov et al., 2016; Placidi et al., 2018) or other specific rehabilitation gaming system (C. Cameirão et al., 2011).

Virtual reality technology:

The virtual reality is the most recent technology that allows users to interact, explore, assign a sense of being to the task and have autonomy (T. Silva, 2016).

When we talk about virtual reality is through of this new technology that users can interact with several sensory environments providing, in real-time, feedback related with performance and even it is used with proposed methods to enhance the effects of rehabilitation therapy and enabling a varied and pleasant environment in which users can have a motivation to practice movements necessary for rehabilitation, over long periods (Cardoso, 2016).

The therapy through of virtual reality can be divided in immersive and non-immersive depending on the way of using games. The immersive reality is classified as the one that the individual moves an avatar in the simulate environment and non-immersive is the one that the individual performs movements with arms or legs into the simulate environment through a computer or television (Gonçalves, 2017).

The use of virtual reality systems contributes to enhancing the function of an affected limb, by facilitating cortical reorganization, which can be facilitated by providing multisensory feedback (auditory, visual and tactile) from virtual reality systems, in this sense according to several studies, using magnetic ressonance images demonstrate evidence of cortical reorganization (Cardoso, 2016; Melo, 2019).

In this sense, when we approach the word rehabilitation, it can be defined as a process designed as a solution to life changes, not outlined, established by pathologies or even traumatic accidents, whose objective is to admit that people with some type of disabilities can reach and maintain their physical and sensory levels of ideals, offering them the essential tools so that they can achieve their independence (Rocha, 2015).

Rehabilitation consists of enabling individuals with disabilities to improve physical, intellectual, psychological and / or social functions, comprising a whole plan during which the patient progresses towards or maintains the maximum degree of autonomy he is capable of (Silva, 2010).

Rehabilitation can be local, when healthcare professional assists the patient closely, or remotely when the healthcare professional assists by distance (Souza, 2019).

Virtual reality provides a unique and appropriate means for the effective performance of motor rehabilitation, specifically because this therapy can be provided within a purposeful and motivating functional context, presenting opportunities for patients to participate in experiences that are engaging and rewarding, being extremely important that patients enter the domain of exercise voluntarily (Lourenço, 2018).

Virtual reality simulates real situations, such as sports activities and basic activities of daily living, through games or simulators, so it is believed that the use of this distracts the patient with nerve injuries from the focus of pain or discomfort, improves functionality affected members and leads them to practice activities in areas of occupational performance without major damage to their health (Fernandes et al., 2016; Grande et al., 2011).

The use of virtual reality as a tool requires greater control of upper limb movements. This control is performed by neural neurofeedback mechanisms. To achieve a functional objective with precision when performing complex movements with the upper limb (reaching or targeting) from visual reference, great dexterity is needed (Gonçalves, 2017).

Gamification as a therapy resource:

Resources such as games and recreational activities are known to occupational therapists due to their benefits and aim to promote client involvement and motivation while favouring the development of occupational skills and performance.

However, virtual rehabilitation through video games offers, in addition to the technological appeal, the possibility of adapting to various types of requirements according to the client's need and capacity. Thus, he can develop motor and cognitive functions required to perform activities of daily living in a pleasurable way (Grande et al., 2011).

Compliance with treatments and therapies is crucial and requires high motivation. The gamification of rehabilitation exercises and their deployment in ubiquitous and pervasive devices such as smartphones or tablets may enable a more engaging and compelling rehabilitation at home while also improving the cost-efficacy of stroke recovery. The smartphone or tablet screen allows creating virtual-reality scenarios for the rehabilitation games. Additionally, their built-in inertial sensors can be used as wearable sensors, attached to different parts of the body and communicating with the virtual scenario by bluetooth or wifi, to assess the compliance to the movements prescribed.

The smartphone can be used to promptly send the metrics of the patient performance during the rehabilitation exercises to the therapist. A few smartphone applications have already been developed for stroke rehabilitation. "Dr Droid" is an Android application that administers the Wolf Motor Function Test by giving audio and visual instructions to the patient and collecting the accelerometer data of the smartphone in the wrist. The "DroidGlove" application uses various inertial sensors built-in the smartphone to assess the compliance of the patient to the exercises learned by visualizing a video recorded by the therapist. Using only the smartphone, these applications enable the practice of the exercises anywhere. However, none of them allows the visualization of the game in simultaneous with the execution of the tasks.

More sophisticated systems make use of wearable sensors connected by bluetooth to the smartphone, which requires the acquisition of additional equipment. This is the case of "SQUID", a smart shirt used to provide feedback to the user by measuring electromyography and heart rate data. "UBI-Rehab" is a mobile-based rehabilitation system using augmented reality and a wearable accelerometer deployed in a glove (eGlove) to play pick-and-drop games (Ferreira et al., 2014).

Ferreira and collaborators (2014) developed a study where three-stroke rehabilitation exercises were implemented in a game-like structure. They are played on a computer screen and the smartphone is attached to the wrist of the user. The first exercise is the supination/pronation of the forearm, the second is the flexion/extension, and the third is the medial/lateral rotation. These exercises are simple to evaluate with a smartphone and the developed games help to assess all degrees of freedom of the forearm.

This work contributed to demonstrate that smartphone inertial sensors can be used to develop stroke rehabilitation games and to monitor the patient's performance. The routine of rehabilitation can become tedious, repetitive and demotivational and an application of this kind can increase the patient's motivation. These games may constitute an alternative to more traditional approaches and ensure the continuation of the treatment at home. This paper presents an original virtual reality application for the upper limbs stroke rehabilitation that relies on a smartphone and a desktop computer. This application has the advantage of using tools of increasingly widespread access that can be used to monitor the exercise execution and send information to therapists (Ferreira et al., 2014).

Non-invasive motion tracking systems:

To help in home-based hand-therapy, a various computing platform such as Microsoft Kinect, Microsoft Digits, Myo, and Leap Motion, to name a few, have recently emerged that help in identifying physiological parameters from a hand therapy session in real-time. Recent works have suggested that using non-invasive motion tracking system that does not make use of external wearable devices lets the patient perform movement more naturally.

Other approaches in this area seem to favour analysis of kinematic therapy data to help track the disability level of a patient. Although Microsoft Kinect 2 is a popular platform for full-body gesture recognition which can detect basic hand open/close gestures, it cannot track subtle motions of different joints in the hand with great accuracy. Recently, a 3D motion-based gesture control device called Leap Motion has been presented. It is a specialized device for tracking hand joints only. It provides 3D positions of joints of two hands at a frame rate of 60-200 fps within a range of 0.6m. The sensing range and very high resolution makes it well suited among the state-of-the-art monitoring devices for in-home hand therapies. Some of the disability metrics that can be measured by the Leap Motion include the range of motion of small joints of individual fingers, the velocity, and the acceleration of the connected limbs. A tracking layer then creates a stream of data frames consisting of tracking information about the wrist and fingers.

Although the most important factor in the rehabilitation process is the time spent exercising under the supervision of the therapist, home-based e-therapy can become a great factor in the improvement of the patient given its low cost, flexible, relaxing, and easy to perform factors (Afyouni et al., 2017; Souza, 2019).

Afyouni and collaborators (2017) developed a paper that introduces an innovative e-health framework that develops adaptive serious games for people with hand disabilities. This work aims to provide a patient-adaptive environment for the gamification of hand therapies to facilitate and encourage rehabilitation issues. In previous work, and to track the movement of a subject, they have used two low-cost sensors, namely, the Leap Motion and Microsoft Kinect, which are equipped with 3D motion-sensing cameras. The data streams produced by the two devices can be rendered on the screen in real-time or recorded for offline playback and analysis.

They have also developed an authoring tool to allow the therapist to select joints of interest from the image of the human body in a highly intuitive manner. This paper extended the previously proposed concepts by introducing a fully-fledged gamified hand-therapy framework with several main features. In this work, they introduce a patient-adaptive environment for the gamification of hand therapies to facilitate and encourage the rehabilitation process. This framework provides a very encouraging and motivating environment to physically challenged individuals for performing routine and boring physical therapy exercises using patient adaptive serious games.

So, they developed a gamified e-therapy framework to provide patients with an entertaining and personalized environment to practice physiotherapy under the guidance of therapists and caregivers. An intelligent game generation within a map-browsing environment was implemented, where each game is represented by navigational movements generated according to patients' preferences and constraints. The implemented system generates metrics and lives plots after each gameplay. Them initial test results show that this framework has the potential to explore for more advanced serious games and detailed clinical data mining and analysis (Afyouni et al., 2017).

Rehabilitation robotics:

Developments in technology-mediated rehabilitation have made it possible to use rehabilitation robotics to provide safe and intensive training to people with mild to severe motor impairments after neurologic injury. Such devices can provide high-intensity, repetitive, task-specific, interactive training of the impaired upper extremity, and have the potential to more accurately quantify therapy and monitor patients' progress.

Rehabilitation robotics is effective for the hemiparetic arm. However, many training studies using robotic devices focus on either the proximal or distal arm only. To improve independent use of the upper extremity in daily life, it is important to include functional movements of both the proximal and distal arm and hand into post-stroke training.

Two examples are The Activities of Daily Living Exercise Robot (ADLER) and Gentle/G system which can train both reaching and grasping movements. A next step would be to use such technology at home to support self-administered training, without requiring direct therapist involvement continuously. This requires a training device to be compact and easily transportable (Nijenhuis et al., 2015).

A study developed by Nijenhuis and collaborators (2015) evaluated the feasibility and potential clinical changes of the self-administered and remotely monitored arm and hand training at home, with physical support from a dynamic wrist and hand orthosis and games representing exercises, in chronic stroke. Together with the effective use of 105 minutes per week, these findings indicate that home-based arm and hand training with physical support from a dynamic orthosis is a feasible tool to enable self-administered practice at home. Arm function improved, together with modest improvements in quality of life, indicating home-based arm and hand training can have clinical value, especially for mild to moderately impaired patients.

Current physiotherapy services may not be effective or suitable for certain patients due to lack of motivation, poor adherence to exercises, insufficient supervision and feedback or, in the worst case, refusal to continue with the rehabilitation plan. The study developed by Munoz and collaborators (2019) introduces a novel approach for rehabilitation of upper limbs through KineActiv, a platform based on Microsoft Kinect v2 and developed in Unity Engine.

KineActiv proposes exergames to encourage patients to perform rehabilitation exercises prescribed by a specialist, controls the patient's performance, and corrects execution errors on the fly. KineActiv comprises a web platform where the physiotherapist can review session results, monitor patient health, and adjust rehabilitation routines. The system relies on an RGBD (Red, Green, Blue, Depth) sensor (MS-Kinect V2) and on a friendly, interactive, gaming-based user interface, aimed at making the execution of the exercises easier and enjoyable. The system quantitatively measures upper-limb movements and compares them with expected goals previously established by the physiotherapist. The results show that KineActiv is a usable, enjoyable and reliable system, that does not cause any negative feelings (Munoz et al., 2019).

Another example of gamification is the T-TOAT (Technology-supported Task-Oriented Armhand Training) introduced by Delbressine and his team. This method has been conceived specifically for enabling the implementation of task-oriented training in rehabilitation technologies.

They present a novel technology to support playful rehabilitation of arm-hand performance for stroke survivors. The system combines tangible tabletop interaction with wearable technology, to encourage stroke patients to train their arm-hand skills in a task-oriented manner, while a jacket supporting tilt-sensing and vibrotactile feedback guide patient´s regarding the correct execution of exercises and specifically to avoid compensatory movements (Delbressine et al., 2012).

Delbressine and collaborators (2012) presents an arm training system for stroke survivors that aims:

- To invite for frequent movement repetition of activities of daily living with real-life objects in a real-life context through motivating interactive games, a training approach that has been shown to improve arm-hand performance after stroke;
- To improve movement quality by supporting awareness of compensation and guiding feedback on compensatory movements;
- Support compliance and motor learning through the provision of information to patients (and their therapists) about progress in arm-hand performance during rehabilitation.

The vest is designed such that this can be achieved without compromising the freedom of movement of the patient, it can be worn on both left and right shoulder, it fits both genders and should be suitable for different sized patients as much as possible. The sensor vest uses accelerometers to measure: trunk movements in the horizontal and sagittal planes at the chest sensor on the sternum, shoulder girdle movements at the sensor on the acromion, and shoulder joint (i.e. upper arm) movements in the frontal plane at the sensor on the lateral part of the upper arm.

This method has been implemented in several supporting technologies:

- Scribeo was designed to support patients to re-learn how to write playfully - interaction was supported through a tablet device supporting pen-input;
- The Philips Stroke Rehabilitation Exerciser is a hybrid system supporting tangible interaction and modelling hand movement through accelerometer data on the arm, hand, and torso. It supports only a limited set of exercises, which cannot motivate and challenge patients for sustained training periods;
- The Haptic Master implementation of T-TOAT supports recording of movements and guiding patients through movement trajectories by offering Haptic feedback on the deviation of the recorded path. The hand is left free to let patients train on realistic tasks using everyday objects.

Clinical trials have shown that the T-TOAT method is effective for the improvement of arm-hand performance after st1roke, even in the chronic stage after stroke (Delbressine et al., 2012).

Szturm and collaborators (2008) developed an interactive exercise gaming system for hand function rehabilitation that involved the manipulation of real objects. effects on the recovery of finger motion and hand function and are consistent with studies that have evaluated the efficacy of constraint-induced movement therapy.

The rehabilitation activities based on gross movements are growing very fast. The gross movement responds to the body movements that require a drastic change of position. Thus, a gross gesture is defined as a movement that demands big amplitude in its execution. Besides, fine gestures are movements with a high precision requirement and a high coordination level. The gross motor gesture recognition has been employed for many systems as a strategy to supply motor exercises. A remarkable example is the system BioTrak which is a platform for training and rehabilitation of many diseases as a result of some pathology. This system includes a magnetic tracker which can detect gross gestures from the upper limbs. Another example is shown by the system IREX (Interactive Rehabilitation and Exercise System) which includes a wide range of interactive games focused on gross motor movement for the arms. All these systems are efficient showing good results.

The Myo Armband is a device in the form of a bracelet below the elbow, developed by Canadian company Thalmic Labs. Myo is placed on the widest part of the guide (dominant) hand. A key point is that the bracelet should always be in direct contact with the skin. It can be worn under clothes, but not on them. Myo uses sensors that measure muscle activity in the hand. They work on the principle of electromyography (EMG) - recording the electrical potential of muscle cells when they are electrically or neurologically activated.

Leap Motion (LM) controller is a device from the second type. The controller is a computer hardware sensor device developed by the American company Leap Motion, Inc. It can detect in real-time the movement of the hands and pointers. It is used as an input peripheral device, similar to the computer mouse, but there is no need for physical contact. The mechanics of the Leap Motion controller are relatively simple. The basic units of LM controller are two VGA monochrome cameras, three infrared LEDs (light-emitting diode) and a USB controller. The cameras and light-emitting diodes serve for monitoring the infrared light with wavelength $\lambda = 850$ nm (outside the visible spectrum to the human eye). Thanks to the wide-angle lens the unit has a large space of interaction, it is approximately $0.23m^3$ of the shape of inverted pyramid obtained by the intersection of the visual fields of the two cameras (Karashanov et al., 2016).

Karashanov and collaborators (2016) describe a solution to capture and recognize the movement of upper limbs using the Leap Motion controller based on the gamification approach with application in the physical rehabilitation therapy.

The basic idea of this application is to help develop the muscle tonus and increase precision in gestures using the opportunities that the new technologies offer by making the rehabilitation process fun and engaging. The application, developed for this work has a main menu and sub-menus, which unite groups of exercises. Each group will bring together several exercises that are very close to each other or variations of the same exercise. The exercises will be organized in levels. The levels are selected to be of four types:

- "Labyrinth" in which the patient moves a ball to the exit. Each successive level is of a more complicated labyrinth.
- "Pyramid", in which the patient hand must put the missing pieces in the correct slots and sort them. On each level the missing pieces are more and more complicated.
- "Trash can" in which patient must collect and carry small objects with his hand to the trash. Bins are equal in number to the number of levels (e.g. The third level has three bins). Each hand is responsible for filling only one basket;
- "Drawing" in which patient with his fingertips or with a pen (or similar object) uses a pre-drawn template to follow. Each successive level requires more complex coordination and more precise work.

Different levels can be added and the time of execution of each task can be followed to measure the outcome of therapy. As a function of the application is an added option for the selection of random level.

Another example of exergames is "Motion Rehab 3D Plus" which is advanced of "Motion Rehab AVE 3D", an exergame designed to upper limb motor rehabilitation and balance for individuals that suffered a stroke. The previous version included six activities that the patient hat to move his hands, upper limbs, lower limbs and the torso as well, to capture objects on the screen and score in the game. All activities were designed from the conventional treatment of stroke rehabilitation, which makes this version specific to this pathology. The treatment of other pathologies, therefore, requires the development of new games (Trombetta et al., 2018).

The research "Hand Therapist: a rehabilitation approach based on wearable technology and video gaming" is a hand rehabilitation system, mainly for stroke patients, consisting of Myo armband, robotic glove and the Unity game engine 3D. This approach presents a solution that combines performance, low cost and motivation for hand therapy (Fernandes et al., 2016).

Myo can control devices, being able to control games and videos, go through of the slides and manipulate model aeroplanes with only the movements of the upper limb. This information is sent to a processor in the armband, and an algorithm translates the commands, which are sent via Bluetooth with low energy consumption to the gadget that the user is trying to control, such as a smartphone. Thus, to perform the tests, the patient places the wearable device Myo on the upper limb to perform the recommended movements and gestures during the game and positions himself in front of a computer or tablet.

Another examples of gamification in upper limb rehabilitation process:

A study developed by Cameirão and collaborators (2009), focused on virtual reality-based rehabilitation systems in particular, so-called Rehabilitation Gaming System (RGS) that proposes the use of non-invasive multi-modal stimulation to activate intact neuronal systems that provide direct stimulation to motor areas affected by brain lesions. This system is designed to engage the patients in specific training scenarios task that adapt to their performance, allowing for an individualized training of graded difficulty and complexity. Although this system stands for a generic rehabilitative approach it has been specifically tested for the rehabilitation of motor deficits of the upper extremities of stroke patients.

Unlike classical rehabilitation techniques, the RGS is grounded in an explicit neuroscientific theory about the mechanisms of recovery, activation of the motor system and cortical plasticity. RGS generates task-specific training scenarios designed for the rehabilitation of the upper limbs, and monitors and quantifies the improvement of the patients over time. The RGS tasks follow a model that deploys an individualized training that has been divided into three phases of increasing complexity, ranging from arm extension/flexion to a coordination task that combines arm movement with grasp and release (Cameirão et al., 2011).

At present, many modern health care centres have computational systems based on virtual reality games oriented to motor training and motor learning through both, fine and gross movement exercises. The gross movement responds to the body movements that require a drastic change of position. Thus, a gross gesture is defined as a movement that demands big amplitude in its execution.

Besides, fine gestures are movements with a high precision requirement and a high coordination level. The gross motor gesture recognition has been employed for many systems as a strategy to supply motor exercises.

A remarkable example is the system BioTrak which is a platform for training and rehabilitation of many diseases as a result of some pathology. This system includes a magnetic tracker which can detect gross gestures from the upper limbs. Another example is shown by the system IREX (Interactive Rehabilitation and Exercise System) which includes a wide range of interactive games focused on gross motor movement for the arms. All these systems are efficient showing good results (Karashanov et al., 2016).

There are two types of devices for recognizing gestures available on the market: motion-sensing systems and computer vision systems. The Motion sensing systems can be bracelets, rings, bracelets under elbow, gloves and pointers. The primary advantage that motion-sensing gesture recognition devices have over computer vision systems is a larger library of possible gestures enabled by the precision sensor array. Furthermore, the gesturing itself may be less conspicuous because it can be done with smaller movements made closer to the body thus calling less attention to the user.

The disadvantage is that motion sensing devices are separate pieces of hardware that must be toted along with the user. They have the additional burdens of needing their power sources and having to establish and maintain a radio connection to the human-computer interface (Karashanov et al., 2016).

The Computer Vision Systems consist of two or more camera sensors and one or more infrared laser or LED light projectors. The cameras track infrared light which is outside of the visible spectrum and work in stereo to aid depth perceptions through parallax as human eyes do. The angle of the camera lenses defines the width of the sensor systems field of view which gets wider as it gets farther from the lenses; however, the viewing range is limited by the output of the light source.

This system has several advantages. Unlike motion-sensing peripherals, the depth-sensing time of flight components can be integrated directly into the human-computer interface. This means that there is only one device to carry, one battery to charge and no pairing necessary between devices.

There are also disadvantages to this technology which are related to the physical aspects of hand gesturing. The sensors have a relatively narrow band of sight which means the gestures must be performed immediately below one's line of sight. Such gesturing may be socially awkward in certain public situations. Also, holding one's arms elevated in front of them tends to lead to fatigue after a period (Karashanov et al., 2016).

The Nintendo Wii is a game device that uses a wireless remote control, this control has a bluetooth, accelerometer and a gyroscope that enables or enables the device to detect users' movements. The user performs the movements similar to those seen on the screen, thus the control captures, translates and sends the game to read these movements.

It is a virtual environment that provides the patient with greater motivation with treatment, and a greater sense of ownership, balance control, postural corrections, increased functional mobility, improvements in physical capacity, the exercise of imagination, memory and concentration, and with that, an experience of a different treatment reality (Costa & Ribeiro, 2018).

The benefits of using Nintendo Wii in the practice of rehabilitation as a therapeutic tool is still recent, but the constant evolution of studies brings information that further helps in the applicability of this tool for rehabilitation, as they mention great benefits; such as postural corrections; balance training; increased locomotion capacity, range of motion of the upper and lower limbs; in addition to the patient's motivation for exercising (Costa & Ribeiro, 2018).

In the last years, several automated "tele-rehabilitation" gloves, based on mechanical devices or tracking sensors, have been presented. These gloves allow the execution of therapy at home and effective rehabilitation can be analytically calculated and summarized in numerical parameters, controlled by therapists through the Internet.

Moreover, this equipment can be easily interfaced with virtual reality environments, which have been proven to increase the effectiveness of rehabilitation. Mechanical devices are equipped with pressure sensors and pneumatic actuators for assisting and monitoring the hand movements and for applying forces to which the patient must oppose (Placidi et al., 2018).

Placidi and collaborators (2018) developed a study where they proced to the implementation of a multi-sensors approach, the virtual glove, based on the simultaneous use of two orthogonal LEAP motion controllers. This virtual glove is calibrated, and static positioning measurements are compared with those collected with an accurate spatial positioning system.

The error of the system, when collecting small objects (the dimension of the stick was about 5 mm _ 5 mm) was lower than 6 mm, thus making the proposed system well suitable for accurate hand tracking measurements. Hand tracking tests confirmed that: real-time hand model reconstruction was possible when using two orthogonal LEAPs; the algorithm used by virtual glove switched correctly from one sensor to the other; no discontinuities were evident and calibration was effective; and most of the occlusions, highly frequent when a moving hand is tracked by a single LEAP, were eliminated, which could be particularly important when tracking of the hand is done while grasping a tool.

A study developed by Gauthier and collaborators (2017) also refers that motor interventions, such as constraint-induced therapy, that include both intensities of training and techniques to enhance carry-over have been shown to enhance post-stroke outcomes and promote brain plasticity.

The results of the randomized controlled trial developed by them will provide a significant addition to our body of knowledge regarding the potential for functional motor improvement of upper extremity hemiparesis following stroke. Specifically, they will determine whether using technology can address primary access barriers to quality care, including the difficulty of travel for in-person therapy, expense, scheduling demands, and a dearth of trained constraint-induced therapy providers. Moreover, if effective, a remotely delivered model of care may facilitate the patient choice of providers or clinics (e.g. a client may seek a treatment provider who is located far from their home).

Serious games have gained a lot of space in the area of education, high-performance training and rehabilitation. This is because these games provide deep and sustained learning and, also, have the possibility of reaching a wide range of populations (Marques, 2019).

In rehabilitation, video games may play a decisive role in creating a more pleasant environment for patients, while the user has fun interacting with the virtual world, there is a collection of data to certify the patient's evolution and therefore, as already mentioned, these games can help patients in physical rehabilitation. With existing devices on the market, users feel more support in their motor rehabilitation in a more motivating way, making this more efficient (Leal, 2016).

The use of games in rehabilitation is increasing and gamification has been framed as a promising new alternative that embodies a "new model for health" (Carneiro et al., 2018; Johnson et al., 2016; Sardi et al., 2017).

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Chapter 14
Fun and Games:
How to Actually Create a Gamified Approach to Health Education and Promotion

Helena Martins
Lusófona University, Portugal

Artemisa Dores
Polytechnic of Porto, Portugal

ABSTRACT

Gamification is a relatively new approach that allows the use of videogame design techniques in contexts that are originally not game related, including for the promotion and education of health outcomes. Gamification has been used in many contexts, but healthcare practices, which include often boring, frustrating, or painful tasks, can especially benefit from the fun enjoyable games people play for entertainment purposes. Games can be helpful both promoting an increase in health knowledge and behaviors, as well as the positive emotions elicited by health-related contents and behaviors. This chapter begins by discussing the concept of gamification, the gamification toolbox, and gamer taxonomies and the different uses of gamification and game-based approaches in the healthcare context are explored, to figure out what the key success elements are and why this promising approach has yet to achieve its wide-spread potential use.

INTRODUCTION

Gamification is a relatively new concept that proposes the use of elements from video games in non-game applications (Deterding et al, 2011). Gamification's popularity has been increasing in the past years, drawing attention to different strategies, tools, and fields of implementation (Gentry et al, 2019). This approach aims at changing human behavior by engaging people and can be used in a myriad of possible areas of business and society. Although it has been explored primarily in the marketing area, the potential

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of gamification's application has been extended to other areas such as Environment, Government, Education, and of course, Health (Simões et al, 2012). This chapter aims at creating a practical framework for planning and designing gamified approaches for health purposes, providing the much-needed conceptual clarity and practical implications for successful gamified approaches in health education and promotion.

Engaging people in health education and promoting health behaviors may be challenging. Often these include repetitive, sometimes unpleasant behaviors, that may be boring at times, and whose consequences are not immediately felt. Fenerty and colleagues (2012), for example, report that 30% to 50% of patients have poor adherence to medication use. Lack of adherence is a major problem because the intended outcomes of the interventions – improved health outcomes - are not likely to be achieved. This means that the costs associated with providing health services - often founded on costly and scarce resources - are wasted (Fenerty et al., 2012). The issue is amplified when access to healthcare is delayed due to waiting lists, given to the possibility of further deterioration of patients' conditions and the additional costs involved in managing those ailments (Richards & Caldwell, 2016). Games, on the other hand have shown to be effective in the increased motivation and involvement of players in game tasks (Simões et al. 2012) and go so far as to determine the release of dopamine in users (Koepp et al, 1998). Games are defined here as voluntary activities structured by rules, with defined outcomes (e.g., winning/ losing) or other quantifiable feedback (e.g., points) that facilitates reliable comparisons of in-player performances (Thai et al, 2009) are becoming more relevant. We seem to be moving from a paradigm of survival and efficiency into a new era where people are mostly focused on what is pleasurable (Deterding et al, 2011).

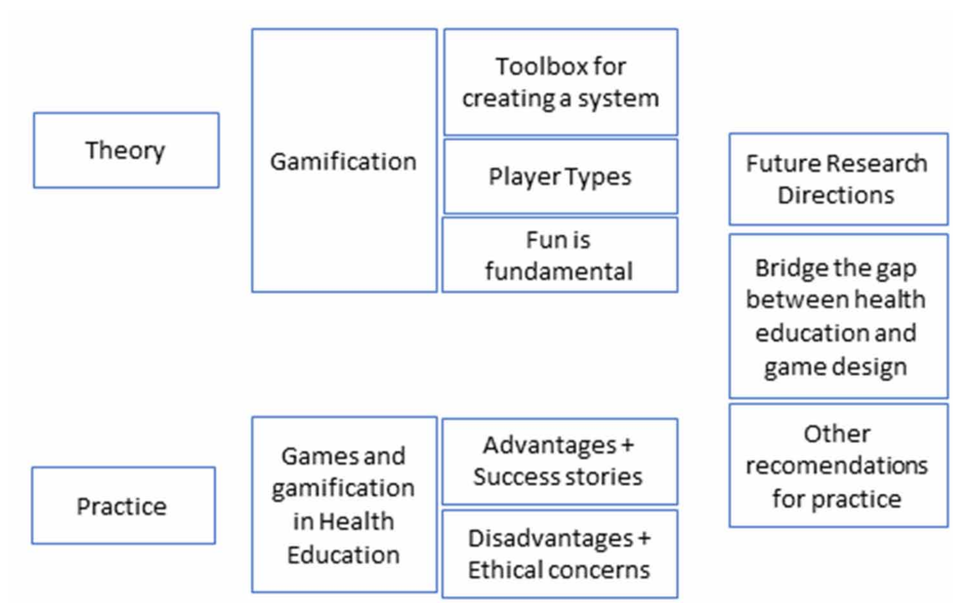
Gamified education has the potential to provide a quality, cost-effective, novel approach that is flexible, portable, and enjoyable and allows interaction with tutors and peers (Gentry et al., 2019). Such an impactful transversal trend involves many opportunities and risks (Gartner, 2011), as well as ethical concerns (Stetina et al, 2012). Still, the pervasiveness of games and gamification in society cannot be ignored by the healthcare sector, whose systems benefit crucially form individual engagement and positive behaviors.

Health education as a tool for health promotion has a relevant role in the improvement of populations' health, individually and at the community level which can be key in individual well-being as well as society's health, as is the case of outbreaks and pandemics, like COVID-19. Many studies have shown that inadequate health education can have a significant impact on health outcomes, in the use of health care services and health costs. Different factors have limited the attention paid to this area and the success gathered by health education strategies, among them, the limited understanding of health education by those who work in this field; lack of consensus on many different theoretical frameworks and concepts; and the difficulty in demonstrating the efficiency of the actual practices (WHO, 2012). To face these challenges new tools and strategies are urgent to promote the engagement of the public (including healthy people, patients and relatives) and professionals in effective health education practices. Further, game-based and gamified approaches, especially when based on digital technologies and internet have the potential to reach developing countries and vulnerable populations where healthcare resources, especially professionals are missing and the populations' needs are most dire. Gamification can be useful to this endeavor, promoting health education core competencies, supported by leading practices. In general, gamification uses the potential developed by the video game technology to shape user behaviors or embed values in users (Deterding et al, 2011) and some authors go as far as to say that games can make us better (McGonnigal, 2011). All definitions seem to perspective gamification with the goal of user engagement (Xu, Hi & Honolulu, 2011), which is key in the healthcare sector.

Further, play is an important element for healthy personal development (especially in children) (Ginsburg, 2007), including learning development. Hence, more than being a distraction, games can be an integral part of learning and intellectual development, since they stimulate cognitive functions (e.g., imaginative play) and intended behaviors (Ke, 2009), a feature that is crucial in promoting health behaviors. Thus, gamification can be effective in promoting and sustaining healthy behaviors, tapping into playful and goal-driven aspects of human nature with strategies such as goal setting, feedback on performance, reinforcement, comparing progress and social connectivity, techniques that share key elements with established health behavior change techniques (Edwards et al, 2016).

However, the popularization of gamification has been posing some challenges to the construct, with authors like Bunchball (2010) calling out that many approaches are nothing but a "pointification" instead of a true gamified approach, where fun is crucial and other elements should also be considered. Authors often hope to find the outcomes touted for gamification using a simple task-reward system that, despite having its own benefits and applications (even in games), is far from being what gamification is all about (Bunchball, 2010). This chapter is aimed at professionals in the healthcare sector and gaming. The framework of the chapter is presented in figure 1, where we will begin by bringing conceptual clarity to the construct of gamification, differentiating it from other similar constructs, and move on to the essential aspects of gamification, namely tools, components, strategies as well as gamer taxonomy, establishing an appropriate theoretical background, where fun is highlighted as a key (and often forgotten) element of games and gamification design. We will analyze some applications of the gamification approach in the field of health education, and reflect on advantages and disadvantages, as well as ethical concerns. The book chapter will conclude with recommendations for practice and deliver specific guidelines for creating a successful gamified approach in health education, as well as future research directions.

Figure 1. Framework and key takeaways of the book chapter



BACKGROUND

Gamification: What it is and What it is not

Although gamification has become a buzz word in the past few years, gamification as a concept is not clearly defined in the research literature (Marston & Hall, 2016).

Generally speaking one can say that gamification is "the use of game design elements in non-game contexts" (Deterding et al., 2011, p.9). In this definition, four terms can be singled out: (1) game, (2) elements, (3) design, and (4) non-game contexts. The term (1) game reflects the set of rules that involve players as opponents or team members and tend to lead to a quantifiable outcome; (2) elements denotes that gamification merely uses some of the game components, as is the case of points, badges and leaderboards; (3) design indicates the intentionality of strategies implemented in a gamification system; finally, (4) non-game context refers to the transcendence from entertainment that the approach has, encompassing a diversity of contexts and areas (Deterding et al., 2011).

Although there are many definitions in the literature (e.g., Deterding et al., 2011; Huotari & Hamari, 2017; Werbach, 2014) originated from distinctive perspectives and contexts, there seems to be consensus in three different aspects (Martins et al, in press):

1. Gamification is based in games and game theory;
2. Gamification is used in non-game contexts;
3. Gamification's goal does not merely entail entertainment, it aims at incentivizing behaviors and supporting added value for the stakeholders.

Gamification can be seen as a form of persuasive or motivational design (Alahäivälä & Oinas-Kukkonen, 2016). Generally, gamified systems are complex interventions, that require thoughtful consideration of the context, content, structure, and delivery of the program and its components which should be articulated with the strategically intended outcomes (Alahäivälä & Oinas-Kukkonen, 2016). Although gamification has been often linked to digital technologies, a gamified approach does not require this aspect and can be analogically driven.

Gamification is not the same as a game. There are several definitions of what a "game" is. In general, a game is a system within which players traditionally engage in an artificial conflict, trying to solve a specific problem. A game is defined by rules and measured by a quantifiable outcome (Deterding et al., 2011). According to McGonigal (2011), a game has four key elements: (a) a specific goal that people are willing to work for, (b) rules that stimulate creativity, (c) a feedback system that lets individuals know how they are doing regarding the goal, and (d) voluntary acceptance of the goal, rules, and feedback systems.

Gamification is more than the simple transformation of everyday activities in a game: it is the redesign of tasks and processes in game mechanisms, in order to stimulate the emergence of motivation in otherwise unappealing processes (Martins et al, in press). Another way to look at the difference between gamification and game-based approaches is that in game-based approaches, a game is used as an artifact to create an extra layer of motivation (typically extrinsic motivation) to the task/mission/goal, whereas a gamification system creates aims at creating a sort of parallel reality where the tasks at hand (usually not very appealing) are transformed into the tools to achieve a certain outcome in a fun way. As such it is important to ensure the necessary conditions for the correct development of a gamified system as to capture user interest when it is applied and must unequivocally consider the diverse and complex user motivation mechanisms (Martins et al, in press).

Gamification is also not the same as serious games. Serious games are the use of interactive computer software for one or more players (e.g., computer simulations), developed to be more than entertainment, explicitly aiming to develop skills and competences in players (Deterding et al., 2011).

Finally, gamification is not the same as pervasive games, which detain one or more characteristics and expand the game dimension in space, time, and social circles, as is the case of the app "Pokemon Go" (Martins et al, in press).

The Gamification Toolbox: Dynamics, Mechanics and Components

The elements in the gamification toolbox are responsible for motivating players and should be selected according to the purpose of the system, the players and software; in order to be effective, gamification strategies should be bespoke to the specific needs of the contexts they are applied to, shunning one size fits all solutions (Martins et al, in press).

Game dynamics are the more conceptual elements of the game, responsible for attributing coherence and standards to the gaming experience: they structure the gamification strategy conceptually. Game dynamics include emotions (e.g., joy or surprise), narrative/story/theme of the game, progression, relationships and game restrictions (Werbach & Hunter, 2012).

Less abstract than dynamics, game mechanics can be compared to verbs in gamification, because they decide what players are doing in each moment (e.g., compete, reward, cooperate); they determine not only the participants to be involved in each step but also how they interact in a gamified system (Robson et al., 2015). Mechanics include challenge, luck, competition, cooperation, feedback, acquisition of resources, rewards, transactions (e.g., buying or exchanging things among players), player turnover, and the feeling of winning (Werbach & Hunter, 2012). Although mechanics build the experience of gamification, since they remain constant and control the course of player action (Robson et al., 2015), by themselves they are not enough to produce the sought after behaviors: they must be aligned with game dynamics and components (Bunchball, 2010).

Components are the more superficial, yet visible elements of a game. They are how higher-level actions are executed and they derive from both game dynamics and game mechanics. They include avatars, virtual goods, artifacts, final fights, collections, conquests, social graphs, quests, levels, gifts, teams, points, badges, and leaderboards (Werbach & Hunter, 2012). Werbach and Hunter (2012) call points, badges and leaderboards the PBL triad and they are an extremely used group of elements in all types of games and gamification strategies.

Points aim at incentivizing users to complete certain actions in a game and especially impact more competitive and focused players (Werbach & Hunter, 2012). Badges represent visually the conquests and achievements and can be attributed spontaneously to upturn player motivation and engagement (Werbach & Hunter, 2012; Zichermann & Cunningham, 2011). Leaderboards allow for the intuitive comparison and interpretation of several players performance simultaneously (Zichermann & Cunningham, 2011). When compared to points and badges they are a more direct element that publicly states each player's progression, but it's application should be cautious to not compromise player experience by generating exacerbated competitiveness (Werbach & Hunter, 2012), and also because not all players enjoy this type of game element (Jia, Liu, Yu, & Voida, 2017).

In sum, components are the pieces of the gamification puzzle, per say: they are the elements that execute the mechanics which in turn embody the dynamics of the game. When designing a gamified or game based approach, the game master would be wise to start with the goals of the game (e.g. lose weight, stop a bad habit, take the medication on time, etc.), then create a game dynamic strategy (e.g. Nike released an app where the user would pretend to be evading zombies to motivate him or her to run: the zombie attack narrative would be the dynamic here). Game mechanics would refer to how the dynamic comes to fruition in terms of interaction with the game and other players (in the previous example, are other players zombies [competing] or allies [collaborating]?) and finally components are what materializes these elements (how are points attributed? How do you know if you "survived"? Are there quests within the game? Are there Easter Eggs?).

Aside from these considerations regarding the goals and available tools, the gamification/ game-baed approach designer would do well to consider the target of the game and bear in mind what type of players they will be catering to.

The Gamification Customer: Gamer Types

Players are at the core of gamification and as such, the effectiveness of any gamified system depends on a profound knowledge of its target audience (Zichermann & Cunningham, 2011). Every player thinks, acts, and interacts in a particular fashion in the game and everyone has their specific distinctive reasons to play, adding to the fact that every game should be disputed with its own purpose (Yee, 2006).

There are many player typologies, but the most popular to date is Bartle's (1996) achievers, explorers, socializers, and killers. A well designed game will contemplate these four types in a sort of balanced ecosystem, which is key for capturing as many players as possible (Yee, 2006; Martins et al, in press).

Achievers are most interested in acting in the game world: they play to win, establishing goals and committing fully until they achieve them. Explorers prefer to *inter*act with the game world; they like to be surprised by the game and have fun exploring it. The joy of finding things out is their main motivation. Socializers represent most players, circa 80% of the overall population (Vianna, Vianna, Medina, & Tanaka, 2013). The main motivation for this type of player is the social interaction that happens in the game. The more collaborating players strongly believe that they can achieve higher and better accomplishments with the synergies they establish. Although socializers can be the least competitive players, they are equally active and ambitious (Vianna et al., 2013). Finally, killers have the most aggressive posture and like to interact with other players as to overpower them and create more difficulties and stress through the game tools and elements (Bartle, 1996).

Other taxonomies have been developed that could be referenced but considering that we are here connecting gamification with learning, we'll simply mention Heeter (2008) and Quick and colleagues' (2012) taxonomies.

Quick, Atkinson and Lin (2012) performed a cluster analysis of personality characteristics with 21 aspects of game play which revealed six types of player: (1) Dutiful Companion, (2) Extroverted Fidelitist Companion, (3) Introverted Fidelitist Explorer, (4) Conscientious Companion, (5) Introverted Challenger, Seeking Fidelitist, and (6) Calm Challenge-Seeking Companion. This analysis overcame the limitations of analyzing isolated individual aspects of game mechanics.

Heeler (2008) on the other hand, established four game playing types: (1) Achiever (high scores, fast times), (2) Lost (low scores, slow times), (3) Explorer (high scores, slow times), and (4) Careless (low scores, fast times). This taxonomy relates to intrinsic motivation for education and requires further testing regarding game play fun or enjoyment (Heeler, 2008).

When creating a game, it is fundamental to consider different gamer typologies as to maximize the involvement of the target audience; this means that the choice for game elements itself should be strategic to enable the achievement of healthcare goals without being detrimental to gamer motivations (Xi & Hamari, 2019).). Individual differences in personality and game play provide a potentially important perspective for understanding who experiences what kinds of fun, and perhaps tailoring game design features to characteristics of the player to maximize their experience of fun (Mellecker et al, 2013).

In sum, considering gamer typologies allows for game design to strategically focus on gamification outcomes without overlooking player involvement, enjoyment, and fun – key aspects to keep subjects playing the game and motivated for the task.

MAIN FOCUS OF THE CHAPTER

The Gamification X Factor: The Elements of fun, Play, Enjoyment, and Gamefulness

Mellecker and colleagues (2013, pp. 142) remind us: "ostensibly games are played for fun or enjoyment". Games have a spontaneous quality, a potential for joy and flow, and are characterized by intrinsic motivation (Stetina et al, 2012). Werbach (2004) proposes that gamification, as a process of making activities more similar to games, should include both game elements referenced in the previous sections of this chapter as well as the holistic experience of playing a game, usually referred to as *gamefulness* (McGonigal, 2011).

Fun has not been a common topic in behavioral theory (Mellecker et al, 2013), but it is important to keep in mind that games hare inexorably connected to the concepts of play and fun. This means that, although gamification is composed of a series of explicit rule bound systems where players interact in an artificial conflict to reach quantifiable results (Huizinga, 2000) to really achieve gamification/game-based approach goals the attitude of play and playfulness must be contemplated (Nicholson, 2015).

The power of playfulness is well known across the healthcare interventions research. For instance Stetina and colleagues (2012) refer that playfulness in psychological intervention can dramatically increase insight processes in patients (e.g., modeling problematic situations with the help of plasticine, building blocks, paper and felt pens) and that this characteristic also keeps players motivated to engage in gamified approaches, for example, to exercise and lose weight. Playfulness which can be construed as an intrinsically motivating game characteristic can be instrumental in creating a lasting therapeutic alliance with the patient, empowering, engaging and encouraging therapeutic adherence, even in pediatric settings (e.g. pediatric incontinence) (Richards & Caldwell, 2016).

Literature has been indicating that games enable the release of dopamine in individuals (Koepp et al., 1998), and make the experience more pleasurable. This leads to the assumption that games are perceived as fun and played continuously only for the pleasure they provide and translate an increased intrinsic motivation. Thus, the fact that games are so pervasive in our society due to the convergence of social, economic, cultural, and technological factors gives gamification an auspicious perspective in the power it may have to motivate individuals. Societies have been shifting focus from survival and effectiveness to a more hedonistic one, in which motivations seem to stem mostly from the pleasure provided by the experiences themselves (Schell, 2008).

Research indicates that fun or enjoyment in games has psychosocial, physiological, and embodiment dimensions (Mellecker, 2013) and different types of people may experience different game design features and mechanics as fun. For example, extroversion (a personality trait) seems to be related to experiences of videogame ecstatic and sociability fun, agreeableness is associated with experiences of sociability and lower experiences of sensual fun, openness was linked to achievement fun (McManus & Furnham, 2010).

Lazzaro (2004) refers that a motivating game offers at least three out of the four following types of fun: 1) hard fun – fun associated with problem-solving and overcoming obstacles; 2) easy fun – fun related to game exploration, more casual and joyful; 3) people fun – associated with socializing and teamwork and 4) serious fun – related to achieving something significant for the community.

The different types of fun are not only responsible for the neurochemical activation of players (Werbach & Hunter, 2012), they are also important in diluting the "imposed fun" factor and increasing engagement (Mollick & Rothbard, 2014). Gamification should be developed in such a way that it attracts the interest of players in the short and long run and ensures that there is a balance between player skills and game challenges in all moments of the process, enabling the emergence of flow experiences (Csikszentmihalyi, 1990).

The experience of flow is another approach to the element of fun and playfulness in games (Koster, 2005). Flow is highly associated with positive mental status, including enjoyment (Csikszentmihalyi, 1990) and it happens when a game incentivizes gameplay and exploration on the behalf of a player through the setting of goals that are perceived as challenging but not unattainable. Flow may even be defined as an equilibrium between the challenge and the competencies/skills of a player to meet said challenge, where the challenge is only slightly over skills, and the gap is perceived as being easily to overcome. Flow is a positive state of mind and is translated as the total immersion in activities and can even be accompanied by the loss of track of time and forgoing basic needs like sleeping or eating (Csikszentmihalyi, 1990).

For players achieve this psychological state, goals must be perceived as non-trivial but achievable, that players must be motivated to pursue these goals under arbitrary and externally imposed restrictions and believe that game actions are voluntary under those restrictions (Landers et al., 2018).

Self Determination Theory (Ryan & Deci, 2000), which emphasizes motivation to perform a behavior, has been used to identify the psychosocial characteristics for enjoying videogame play (Mellecker et al, 2008). Intrinsic motivation is the ultimate motivation in Self Determination Theory, and the enjoyment derived from doing the behavior is a defining characteristic of intrinsic motivation (Ryan & Deci, 2000).

It is thus clear that gamification can access both extrinsic and intrinsic motivation processes. Extrinsically motivating game mechanics are added via the token economy (Richards & Caldwell, 2016). Extrinsic rewards can be a prize or benefit explicitly given as a consequence of players doing what game designers intended; intrinsic rewards come from the players' will to win and succeed in the game (whatever that may be for each player) as well as the fun (whatever type) involved in playing the game.

The experience of enjoyment in playing a game has been detailed as a result from player perceptions, namely autonomy (making in-game choices), competence (being good at playing the game), and relatedness (relating to significant others or to personal values) (Ryan, Rigby & Przybylski, 2006). Further, Klimmt, Hartman and Frey (2006) found that personal characteristics of players (namely effectance, a mix between the concepts of self-efficacy and outcome efficacy) and not situational characteristics (specifically control), were the primary determinant of game enjoyment.

The fun, enjoyment, playfulness and gamefulness of a gamification strategy is extremely relevant because it is the key to keep players interacting with the game despite a lack of immediate health results, or even in the event of boring, frustrating, or painful tasks required. The longer a player is engaged, the more likely a game will be a hit; commercial of the shelf (COTS) videogames, for example, strive for many hours of initial gameplay followed by long-term re-playability (returning to a game after completion for more experiences) (Buday, 2012). During an exercise game (exergame), for example, play should enhance the intensity and duration of physical activity, and thereby the health benefits associated with this intervention (Mellecker et al, 2013).

Boring games happen when you are focused on the outcomes as opposed to the experience of play (Mellecker et al, 2013). From the Design, Play, Experience framework, enjoyment or fun is the experience of game design features (Mellecker et al, 2013) and is therefore impossible to dissociate from gamification. With this in mind it is extremely important that when designing a gamification strategy for health, health outcomes are considered and used as goals, but that the game proposes activities that captivate the user as a priority; it is preferable to have less ambitious health outcomes and motivated, involved players than to have perfect health outcomes for a game that does not captivate users.

The general attributes of playing a game involve spontaneity, intrinsic motivation, defined levels of active engagement and distinction from any other behavior with a make-believe quality (Stetina et al, 2012). Mellecker and colleagues (2013) refer that fun and/or enjoyment in games are inherently laden with psychosocial, physiological, and embodiment aspects and that research is needed to integrate these levels of experience and to identify the game mechanics that enhance, and even maximize, the fun or enjoyment experienced, to consequently increase the potential health benefit.

How Have Games Been Used in the Health Context: A Panoramic View of the Field

Preventing diseases through a healthy lifestyle, supporting autonomy in the management of treatments, and creating public awareness are increasingly being carried out using new technologies (Alahäivälä & Oinas-Kukkonen, 2016).

The urge for “health games” research since 2008 can be attributed to advancements in gaming technology (e.g., Microsoft Kinect® or Nintendo Wii®), the use of smartphones (bringing forth mHealth apps such as Fitbit and Runtastic) as well as the establishment of special conferences (e.g. “Games for Health Conference”) (Stetina, 2012).

Smartphone use has increased rapidly in recent years in developed and developing countries: there were over 2 billion smartphone users globally in 2016 (Edwards et al, 2016). Digital games have become very popular not only for adolescents, but for adults and elder people too, composing a 25-billion-dollar industry (Stetina, 2012).

Game-based approaches for health and gamification among them are therefore at the center of this constellation of cultural, behavioral, and technological factors. Health behavior change is one of the most prominent areas of action, and physical activity intervention systems specifically have proven to be a viable application domain (Alahäivälä & Oinas-Kukkonen, 2016)). There are over 100000 health applications (apps) available worldwide for smartphones with exercise, diet and weight management apps being the most popular downloads (Edwards et al, 2016). A systematic review of literature conducted by Kharrazi and colleagues (2012) indicted that notable clinical/health domains attracting most of the health game studies included physical activity (27.1%), nutrition (10.3%), stroke (9.7%), balance (5.8%), cerebral palsy rehabilitation (5.2%), and pain distraction (5.2%).

Many of the gamified applications are designed to support individuals in adopting good health behaviors via positive reinforcing experiences with good results in different areas such as physical activity, diet and weight loss, hygiene, healthy working habits, and medical treatment; the use of an app provides a contingent feedback for situations in which outcomes may not be immediate (Alahäivälä & Oinas-Kukkonen, 2016)).

Although it is acknowledged that eHealth and mHealth interventions have the potential to significantly improve the quality and safety of healthcare processes and outcomes (Richards & Caldwell, 2016), unfortunately, so far only a few games for health have undergone a scientific evaluation to validate their effectiveness (Stetina et al., 2012).

Despite a rapid increase in the use of gamification in the commercial and education sectors, smartphone applications using gamification for promoting health are currently limited (Edwards et al, 2016).

There is a certain trend in the last years on the outcomes of exercise and rehabilitation games and the games concentrate on physical activity and nutrition, focusing on exercise and fitness. (Edwards et al, 2016). Literature suggests however suggests, that with the appropriate design and use, digital games have the potential to be very effective psychotherapeutic tools (Stetina et al, 2012).

The use of videogame consoles as an analgesic treatment alternative has also been studied, as is the case of burn patients who reported with better performance in physical tasks and recovery after a game treatment, as well as higher levels of motivation and faster increase in functional mobility (Yohannan, Kwon & Yurt, 2010).

Older people can benefit from digital games as well. Games have a positive impact on their health condition and improve the capability to carry on everyday life activities. The key factors of interest in games for health are challenge, socialization, escape from a daily routine, and (we cannot stress this enough) fun (Stetina et al., 2012).

Yet, there is little evidence that public health practitioners and users participate in the design of health apps and surprisingly or not, most apps do not contain theoretically consistent behavior change techniques or have had their effectiveness formally assessed, leading to concerns about lack of benefit or even potentially harmful apps (Edwards et al, 2016).

In the following section, we discuss positive effects of games for health as well as negative aspects, including ethical concerns in this area. It is highly important to consider negative side effects, such as excessive gaming behavior as well as social isolation before activating gamified healthcare interventions (Stetina et al., 2012).

Advantages and Success Stories vs Disadvantages and Ethical Concerns

Although research generally indicates positive results with gamified systems, there is plenty of work yet to be done in assessing the effectiveness of strategies for evidence based practice, considering most results refer to the aforementioned PBL triad (Koivisto & Hamari, 2019).

Gamification seems to be an adequate strategy to attract, develop and retain players from Gen Y (millennials) and Gen Z (Narayaan, 2014; Trees, 2015), due to its interest and proximity to games.

Playing a game for health means change in the sense of self-actualization as well as in the sense of treating disorders with many additional possibilities that real life cannot offer (Stetina, 2012).

Edwards and colleagues (2016) found that self-regulatory behavior change techniques were most commonly used (feedback and monitoring including self-monitoring of behavior) in games for health but also in non-gamified apps targeting physical activity, healthy eating and alcohol reduction which is understandable since the effectiveness of these techniques in achieving behavior change is supported by findings from a wide range of studies. Edwards and colleagues (2016) found that frequently used behavior change techniques were comparison of behavior and reward, and threat but also social support, nonspecific incentive and reward and focus on past success. The same authors proposed that although these are effective techniques, the decision to use some of the strategies might be driven mostly by the ease of implementation in smartphone games with an internet connection (e.g. sharing activity on social media) (Edwards et al, 2016).

Further, smartphone-based intervention could provide a potentially cost-effective platform for health promotion and, thus, could have a substantial public health impact (Edwards et al, 2016).

Although fashionable and full of potential, gamification has been strongly criticized on two fronts: 1) it's not engaging enough and 2) it is too engaging and even addictive.

On the first front, Bunchball (2010) calls out most gamification strategies as "pointification" due to the simple attribution of points to tasks and other superficial elements that – as previously discussed is not enough to develop an effective gamification strategy. The pointification of a system is arguably no different than other previous approaches such as behaviorism, remaking that although these game elements are great tools for communicating and regarding player progress, they do nothing for creating value and meaning in the experience, not to mention that the excessive use of rewards may backfire and diminish player motivation (Bunchball, 2010; Koivisto & Hamari, 2019).

The gamification approach may not be suitable for everyone, as each person's characteristics may affect the outcomes of different gamification types, which needs to be taken into consideration (Alahäivälä & Oinas-Kukkonen, 2016).

On the second front, ethical concerns have been raised claiming that there can be a fine line between addicted and engaged players (Stetina et al., 2012), in the sense that creating a gamified experience to deal with an issue might be contributing to create a different one (i.e. gaming addiction); further, regulations and deontological guidelines concerning health data and healthcare professionals conduct in digital settings is still scarce.

Regarding the gaming addiction argument, several definitions, criteria and descriptive symptoms make it very difficult to characterize the maladaptive behavior of problematic computer gaming (Stetina et al., 2012). However, the International Classification of Diseases recognized a gaming disorder, i.e., a behavioral (non-substance-related) addiction (ICD-11; WHO, 2018). For gaming disorder to be diagnosed, the behavior pattern must be seriously compromised and result in significant impairment in several areas of functioning, including personal, family, social, educational, occupational; further, it would normally have been present for at least 12 months (WHO, 2018).

Some authors suggested that the elements such as mood change, tolerance and cognitive (and not behavioral!) preoccupation should be explained better by using the term "highly engaged gamers", because the players show merely symptoms according to a high level of interest in the given activities. Therefore, it makes sense to distinguish between an "addictive" and an "engaged" behavior (Charlton & Danforth, 2004). There are significant differences between highly engaged players and "addicted" players, with highly engaged players often mistaken as addicted. "Addicted" players spend significantly more time playing and there are more negative consequences in their lives (resulting in poorer quality of life), in comparison to highly engaged players.

Different societies (e.g., International Society for the Study of Behavioral Addictions [ISSBA]) and international programs, such as the European Cooperation in Science and Technology (COST) Action Program, have addressed the study of behavioral addictions, which include problematic video game use (e.g., CA16207 - European Network for Problematic Usage of the Internet). Researchers have been studying these disorders, but additional research is needed, including into the phenomenology, etiology, assessment, epidemiology, brain-based biology, socio-health-economic impact, empirically validated intervention, and policy approaches (Fineberg et al., 2018).

Concerning documentation guiding/ regulating professional practices in eHealth, although they are available in some countries, a legal or normative void still exists in others. For example, guidelines have been released for on-line practice and use of digital technologies in Psychology in some countries, as the result of the work of several national and international associations and bodies (e.g., American Psychological Association, European Federation of Psychologists' Associations), but also here the information is still scarce to ensure best practices, including in ethical terms (Mendes-Santos et al, 2020).

In sum, there seems o be plenty of potential concerning gamified and game-based approaches to health education and even healthcare, including the possibility to reach effectively younger generations and to effectively change behavior in a pleasurable manner. However, gamification is not for everybody and all situations without distinction, and ethical concerns regarding game addiction and deontological guidelines regarding professional conduct should be considered when using such an approach.

SOLUTIONS AND RECOMMENDATIONS

Health Theory vs Games Practice: A Major gap That Needs to be Bridged

Interestingly the focus of research on game-based approaches and gamification has more or less neglected the developmental side of intervention strategies (Stetina et al., 2012). A major gap of theory *vs* practice, healthcare professionals *vs* game and app designers seems to exist.

A popular opinion seems to be that educators and health professionals tend to "suck the fun out" of videogames, meaning that when these professionals are put in charge of game design they tend to focus on outcomes and sacrifice the element that attracts and retains players: fun! (Buday et al., 2012).

Healthcare professionals have been mostly focusing on theoretical issues and definitions, while game designers and app developers have mostly been presenting products that can be monetized. This means that not a lot of theory has been built on how to actually transpose healthcare principles and know-how to practice and conversely, practice has been preoccupied with creating products without previous research or consultancy from health care providers and experts.

Good game design is difficult to achieve and not possible for most healthcare providers. Successful COTS game development involves well-oiled teams of creative game designers and artists working hand-in-hand with software programmers (Buday et al, 2012). Multiprofessional teams and respectful interaction in those teams are needed to create an effective intervention with the aforementioned fun aspect (Stetina et al., 2012). There are differences between game developer and researcher-led projects, but this gap must be breached in order for gamification and game-based approaches, in general, to avoid being boring and alienating players (Buday et al, 2012). The skeptics remain, and for many, the problem is not one of intent, but of execution (Buday et al, 2012). The ideal intervention design would be one were experts on gaming behavior would be acknowledged for their knowledge and skills to would enhance the development of interventions (Stetina et al., 2012) and healthcare professionals and experts would be recognized for their knowledge of illnesses and health in general, as well as the more important *de facto* changes that subjects should be making in their lifestyle, etc. This is to say that healthcare professionals should be defining priorities in terms of health behavior outcomes whereas game designers should be given the freedom to decide game strategies and negotiate the goals of the interventions. A creative's job is building entertainment value, measured by the game's ability to emotionally connect and immerse players (Buday et al., 2012).

In a game for health, the designing team, along with game creatives and coders, there should be doctors, psychologists, nurses, nutritionists, exercise specialists, occupational therapists, physical therapists, qualitative methods specialists, public health professionals, among other professionals involved (Buday et al, 2012).

Evidently games created for health purposes do not enjoy the type of budget that COTS videogames possess, and such a reality is unlikely considering the relatively low return on investment prospects of health promoting games. Considering this reality two things should be taken into consideration: 1) the economics of production and scale of delivery could potentially give smartphone apps an advantage over other health promotion interventions; similar methods of assessing cost-effectiveness could be used as for other health technologies (Edwards et al, 2016) and 2) it is unrealistic to expect a gamified approach to health to be on the same level as a COTS; thus, instead of setting the stage for direct comparisons, serious games might consider a different strategy (Buday et al., 2012).

It may also be wise to consider that different health outcomes may require long-term socio-emotional relationships with users, including trust, rapport, and therapeutic alliance, to enhance adherence to treatment as is the case of some mental health interventions; in these cases, the use of computational artifacts or other forms of relational agents may be a relevant strategy (Richards & Caldwell, 2016).

Alahäivälä and Oinas-Kukkonen (2016) identified reinforcing behaviors through positive feedback as a major gamification strategy. A lower-difficulty game that produces less feedback about failure seems to lead to greater game excitement (a proxy for game enjoyment) (Chumbley & Griffths, 2006).

Flow can be a design feature and can be reflected in the way a game is played (Mellecker et al, 2013). It is reflected in experiences of immersion in the activity and control over one's environment; flow increases intrinsic motivation and enjoyment and results from a person's increasing skill dealing with an increasingly difficult environment (Csikszentmihalyi, 1990). When considering flow, the presence of a story or narrative accompanied by the player's immersion in or transportation by the story offers appealing opportunities to promote behavior change (Baranowski et al, 2008).

From this perspective, it also is very important to match the level of difficulty of tasks with player level of skill: low skill in a high-difficulty environment leads to frustration or anxiety, and high skill in a low-difficulty environment leads to boredom (Sherry, 2004). Thus, an engrossing story in which a player is faced with challenges that surpass their skills in such a way that they can increase skills quickly enough to overcome the difficulties but not so hastily to get bored by the challenges appears to provide an important game design structure for enhancing fun or enjoyment (Mellecker et al, 2013).

For a sustainable behavioral change however, an attitude change is ultimately needed, so it is arguable that the designers of gamification interventions should target the attitudes of users more often (Alahäivälä & Oinas-Kukkonen, 2016).

Finally, it is important to consider that also point out that managers and healthcare professionals may not be familiar with the gamification approach and may deem it not credible: careful attention must be paid to concerns such as ethics, confidentiality, and personal privacy when designing gamification for healthcare (Alahäivälä & Oinas-Kukkonen, 2016).

We suggest that strengthening collaboration between app developers, behavioral scientists and public health practitioners is necessary to realize the full health benefits of this game-based approaches like gamification, which could be substantial (Edwards et al, 2016). The gamified approach does not aim at entertaining for the sake of entertainment: it has specific non-game related goals; however, those goals are very unlikely to be met if the gamified strategy is not entertaining or fun.

FUTURE RESEARCH DIRECTIONS´

Health game research has grown constantly over the past years. Despite occasional setbacks due to limited research funding, the general trend shows positive progress toward adapting new gaming technology in specialized health contexts (Kharradzi et al, 2012). On the theoretical front, at this point in gamification and game-based approaches development, there is already a lot written about what gamification is and what the best goals and strategies for attitude and behavior change are. On the practical front, there are many teams (often missing either game designers, coders, or healthcare specialists) developing game-based approaches and gamified systems for healthcare, which brings us to our first future research direction. Carrying out research on the health behavior change field should always be based on the theoretical groundwork, not just the recent trends of the software industry (Alahäivälä & Oinas-Kukkonen, 2016). It is imperative to promote cooperation and synergies between health experts and game designers for research to advance in the near future. (Kharradzi et al, 2012)

Although gamification has become a buzz word in the past few years, interventions that test gamification components for effectiveness in healthcare interventions or clinical applications are still scarce (Marston & Hall, 2016). The immense gap in the testing of such games means that thus far, both research and practice are blind to whether or not the gamification and game-based approaches this far implemented are working and what are the exact elements that make it thrive with different pathologies and populations. Research is in dire need in the area of game efficiency testing, where quantitative results and qualitative insights, for example, with focus groups are equally pertinent (Kharradzi et al, 2012).

The majority of apps seem still be focused on exercise and diet, focusing on the global obesity epidemic (WHO, 2003), but also on beauty standards and in the fact that people are living longer. This is an area that might be a good investment due to the financial return made possible by the millions in revenue generated yearly by this industry. However, there is a great deal of potential in gamification and game-based approaches for other areas such as the strengthening of upper strength for wheelchair users, people recovering from an injury or even mental health benefits which can benefit from research and investment.

In the general discussion, gamification is often dismissed as adding systemic game elements, such as points or badges, to the user interfaces of existing systems. However, gamification strategies may also be carried out using little to no technology as well as through novel or existing full-fledged games or virtual worlds (Alahäivälä & Oinas-Kukkonen, 2016). While using COTS and other such technologically enhanced games can be appealing, it is important to remark that studies indicate that solely framing an activity as a game may be as effective as implementing actual game mechanics (Liberoth, 2014). This means that these types of strategies can be implemented with little to no budget and with a multitude of technologies (digital and analogical) that should be equally studied beyond apps.

Future studies on the topic should inspect further the impacts of game elements and the game frame, as well as the differences between using "full" games and game-inspired interaction design elements (Alahäivälä & Oinas-Kukkonen, 2016).

Further, game-based approaches and gamification in the healthcare context are hardly a "one size fits all" issue, and efficiency of different strategies will most likely depend highly on context, including not only sociodemographic characteristics of the target population, but also of the type and stage of the ailment being addressed. That is, if we are dealing with preventive, clinical or palliative medicine, physical or mental disorders, games for expanding existing care or games for coping with a lack of resources, short-term or long-term interventions, focused on compliance with medication protocols, therapy, lifestyle change or others. Identifying the contextual factors is critical for designing gamification in systems that support actual user needs (Alahäivälä & Oinas-Kukkonen, 2016). Individual differences in personality and game play provide a potentially important perspective for understanding who experiences what kinds of fun, and perhaps tailoring game design features to characteristics of the player to maximize their experience of fun (Mellecker et al, 2013).

The authors propose that game-based and gamification strategies should be the focus of more systematic reviews of literature, following the Cochrane principles, in order to get a truly panoramic view of the field when trying to decide the next steps in both theory and practice.

To add to the above-described entropy there is no agreed-upon baseline, follow up period or assessment protocol for assessing the effectiveness of these strategies which can make things even more confusing (Kharradzi et al, 2012). This means that studies vary immensely on the intervention period being assessed and user-game interaction time (Kharradzi et al, 2012). Therefore, is crucial to develop guidelines and protocols and require their use in order to not only truly advance game-based and gamification strategies knowledge but also to legitimize its use, not a mere fad but as efficient, cost-effective, and adequate approaches to healthcare interventions.

CONCLUSION

Games are important because they tap into key elements of the human experience, namely engagement, enjoyment, fun, play, social interaction, learning. Gamification can be effective because it uses this important part of human nature to achieve its goals of promoting and sustaining healthy behaviors.

Gamification and game-based approaches, the use of game design and principles to non-game areas of life (e.g., work, management, training, health) is an intuitive approach that allows for the benefit of gamefulness and playfulness to pervade other areas of life. In health as in other contexts, gamification aims generically at increasing results while decreasing perceived effort, augmenting persistence, and reducing turnover and helping people cope with less than ideal situations (e.g., burn patients [Yonan, Kwon & Yurt, 2012]). Gamification strategies such as goal setting, providing feedback on performance, reinforcement, comparing progress, and social connectivity share key elements with established health behavior change techniques (Edwards et al, 2016). These have the potential to reach developing countries and vulnerable populations where healthcare resources, especially professionals are sorely missing.

While adherence is a multifaceted problem and the context will differ for each patient, gamification has the potential to improve this aspect of health interventions. Game-based approaches and gamification can help overcome health literacy barriers by improving medical knowledge, and encouraging healthy behavior; more importantly, gamification can be used to provide therapy, treatment advice, and support similar to the ones provided in the traditional clinical practice (Richards & Caldwell, 2016).

In this chapter we discussed key aspects of the game-based and gamification approach to health education and promotion, reflecting on theory and practice and offering some guidelines and considerations when designing one such intervention. This brief overview reveals that gamification and game-based approaches are extremely promising, but the fulfillment of this promise is dependent of a few key aspects, of which we focused two: the importance of not sacrificing fun, enjoyment, gamefulness and playfulness to obtain the desired healthcare outcomes (when it's not fun, it is no longer a game but a chore or assignment) and the importance of multiprofessional teams when designing these approaches, where subject matter experts (healthcare professionals) and game designers respectfully create a synergy that promotes great healthcare strategies and goal setting that has great health outcomes in an engaging entertaining fashion.

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KEY TERMS AND DEFINITIONS

eHealth: Is the use of internet technologies to deliver health content and interventions.

Enjoyment: Is the emotional benefit from being involved in a pleasurable activity.

Fun: Is the positive emotional state that derives from taking part in activities that are amusing and engaging.

Game-Based Approaches: Broad specter term that encompasses all strategies that use games as a resource for motivating and engaging users in activities that are not games *per se*. These approaches can be digitally or analogically based and include serious games, gamification and learning games, etc.

Gamefulness: Is the characteristic of an activity that imbues it with the spirit of playing a game, promoting a level of abstraction from the context the player is in and giving them focus to interact with and achieve the goals of the game with a positive emotional state. Gameful players are not filled with fear of losing the game, they are excited to achieve the goals and develop the skills they need to win the game.

Gamification: Is the use of videogames strategies, principles and elements to non-game contexts in order to gamefully promote desired and pre-established outcomes.

mHealth: Is the use of mobile devices (e.g. smartphones) to deliver health content and interventions.

Play: Is the element in an activity that allows for experimenting with reality and learning from it, without facing the harshest level of consequence; play usually elicits positive emotions and even flow; a crucial part of human development (children especially learn by playing) and experience it permits testing attitudes, behaviors and strategies because it temporarily suspends the effect of consequences, while informing subjects of what the results of their actions would be.

Playfulness: Is the characteristic of an activity that imbues it with a playful attitude, meaning that the activity can become autotelic (an end in itself) and that it produces a positive and active spectrum of emotions, such as joy and laughter but also mischief and rule-testing/breaking.

Chapter 15
Nutrify:
Promoting Nutrition Literacy Using Gamification

C. Balakrishna
Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India

Thota Ganesh
Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India

Arun Khosla
https://orcid.org/0000-0001-8571-7614
Dr. B. R. Ambedkar National Institute of Technology, Jalandhar, India

ABSTRACT

Generally, exercise and nutrition are the two ways to maintain a healthy weight. Most of the time exercise is given more importance over nutrition. However, nutrition is equally important or else it leads to malnutrition which is of major concern in many of the African and Asian countries. Through this chapter, the authors attempt to understand the reasons for lack of knowledge about nutrition and help in designing solutions using gamification to alter nutritional behavior. The chapter discusses malnutrition causes and provides an overview of recent gamified developments to promote nutrition and reduce malnutrition. Few online and offline interventions is proposed by categorizing people into adults, children, and teachers. Finally, octalysis is performed on the presented solutions to get an idea of used and unutilized coredrives/motivators and modify for better gamification experience to improve nutrition.

INTRODUCTION

The awareness to maintain healthy weight and lead a good lifestyle has been gradually increasing in recent years. Exercise and nutrition helps to keep the weight under control. Exercise increases the amount of calories burned whereas nutrition optimizes the amount of calories consumed by an individual. Improper nutrition results in malnutrition. Malnutrition is defined as lack of proper nutrition, which results

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in overweight, undernutrition, underweight, or any diet-related non communicable disease. It further results in inadequate development and many health related problems. The World Health Organisation (WHO) in its 2020 health report stated that 1.9 billion people suffer from obesity which is greater than a quarter of world population, and nearly 45% of total deaths among children below the age of 5 years in the world is due to undernutrition(WHO website, 2020). It is mostly observed in low- and middle-income countries, especially Asian and African countries. One of the major concerns of malnutrition is that the rates of childhood obesity and overweight are rising at alarming rates resulting in early type 2 diabetes. The impact of malnutrition if left unaddressed will have a huge impact on life expectancy, mortality rate and other health indices. Hence Malnutrition is one of the important issues to be addressed to reduce its impact for better development. It also improves lifestyle, increases life expectancy, health care etc for the citizens.

The causes for malnutrition can be broadly classified into biological and social factors(News Medical website, 2019). The primary reason for malnutrition in social factors is lack of food, which is highly observed among people below poverty and low income groups. People with limited knowledge and awareness about nutrition follow an unhealthy diet plan with imbalanced nutrients resulting in ailments. The main reason for malnutrition among children is due to lack of education about nutrition among parents. Sometimes even the children will not eat properly due to dislike for a food or social influence especially in school age. People who live alone like elderly, students have difficulty in eating balanced meals due to lack of cooking skills, energy or time. The biological cause for malnutrition is loss of appetite. It occurs due to existing medical illnesses like digestive problems, liver and kidney diseases, stress and other mental illnesses etc. Sometimes medications for any existing disease or ailments may interfere with the body's digestive and metabolic systems. When the amount of food taken is less than the energy demand then also it leads to malnutrition which can be observed in pregnant women.

Though the biological causes require medical treatment, the impact of social causes can be minimized. Even governments of all countries, prominent health and welfare organizations have recognized the seriousness of this issue and fighting malnutrition has been one of the primary goals of the health departments of all governments. Developing countries have progressed a lot in this front and have achieved better results but developing countries still lack behind in both resources and creating awareness. The malnutrition problem can be dealt more efficiently by the use of technological resources like Apps, introducing new initiatives and schemes etc. The effectiveness of these methods can be increased by use of concepts like Gamification for maximum reach and output. From various studies and trials which used game elements like narration, badges, vouchers etc it is evident that employing gamification in this process has provided better results and can be used as a tool to promote and encourage nutritional awareness among individuals. Octalysis is a gamification framework that helps to analyze the core drives/motivators covered and work on core drives that are partially covered (Yu-kai Chou, 2020). The chief focus was on the use of gamification to encourage healthy eating behavior and its analysis

Background Study

Before we enter into recent developments in promoting nutrition, it is essential to understand the method of approach to tackle Malnutrition. Hence a brief understanding of Gamification and game elements, Octalysis as a framework in development of gamification is provided in this section.

Gamification and Game Elements

Gamification is the application of game elements to non game scenarios to increase engagement. Game elements are features in a game which make it more appealing and interesting to play. Game Mechanics defines how the game is played and acts as a control mechanism. Some of well known game elements are points, badges, and leader boards. Popular game elements which are frequently used are

Rewards/Points/Scores: Points or scores are numerical values that show the level of completion of a task or the progress of a player in the task. Rewards are gifts that act as a token of appreciation. Points give continuous feedback and acts as motivation.

Badges: Badges represent achievements. Badges serve as goals or acts as status symbols. Earning badges motivates a player to complete faster and makes the player face the same challenge number of times in order to win all the badges. If a player earns a badge, it has a very good influence on the co-players to earn the batch.

Leader boards: Leader boards are decided on the basis of points or badges a player earns. Leader boards show the rank of a player or a team relative to other players or teams. The competitive spirit is introduced among the players by displaying the leader boards to be on the top. Leader boards can create pressure on a player and can have a positive effect which leads to better participation. According to the skill and experience of players different leader boards are maintained in present day games same.

Narrative: Narrative is the series of events in a game which form a story. Stories make the people connect with either the character or the role they are playing. Being part of a story in the form of hero or aiding the hero is a strong motivator for players.

Performance Graphs: It shows the performance of a player in a game. The main difference between leader boards and performance graphs is that the leader boards compare performance with other players where as performance graphs compare a player's performance with previous performances. Performance Graphs help the player to analyze the progress in performance which has a constructive effect to learn or train.

Time: Time as a game element can be used either in the form time limits or timer. Time limits create the rush in players to complete the level in a given time; timers on the other hand make the player wait for the next thing. This is the reason why a timer during advertisements makes the viewer wait for the next scene.

Avatars: Avatars are pictograms that visually represent a player within the game. Usually players can choose, modify or create it. The main purpose of the avatars is to make the player identify the avatar with them self and feel a sense of possession.

Chance: Chance is what makes the player feel special. Chance makes the player wait for a golden chance without losing any hopes. For example dice, card games etc based on chance or unpredictability are often addictive.

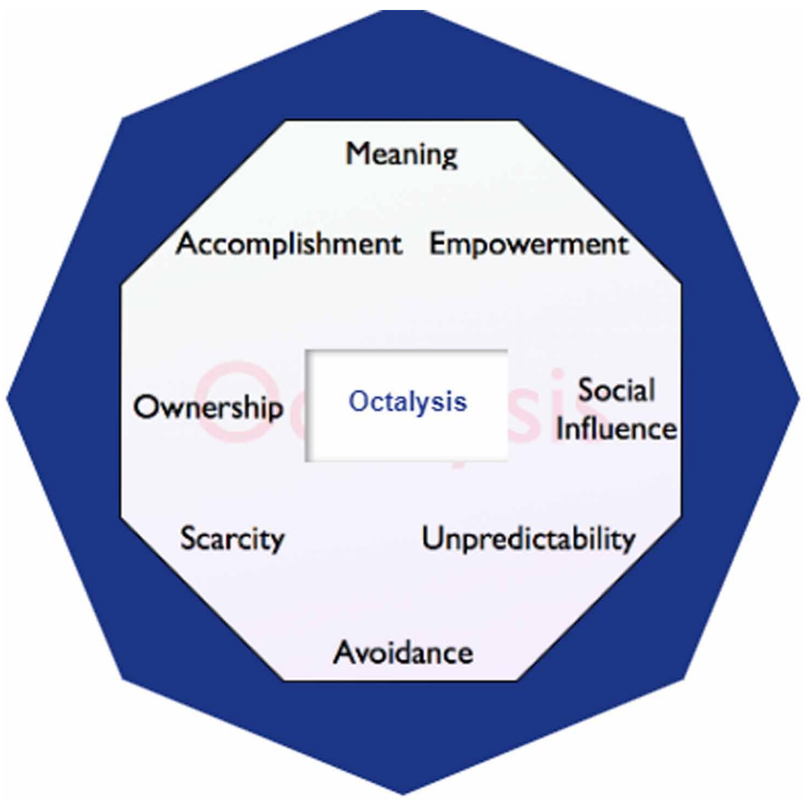
Octalysis

A framework known as Octalysis was proposed by Yu-Kai Chou (Yu-kai Chou, 2020), for Gamification. According to the framework an individual is motivated internally by any of the eight core drives in Octalysis. The eight core drives act as Motivators. The eight core drives are Meaning, Accomplishment, Empowerment, Ownership, Social influence, Unpredictability, Avoidance, Scarcity, and Ownership are represented in the form of a chart as shown in figure 1.

Meaning is the feeling of doing something great for others. For example, online forums with content contributors in websites like Wikipedia are driven by this drive. Accomplishments are achievements. These include prizes, gifts, rewards etc. Empowerment is the encouragement of creativity and doing something better. Feedback is a must for this core drive. Social influence core drive is the influence or peer pressure of people surrounding us. Ownership is sense of entitlement like avatars and virtual currency. Scarcity is something that everyone cannot have. For example, companies release limited goods to increase the craze for the goods. Unpredictability is the element of surprise as in gambling. Avoidance is to avoid something like punishment or loss of progress. The Motivators can be classified into Intrinsic and Extrinsic motivators. Intrinsic motivators motivate us to obtain internal rewards like epic calling, and Empowerment. Extrinsic motivators motivate to get a reward or avoid a punishment. Extrinsic motivation is removed once the rewards or punishments are removed. Hence Game elements which are intrinsic motivators must be used more to keep the player motivated for a longer period.

The gamified model can be assessed by giving points out of 100 for each core drive and the total score is calculated by taking the average of the all scores. A good model is a model which is covers all the core drives equally. Remember the scores are poorly subjective and vary from individual's perspective.

Figure 1. Image showing eight core drives of Octalysis



The Survey

The work began with a survey to get an overview of the nutrition awareness situation. A survey through Google forms is done to collect a broad base of information from people in the age group of 16-30. The survey got nearly 400 responses from people of various backgrounds, different places, educational qualifications, financial conditions etc. The survey conducted can be classified into the categories of attention towards nutrition, knowledge about nutrition, and preferences or eating habits. This huge base of information collected was analyzed and used to understand the problem better.

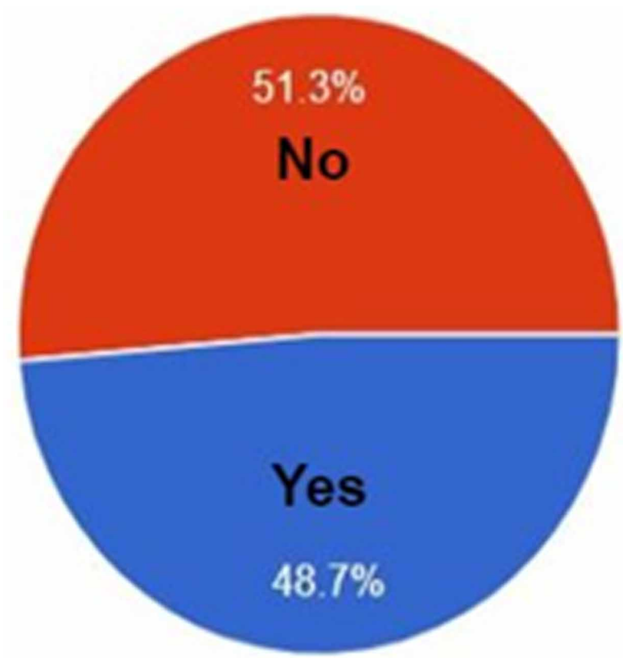
The structure of the survey is as follows: Basic information like Name, Age, Place etc are collected. Awareness based questions like Do you know how many calories to consume? Can you identify different foods with their nutritional importance? Etc were asked. Habit based questions like Do you pay as much attention to nutrition as exercise?, Do you consume required micronutrients?, Do you track your food intake?, few more questions on daily vegetable and fruit consumption, skipping a meal, preference to processed food over organic food etc were also asked. The answers to the questions were collected in the form of Yes/No or four options which are always, often, sometimes, and rarely depending on the type of question to get a brief idea.

The data from the survey of about 400 people is analyzed to get valuable insights about attention paid towards nutrition, the results show the seriousness of the issue and how important it is to promote nutrition literacy. From figure 2 only 12.6 percent of people told that they always pay attention to nutrition, 20.4 percent paid attention often but 42.9 percent paid only a few times and the rest 24.1 percent rarely.

Figure 2. Pie Chart showing percentage of people and type of attention paid towards nutrition.

71.2 percent of people are neither aware of their nutritional requirements nor could identify different foods with their nutritional importance. However, In the food habits section when asked if they consume required nutrients, nearly 52 percent told that they consume required energy and micronutrients which contrasts the previous identification capacity percentage. 85.9 percent of people answered that they don't track their calorie intake. As shown in figure 3 when asked upon if eating wholesome food is important to them nearly 51.3 percent of people responded with a no.

Figure 3. Pie chart showing percentage of people to whom eating wholesome food is important



In another question about vegetable consumption, most people told that their preference varied from vegetable to vegetable. When asked about the wastage of food, nearly 60 percent said that they waste rarely, and the rest 40 percent sometimes. Since the participants in the survey were adults, the wastage percent is less, the wastage of food by children should also be considered.

The people who participated are all educated and are in different roles like engineers, students, software employees etc. and from the results it is evident that the majority of people who are educated still lack knowledge and pay little attention towards nutrition which needs improvement. Gamification could be used as a potential solution to promote nutrition literacy and adopt healthy eating habits.

Recent Developments

Why use gamification to promote nutrition literacy? The need for gamification in this particular context can be understood by the following example. In India, the government has introduced the mid-day meals scheme in 1995 with an aim to increase school enrollment as well as to improve effectiveness of primary education by improving nutrition among children in rural areas. Though significant increase in enrollment has been observed since then, only ten percent reduction in stunting is observed in children under this scheme during 2006-2016(as cited in NDTV article, 2020) This can be attributed to wastage of food by children due to dislike for the food or due to taste, and also improper implementation of the menu in a few scenarios. This evidently shows that though several initiatives are taken by the government, the results are not satisfactory. Hence innovative solutions are required to encourage, create interest and motivate children to not waste food. Game elements introduced to situations that are often considered boring have been successful in improving the experience in a vast number of fields. There are good examples like fitness where gamification was successful to change behavior (Kawachi I., 2017). Nutritional behavior has become routine in daily life and has become boring to learn and follow. Hence Gamification can be applied to promote nutrition.

Many chronic non communicable diseases such as obesity, diabetes, and cardiovascular diseases can be avoided by changing eating habits in addition to little exercise. A review of Forty-three game-based interventions to change dietary behavior, including video or physical games and gamification was done by Chow, C. Y. et al, (2020). In most of these interventions rewards are used as a motivator. The results from the review of these various interventions show that gamification can increase children's vegetable and fruit intake, change their attitude towards food which can be used to fight malnutrition. The game elements narrative, feedback, context, progress bars and challenges can be utilized while designing tools/activities to alter food habits.

In Nigeria, the consumption of foods that are high in sugar, fat, and salt has seen a steady rise. The health related problems started appearing at a young age in Nigeria and neighboring Sub Saharan regions. A trial was conducted by Ezezika et al, (2018) using board games, offering rewards like coupons and gifts in three schools in Nigeria. The program was conducted for duration of 3 to 4 months. The students said that they are more motivated to eat healthy food, the trail changed their attitudes towards nutrition and helped to improve their eating behavior, increase physical activity, and influence parents to change their food habits.

Another study was conducted by Jones BA et al, (2014 Nov) in Utah in 2013 in which the narratives are used as the main game element to increase fruit and vegetable consumption in school children. A fictional narrative was read by teachers before the lunch break in which students have to assist the characters in the story. The fruit and vegetable consumption increased by 39% and 33%, respectively on the day of narrative. Most of the time the result returns to the pre-gamification values once the narratives are removed or the narratives become routine. Similarly in another study by Alsaleh, N & Al Nanog, R. (2020) an app that uses narrative elements was designed and developed for the behavioral change of children. The participants were divided into 2 groups. One group was shown the video and the other group wasn't shown. The eating behavior of the group which watched the video has been influenced due to the game, and increased their inclination towards eating healthy food. Such narratives can be used in future to increase the consumption or participation on particular days.

Obesity was declared as a 21st-century epidemic by the World Health Organization after reaching global proportions. 62% of the population of Spain is overweight of which twenty six percent suffer from obesity, raising the risk of cardiac related problems (as cited in WHO website, 2020) The drastic increase in numbers of people suffering with obesity is due to changes in lifestyles. In a preliminary study by del Rio et al (2018), a gamified training program with audio visual aids and physical games was developed for the age group of 8-12 to prevent childhood obesity. The result from the study stated that Learning healthy habits with the help of digital interventions has significant improvement over traditional methods.

The extensive usage of the concept of Gamification and Game elements can often be observed in digital technology like videos, apps etc. The data analysis from the gamification based digital platform to increase physical activity showed a significant increase in physical activity among families (Patel M. S. et al, 2017). The data from health applications that assist in controlling diabetes have been analyzed by studying game elements, mechanics, and themes to get an idea of frequently used game features in health based apps (Alsalman, D. et al, 2020). The main features observed are questionnaires, avatars, and the storytelling.

From the analysis of data from food challenges, quests, and apps which focus on fruits and vegetable consumption it is evident that use of digital media is easy, feasible and efficient(Azevedo J et al.,2019). The use of Social media and smart phones by youngsters is increasing rapidly. A study by Allman-Farinelli, M., Nour, M, (2020) has identified that use of social media in interventions improved the positive outcomes better than single purpose apps. Analysis of data and feedback from these social mediums by Nour M. M et al (2018), revealed that instead of a self assessment based system, use of game elements such as leader boards, progress bars, badges were more impactful.

The abilities and capacity vary from person to person. Hence tailored advice more specific to an individual is necessary to keep them motivated for a longer time. It also instills belongingness. The data analysis from two apps which use tools like dietary tracking for personalized suggestions like recipe recommendations and feedback indicated that the tailored advice leads to higher success to achieve their nutrient targets, because it is personalized (Schäfer, H., Willemsen, M. C. 2019). Artificial Intelligence which is still emerging could be used to provide tailored nutrition and fitness advice (de Moraes Lopes et al, 2020). Different technologies like Data Analysis, Artificial Intelligence, Virtual Assistants etc can also be used for providing more user specific suggestions.

Equal importance to both physical activity and nutrition is necessary for overall well being. A study has identified that combining both physical and nutritional activity not only helped in tackling obesity, but also helped in better the quality of life and suggested that future will benefit from usage of both exercise and nutrition(Casu L et al, 2020). It is evident from the literature survey that in most of the suggested guidelines gamification can be applied to make people more aware about nutrition and direct them towards healthy choices.

SOLUTIONS AND RECOMMENDATIONS

The World Health Organization has provided few guidelines to reduce malnutrition. The WHO recognizes the central role of Governments to encourage people to consume healthy foods and meals by promoting awareness about nutrition through advertisements, campaigns and programs, introducing schemes in school that encourage children to eat and stay healthy from early childhood, teaching cooking at a young age, educating adults about effects of malnutrition and healthy diet practices (Data from WHO website, 2020).

While most of the recent study to promote nutritional literacy and reduce malnutrition has been done on digital interventions, some activities that do not use any digital interventions are necessary for teaching children. In this session, few solutions with and without technological intervention are discussed that could be adopted easily to promote nutrition and combat malnutrition. The solution can be well designed and understood by categorizing the society into three main interconnected and interdependent levels based on the roles and functions of that particular group as shown in figure 4. The three levels are

Figure 4. Levels based on roles and function

1) Parents/ Individual level, 2) Children level and 3) School/Teachers level. The schemes or programme, activities and games can be designed and implemented keeping a particular level in mind by taking the help of other levels to educate and implement.

Parents/Individual Level

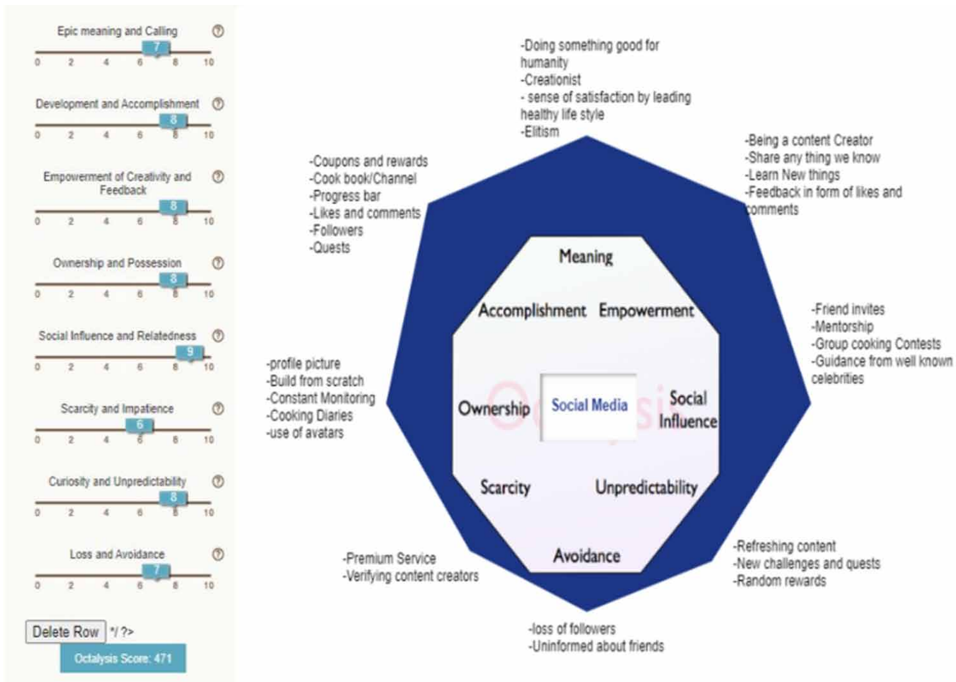
Good nutrition is important to everyone no matter what the age of the person is. In the parent level of intervention, good nutrition helps to prevent some non communicable diseases and certain chronic illnesses such as high blood pressure, cardiovascular diseases, and diabetes. Parents also play a crucial role in the food intake of children. The nutrition awareness methods designed for adults should mainly target Meaning and Empowerment drives of the Octalysis chart to maintain the habits for longer periods.

Gamification at Parents/Individual Level

The parent level of intervention can be improved by use of social media platforms, food clubs, services, educational training etc. It has been observed that Social media has a strong influence on eating habits. Social media can be used to appeal to people about nutrition through established people and organize food contests to increase the information spread to reach maximum people. Social media in its other forms like blogging and vlogging can also be used to create awareness. Having food clubs or services in small groups are also effective to educate parents about nutrition. Special programs and initiatives should be taken to educate pregnant women and women with infant children to make them aware of nutrient requirements of babies and themselves. Since the woman feels the new responsibility of taking care of the baby, it improves their consciousness in what they are eating and motivates them to eat and feed healthy food. The parents can be regularly informed about nutrition with periodic newsletters and blogs by very popular personalities.

Social Media platforms like Websites or Apps can be used extensively to create awareness among adults. A special platform can be created especially for nutrition. This platform connects individuals with doctors, nutrition experts and chefs who are well informed about nutrition. These platforms can also be used by the Schools or kindergartens to educate the parents. Individuals have the options to upload the pictures and recipes of the food and have discussion on them. Winners can be rewarded with some food

Figure 5. Octalysis Analysis of Social Media aspect in Promoting Nutrition Literacy



coupons, gym coupons. Winners can also be awarded a chance to publish their recipes in cookbooks. As shown in figure 5, Interventions with Social media aspect majorly affects the Meaning, Accomplishments, Empowerment, Social influence, ownership traits of Octalysis framework. The scarcity and avoidance core-drives are to be worked upon to balance the chart.

Children Level

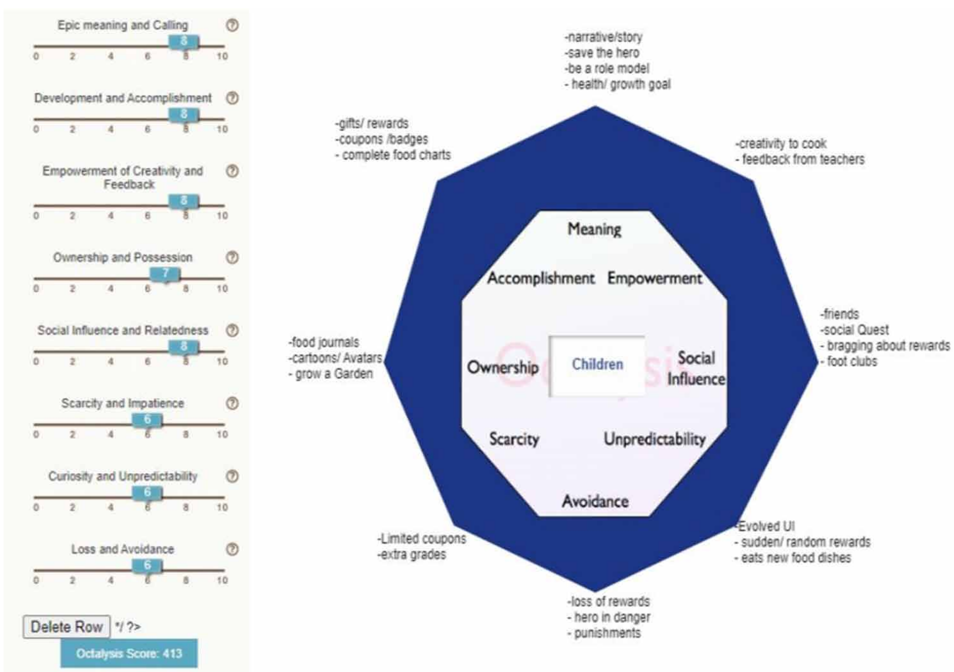
Educating children about nutrition and its benefits helps them consume wholesome food and lead a healthy life in the future. Children love to imitate what adults around them do. Their eating habits are also influenced by what their parents or role models eat. For example Spinach growers credited Popeye with a 33 percent increase in The United States according to Popeyes official website(2020). Narrative Advertisements can be used as a medium to influence children. The food industry in The United States alone spends more than five million dollars every day in advertisements and marketing. Kids on an average watch more than ten food-related ads every day (as cited in prevention institute, nd). Hence care should also be taken by what children get influenced and perceive as healthy food. Once the children are aware of good nutrition and its benefits, the children are more inclined to eat healthy food which is important for their complete nourishment. Through games children can be educated easily and quickly about the foods.

Gamification at Children Level

The children's level of intervention can be improved by food journals, Games and activities, Web quests on food and nutrition etc. Students are given a food journal to maintain in which food is divided into various categories. Students are encouraged to eat food from each category. Food journals also help in keeping track of food habits of children. Rewards are given to well maintained, updated food journals. In schemes like mid-day meals consumption of fruits and vegetables can be increased by associating some kind of narrative or activity with the food. Through this method the wastage of food can also be minimized. Several web quests could be included in the curriculum to create awareness from an early stage. Video games, Cartoons etc can also be used as tools to educate the children.

The fruits and vegetables are classified into different colors according to nutrients and the children are encouraged to eat at least one food from each color. Students are given a food journal to enter their daily covered color foods. Here a little assistance can be taken from parents to avoid false entries. Based on the entries in the food journal the students get rewards like coupons for toys or nearest theme park etc. As shown in figure 6, this activity covers the Accomplishments, Meaning, Empowerment and Social Influence core-drives of Octalysis framework.

Figure 6. Octalysis analysis of children activities



Taste test Chart: This is an offline game in which kids are encouraged to eat new foods. The kids have to eat the vegetables or fruits and note their tastes. This is a group game which can be implemented in kinder-gardens, colony meetings or any club meetings. Teachers and parents should encourage kids to take part in such games.

Gamification at Teachers Level

Teachers are the main architects of society as they play an important role in children's life. The awareness among both teacher level and children level can be created by including nutrition as a part of curriculum in education. In order to make it different and interesting from the rest of the curriculum for students it has to be gamified to make it more interesting and engaging. The role of teacher includes being self-aware, narrating stories with importance of food, educating about diversity of food(food of various cultures) and its nutrition by encouraging student to eat a diversity food, giving activities like grow your own food, conducting games and activities which promote nutrition awareness etc.,

Power Cards

These games can be played in schools where children take lunch boxes. Vegetables are divided into different categories according to the nutrition values. Cards contain food categories on one side and nutrition of those category foods on the other side. Single power card from every category makes a Set. Teachers will check lunch boxes of every student every day and will issue power cards according to the category of food they eat in the Foodland Poster. Students should carry their power cards everyday with them and teachers have to maintain a record of power cards they issue to the students. Students with more different power cards are declared as winners. Rewards can be given in the form of stickers, trophies or with additional grade points in their academic report.

Usage of Technology

With the advancement of Technology, Interactive computer-mediated communication services can be extensively used to inform and impact the public because they are easy to design, can be easily updated and customized, and can be implemented with minimum cost. The digital platform tools include applications, video games, audio visual guides, and interactive virtual assistants. They also help to keep track of daily food habits.

The Stand-alone applications can be used in education classes and in distribution to parents to promote nutrition. The online services which use the internet like newsletters through Emails, Telemedicine, Virtual assistants can be useful in increasing awareness. Techniques like Telemedicine where an individual is connected with a professional for guidance, use of virtual assistants for improving user experience, artificial intelligence to suggest foods based on recent food consumption, data analysis techniques to know the effect of medicine on foods etc are still emerging. The set of solutions are combined and provided in an app to create nutrition awareness and encourage good health. A number of games, activities, tasks etc can be updated at regular intervals to keep constant engagement of people.

CONCLUSION

Nutrition is important for proper growth and overall well being or else it leads to malnutrition. Eating has become a routine task in our daily lives. It is evident from the survey that nutrition is ignored by the majority of the population. People also lack knowledge about identifying food and its nutritional value. Attention towards nutrition is as important as physical fitness for a healthy life. The impact of social causes of malnutrition can be reduced. The social causes can be addressed by gamifying nutrition. From the literature survey it is understood that Gamification of nutrition helps to increase awareness about nutrition, change the eating behavior and reduce malnutrition. Eating is part of daily life. Hence it should not be over gamified that the participant finds it unhelpful. Previous studies have shown that Gamification of Nutrition has improved Nutrition intake in children and adults over a short term which helps in reduction of malnutrition. The problem can be addressed to different levels like parent, children, and teacher. Various emerging technologies like Artificial intelligence in giving guidance, telemedicine etc are useful to give user specific advice. Most of the research has been on digital interventions and the effects are studied over shorter periods. The future scope lies in further research and development of offline ideas. Most of the study and solutions discussed are done over a short term. The effect of gamification in nutrition over the long term is yet to be studied.

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Chapter 16
Gamification:
Improving Patient Adherence in mHealth for Diabetes Management

Diogo Machado
Instituto de Telecomunicações, Faculdade de Ciências, Universidade do Porto, Portugal

Rui Carvalho
Faculdade de Ciências, Universidade do Porto, Portugal

Pedro Brandão
Instituto de Telecomunicações, Faculdade de Ciências, Universidade do Porto, Portugal

ABSTRACT

Diabetes is a chronic disease requiring a strict management. MyDiabetes is a mobile application for type I diabetes management that, as other mHealth applications, faces the challenge of user adherence and motivation. Here the authors describe the application's redesign and the implementation of different gamification techniques to tackle these challenges. The transition to the current version of the application was made in two stages. The first addressed the redesign of the application and started implementing gamification techniques. The second stage improved some of the features and added others. After the second stage, a new survey was conducted to evaluate the implemented features and improvements. While objectives and incentives to increase the number of records were endorsed by 56.5% of users, health directed badges and objectives increased the acceptance rate to 91.3%. Long-term effectiveness of the gamification approach will be done in the future.

INTRODUCTION

Diabetes in 2019 affected 463 million people around the world (International Diabetes Federation, 2019.). It is a chronic disease characterised by high glucose levels in the blood, caused by the person's pancreas inability to produce enough or any insulin. Uncontrolled glycaemic values can have a serious negative impact on quality of life. In severe cases, it can lead to heart problems, blindness and/or amputation.

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However, when managed correctly patients can lead a normal life without complications (World Health Organization, 2016).

Proper diabetes management requires a frequent supervision of glycaemic values, as several variables can influence glycaemic values. Examples are ingestion of carbohydrates, previous insulin administrations, the practice of exercise and other diseases. This number of different parameters burdens the patient in decision moments, for example, while calculating the next insulin bolus.

The rapid evolution and spread of smartphones opened a plethora of opportunities for healthcare. This has led to Mobile health (mHealth), a concept defined as the practice of medicine and public health using mobile devices.

MyDiabetes is an Android mobile application targeted for the management of type I diabetes. This application can be used to record significant diabetes related data and contains features such as: an insulin bolus calculator, a food database and an advice system based on medical guidelines. In order to function correctly, the MyDiabetes application requires the user's input. However, in a time where most devices can interact, users see data input as an unnecessary burden. The tougher the task, the more reluctant the user will be to complete it. Adding to this obstacle, the MyDiabetes application must also motivate their users to manage their diabetes correctly.

This is where gamification techniques come into play. Gamification aims to improve the interaction between users and the application in question, for a purpose other than pure entertainment while using the motivational principles that games provide. Healthcare can be demanding on people, especially in the context of chronic diseases that require frequent management and monitoring. A common challenge for mHealth applications is to maintain user-adherence while continuously motivating users to manage their well-being. The use of gamification can serve as a tool to address both mentioned matters.

In this work, the authors propose to use gamification to motivate the user to not only input more data, but also to improve their diabetes management.

The authors in this chapter will start by discussing gamification notions and principles. This will serve to better value the literature review section. The following sections will describe the work the authors did on the gamification and usability of the MyDiabetes mobile application. The authors will continue, providing some recommendations based on the results previously described. The chapter will end with the reached conclusions and further research ahead.

BACKGROUND ON GAMIFICATION

Gamification is defined as the use of game elements and techniques in serious contexts (Johnson et al., 2016). Before elaborating on the implementation made to reach the proposed application objective using gamification, it is important to introduce the concepts that serve as basis to the work presented. This section will describe existing game elements and techniques used in gamification, player types and will serve to understand motivation and behavioural persuasion.

Game Elements as Gamification Techniques

As stated by Souza-Júnior M. et al., gaming mechanics can be used to engage and stimulate the user's desire to solve health problems, when correctly implemented (Souza Júnior et al., 2016). Werbach and Hunter (Werbach & Hunter, 2012) proposed a framework, in which they present the game elements in the form of a three-level pyramid. According to Werbach and Hunter, the informed use of these elements results in a more attractive gamified system. This pyramid, represented in Figure 1 consists of dynamics, mechanics, and components.

The **dynamics** pyramid's level is constituted by the more conceptual elements of a gamified system, which structures the game, but never enters the system directly. Its elements are the:

- **Constrains** – the game's limitations and rules;
- **Emotions** – the emotions experienced in-game such as pure enjoyment, the sense of accomplishment after completing an objective or even the unhappiness felt by losing points;
- **Narrative** – the storyline that drives the game;
- **Progression** – the developments made in-game and the user's sense of progress;
- **Relationship** – the ability to interact socially and to communicate with other users.

In the authors opinion, the mentioned concepts may be, for the most part, included in a health-related application. The only two concepts that do not seem to have a straightforward translation into mHealth are the Narrative and Relationship elements.

Narrative elements (story-driven), in the authors' point of view, do not suit mHealth unless for educational purposes. If the proposed framework targeted the application to children and young adults, this element could be a relevant resource to educate and motivate users. In an adult context, this element, in the authors' understanding, is not appropriate.

Relationship elements could be used in a positive manner for knowledge sharing and as a community support tool. However, considering the sensitivity of health-related topics, Relationship dynamics may be undesirable for many users, who prefer to maintain the health subject confidential. Moreover, some community knowledge sharing may promote misinformation. Bearing this in mind, the authors believe that Relationship elements must be evaluated with the target audience prior to their implementation.

The **mechanics** are composed by the basic processes that drive the user to act, consequently leading to involvement. Its elements are the:

- **Challenges** - goals that the user tries to complete;
- **Chance** - existence of randomness elements able to proportionate surprise, uncertainty;
- **Competition** - single or community competition;
- **Feedback** - application's ability to inform the user;
- **Cooperation** - teamwork to achieve a shared goal;
- **Resource Acquisition** - availability of collectible items;
- **Rewards** - user compensation for completing an action or goal;
- **Transactions** - possibility of player or market trades;
- **Turns** - alternating the turn of play;
- **Win States** - definition of victory either absolute or partial.

While mechanics such as turns and transactions do not have an evident role in a mHealth context, rewards, challenges, and feedback can be a major contribution for motivating users.

Johnson et al. evaluated the impact of gamification for health and well-being in their systematic review (Johnson et al., 2016). In order to verify individual contributions, Johnson et al. established a connection between the most commonly used techniques and the gamification's success. The nineteen studies evaluated referred 46 gaming elements used. Reward elements were the most common element type (35%). Five of the studies (Allam et al., 2015; Cafazzo et al., 2012; Dennis & O'Toole, 2014; Hamari & Koivisto, 2015; Riva et al., 2014) identified rewards as responsible for an increase in user engagement. One of these studies in particular showed that gamification incentives could contribute to an increase in the number of glycaemic records in adolescents with type 1 diabetes (Cafazzo et al., 2012). Although positive, one study, targeting physical activity motivation (Maher et al., 2015), verified that their reward approach was a temporary success (8 weeks). On the long-term (20 weeks), the reward system was not enough to maintain the users engaged. Although motivating, reward systems require other elements to maintain the user's motivation levels.

Two other studies (Chen & Pu, 2014; Thorsteinsen et al., 2014), related to fitness, associated an increase in user engagement and motivation to a combination of rewards with leader-board elements.

Finally, the **components** are the specific implementations of the pyramid's upper levels. This layer is at the base of the pyramid since it contains elements that are in direct contact with the users. The main elements that constitute this level are the:

- **Achievements** - defined unique objectives;
- **Avatars** - virtual user representation;
- **Badges** - visual representations of an achievement;
- **Points** - numeral representations of an achievement;
- **Levels** - stages that define in-game progress;
- **Collections** - set of accumulated items or badges;
- **Content Unlocking** - content that is unlocked when a certain goal is completed;
- **Leader-boards** - representation of user progression compared to others.

Most of the defined elements implement either mechanics or dynamics that the authors consider positive in a mHealth context.

In this list, the avatar component represents a unique representation tool whose value was not referred previously. According to Johnson et al. avatars are the second most used gamification element (Johnson et al., 2016).

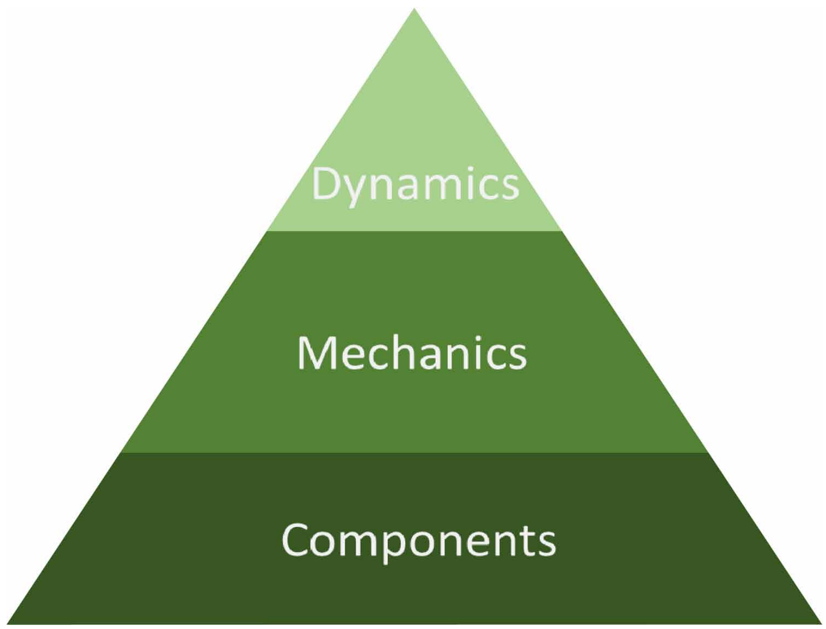
In a mHealth context, the authors believe that avatars, in the same manner as Narrative dynamics, can be useful while targeting a younger audience. In this regard, Yuan Jia et al. in their survey study, only including adults, reported that users appreciated the feedback avatars gave, but there were negative comments considering Avatars as childish (Jia et al., 2016). Nonetheless, the benefits of allowing the user to personalize the application should be taken in consideration even for older or more mature users.

The referred components, to succeed, must be implemented in a manner that satisfies the user's needs. Werbach and Hunter suggest a framework with six essential steps for a successful implementation of a gamified system:

- **Define goals** - have a set of measurable objectives with associated levels of importance;
- **Define desired behaviours** - define the actions the user is expected to have;
- **Describe the users** - know the users, understand what motivates them and understand the difficulties they will have, performing the expected behaviour;

- **Define engagement loops** - make the users learn from their mistakes, motivating them to try again;
- **Entertain** - make the game fun despite the rules, involving the user;
- **Implement the right tools** - select the appropriate mechanisms and elements to implement.

Figure 1. Pyramid of Gamification Elements adapted from Werbach and Hunter, 2012



Player Types

Every person is unique. As players, every person has personal tastes and different motivators. To be successful it is important to know the target audience and appeal to the maximum number or tastes.

Bartle R., while studying MMOGs' (massive multiplayer online games) players, analysed the different factors that motivate players (Bartle, 1996). Bartle created a framework that defines four types of players:

- **Achievers**: These players enjoy having an active role with the in-game world. They feel motivated by in-game accomplishments. The achiever player type attempts to complete every possible objective, achievement, reach the highest level available in-game and attain the top of other possible game parameters. By achieving this, the player has a certain pride in the accomplishments made and how that isolates the player from the other more casual underachiever players.
- **Explorers**: These players enjoy interacting with the world. The main motivator for these players is to uncover every in-game aspect, history, feature, and mechanic. The main pride factor for these players is their extensive and complete knowledge of the game.
- **Socializers**: These players main motivator is in-game player interaction. For these players, the game is just a way to meet people, create friendships and new bonds.

- **Killers**: These players are interested in acting directly over other players. This player type is considered the most competitive. Their main motivator is to be superior to other players and usually they thrive on the other player's in-game misery.

This player characterization describes clearly the major MMOGs population. However, when considering the general population, this method becomes inaccurate (Zichermann & Cunningham, 2011). People regularly identify not as a single player type, but, to some degree, to different types (Zichermann & Cunningham, 2011). It is even possible that throughout their life, players identify as different player types (Zichermann & Cunningham, 2011). While flawed, this system is still considered as an excellent tool to classify player types and to create player-oriented systems (Werbach & Hunter, 2012).

Selay Arkün Kocadere and Şeyma Çağlar in their case study (Arkün Kocadere & Çağlar Özhan, 2018) correlate the gamification components defined by Werbach and Hunter to the preferences of each player type. Achievements and levels were the most appreciated components. The level component had a positive effect on the killer, achiever, and explorer player types, while the achievement component had a positive effect on achiever, explorer, and socializer player types. The leader-board component had a positive effect on the killer and achiever player types. Story (Narrative dynamic) was seen as a positive element by explorers and socialisers. The remaining evaluated components (points, team, and gifting) only managed to have a positive effect each on a player type. Killer player types enjoy points, socializers appreciate both teams and gifting. Contrary to the socializers' preferences, the remaining player types are ill-affected by teams and killer and achiever player types also show aversion to gifting.

These conclusions lead the authors to believe that it is not possible to please every player type. When gamifying a system, the developers should try to maximise the positive impact of the implemented components, while minimizing the elements that have a negative impact.

The previous steps and techniques are guidelines to broadly deal with the problem of captivating the user's attention to an application. Health targeted applications do require captivating the user, but mainly strive to maintain the user's adherence. The key to achieve this goal is to understand the mechanisms that promote the user's motivation.

Motivation

The feeling of motivation transpires from the desire to achieve a certain goal. Motivation can be categorized in one of two types: **extrinsic**, when the objective is tied to external factors such as money or power; and **intrinsic**, where the user consciously completes objectives for the feeling of self-achievement and competence, without expecting any external reward.

Both motivation types, despite their differences, can be used to prompt the user to perform a desired action. The theory of self-determination supports that people are driven by: **autonomy**, the will to self-regulate and control one's goals; the sense of **competence**, the ability to deal effectively with external influences and by **relatedness**, the need of being connected (Deci & Ryan, 2008). Tasks that involve one or more of the three above referred needs tend to be intrinsically motivating, leading people to execute them autonomously without any external influence factors (Werbach & Hunter, 2012).

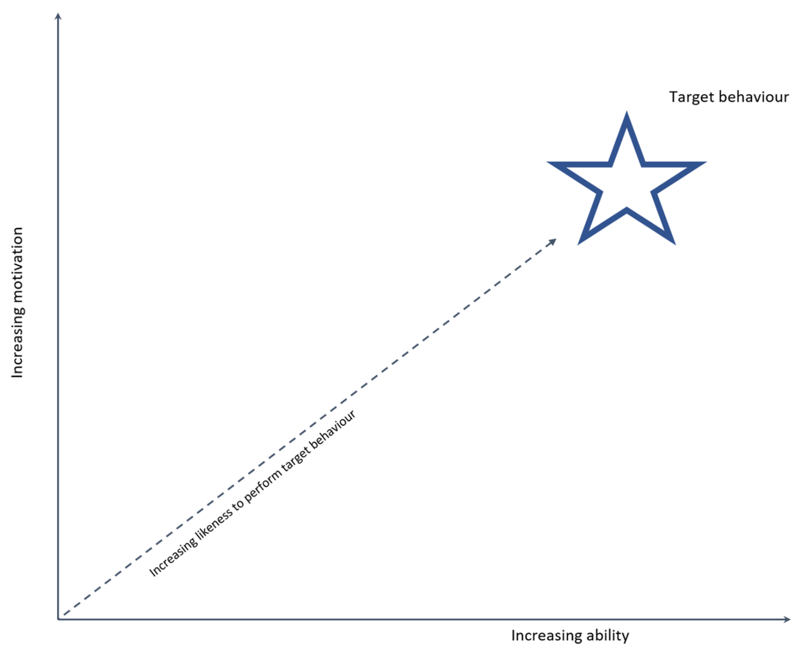
Regarding gamification, applications should implement both intrinsic and extrinsic motivation types. In addition, there should exist a bidirectional connection between the two motivational types. Achieving this, allows, for example, users to discover intrinsic motivation through extrinsic influences. Several studies refer that the implementation of extrinsic motivators in tasks where users do not feel intrinsically motivated, successfully stimulates the user to still accomplish them (Zichermann & Cunningham, 2011). Given the importance of possessing both motivational types, it is important to encounter a balance between intrinsic and extrinsic motivation (Zichermann & Cunningham, 2011).

Behavioural Persuasion

Persuasion, contrasting with motivation, is to influence someone by proof of truth or value. Defined by B.J. Fogg, persuasive technology is the study of automated behaviour change (Fogg, 2009). Although the tools necessary to create persuasive products exist, companies and even individual developers blunder to create a successful persuasive system. This fact originates from the reality that people do not understand which factors have influence in other's behaviour (Fogg, 2009).

The Fogg's Behaviour Model (FBM) represented in the Figure 2 is used in the study of human behaviour. This psychological model defines the three main factors that, when present, influence the performance of a certain behaviour: the user must be motivated, have the ability to execute the proposed action and have a trigger action that prompts the user (Fogg, 2009).

Figure 2. Fogg Behaviour Model, adapted from (Fogg, 2009)



According to this model, tasks with high complexity require a high amount of motivation. Motivation again plays a crucial role in persuading the user to execute a targeted behaviour. As motivation is a scarce asset and hard to increase, this model should be also analysed on the ability axis. The FBM model does show that low complexity tasks require low motivation, and this can be used to captivate the user. The trigger element does also have a fundamental role, as it is the element that sparks the user's attention to the targeted behaviour. According to B.J. Fogg, for a trigger to succeed it must be perceptible, be associated with the target behaviour and only happen in a situation where the motivation levels are high enough to compensate the action's complexity (Fogg, 2009).

In this work, B.J. Fogg created a framework with the objective of increasing motivation, constituted by motivators, simplicity elements and trigger types.

Elements of Motivation

As motivation is a word widely used, B.J.Fogg defined three core motivators, to specify clearly the motivation term used in the FBM:

- **Pleasure/Pain** - seen as the most basic of motivators, pleasure and pain can be used to increase motivation, but, as the author mentions, may not be the ideal approach, especially pain.
- **Hope/Fear** - this dimension is characterized by the anticipation of an outcome. Considered by the author as more powerful than pleasure/pain, this dimension is always present in one's life. An example of hope/fear would be the update of an anti-virus software, for fear of losing the device or hope that this action will solve the current issues.
- **Social Acceptance/Rejection** - Fashion and social-media are proofs of how much people in general crave social acceptance. It is possible to use this desire as motivation. An obvious example is the Facebook platform that, using this dimension, is sustained by user interactions.

Simplicity Elements

People are usually resistant to teaching and training, as this requires effort (Fogg, 2009). B.J. Fogg defined six elements of simplicity. These elements are considered by Fogg to be related to each other and when one fails, simplicity is lost. These elements are:

- **Time** - time required to complete a task;
- **Money** - monetary requirements to complete a task;
- **Physical Effort** - tasks that require the user to move or exercise;
- **Brain Cycles** - tasks that require the user to think;
- **Social Deviance** - tasks that go against usual social norms;
- **Non-Routine** - tasks that, to be accomplished, require the user to break routine.

Triggers

The trigger's objective is to alert the user to accomplish an objective. B.J. Fogg's framework defines three trigger types:

- **Spark** - triggers that should act when the user's motivation is low, but the ability is high;
- **Facilitator** - triggers that should act when the user's motivation is high, but the ability is low;
- **Signal** - triggers that serve as a reminder and should appear when both the motivation and ability is high.

The FBM's objective is to provide developers with guidelines to better understand behaviour. Neither the FBM nor the Werbach and Hunter's pyramid give indisputable answers to what is a well gamified system. Instead, they present useful mechanisms and the theory that supports these mechanisms. Understanding both frameworks allows developers to correctly implement a gamified system.

The MyDiabetes project, being a health-oriented application, requires special attention, given the sensitivity of the topic. Health management is innately related to intrinsic motivation. Gamified health applications should consider this relation as an opportunity to increase the user's motivation and consequently the user's adherence. Extrinsic motivation is a necessary, not obvious, element that can be implemented more subjectively.

LITERATURE REVIEW

In the context of diabetes, an important aspect in a mobile application, that must be addressed, is the ability to facilitate self-management. Jimenez G. et al. studied and characterized available mobile applications for diabetes self-management (Jimenez et al., 2019). This study analysed 24 mobile applications considering their medication management, blood glucose self-management, physical activity, diet and nutrition and weight management features. The most common features present in diabetes management applications were nutrition or diet management features, present in 79% of the reviewed applications and physical activity tracking present in 58%. This study's authors were not able to conclude what key features a diabetes management application should have. Other features present in the applications that the authors considered useful were statistics and data visualization (eg, charts and graphs), data sharing options, the capability to connect to a community, friends and family, health provider, expert or dietician. It is also referred that some applications contain additional monitoring functions for blood pressure, HbA1c, and cholesterol.

The MyDiabetes application is not available to the public. This application can be installed using the Google Play store, but it is only available to volunteers recruited by the project. Considering the aspects evaluated by Jimenez et al. the MyDiabetes application meets most of the evaluated features and additional functions. The only feature that is missing in the MyDiabetes application is generic medication management, not including insulin. On the other hand, the application contains a feature, not present on the study's referred applications. The MyDiabetes advice system, based on medical protocols and guidelines, can advise, and uncover possible causes for different, diabetes related, occurrences (Machado, 2015).

Within the same scope as Jimenez et al., but with a different objective, Kebede M. M. and Pischke R. C. conducted a study from March 2017 to March 2018, to identify popular diabetes applications and verify their influence in cumulative self-care (Kebede & Pischke, 2019). The cumulative self-care, according to the authors, was calculated by summing the scores given for "general diet", "specific diet", "exercise", "blood glucose testing", "foot care", and "smoking." To gather data, the authors disseminated a survey on forums and facebook groups related to diabetes management. The authors were able to gather 1854 survey responses and data on the participants' demographics, clinical and self-management characteristics, self-care behaviours and characteristics of the diabetes apps used. According to this study, the most popular applications for diabetes management are "mySugr", "Dexcom", "Freestyle Libre", and "Xdrip+". In terms of impact on diabetes management, the authors concluded that the cumulative self-care scores were higher in people that used diabetes management mobile applications.

Wu X. et al. studied the efficacy of mobile phone applications to promote lifestyle modification in diabetes (Wu et al., 2019). The authors were able to find a connection between mobile applications and lifestyle modifications for type II diabetes. This study could not prove the same correlation to type I diabetes. This work further supports the conclusions obtained by Kebede M. M. and Pischke R. C. (Kebede & Pischke, 2019), proving that mobile applications for diabetes self-management can have a positive impact in the life of diabetic patients.

Building from the premise that mobile applications can aid in diabetes self-management, this section will now focus on the subject of adherence. Although beneficial, these applications are sometimes neglected and not used (Breitenstein et al., 2017; Vaghefi & Tulu, 2019).

The use of gamification in mHealth to improve adherence and motivate the user is not novel. Although gamification is presented in theory as the link between patients and mHealth applications, it is important to assert its impact in a real-life scenario.

Johnson D. et al. in their systematic review (Johnson et al., 2016) identified 19 articles that they consider to show the effects of gamification on health. The authors state that 59% of the referred papers report a positive impact of gamification on healthcare. In the remaining 41%, gamification had mixed effects with moderate to lower evidence quality which suggests, according to Johnson D. et al., that gamification can have benefits on health and wellbeing when well applied. Their review concludes that gamification excels at targeting behavioural outcomes and has a low impact on cognitions.

Cechetti N. P. et al. proposed the implementation of a gamification method to improve the engagement in the management of hypertension using mHealth (Cechetti et al., 2019). In order to gamify the application, they implemented a score and a level system, leader-boards and achievements. Cechetti et al. state that the implemented gamification promotes intrinsic motivation and helps users to achieve successful results. They proclaim the application can promote engagement, even with users who previously neglected their treatment. It is acknowledged that users assisted by professionals demonstrated a higher interaction rate, suggesting that the user's commitment was influenced to a certain point by the health professionals.

Regarding gamification, Priesterroth L. et al. reviewed the most common gamification and behaviour change techniques present in diabetes self-management mobile applications (Priesterroth et al., 2019). The authors analysed 56 diabetes self-management applications. According to this study, the most common gamification technique is Feedback, present in 38 of the 54 reviewed applications. Given the nature of mHealth applications, to aid people self-manage their condition, it is natural for the feedback component to be broadly present. Contrary to Johnson's et al. belief, that avatars are one of the most used gamification elements in mHealth (Johnson et al., 2016), this study refers that the Avatar component is not present in any of the 56 analysed applications. This fact can either mean that diabetes self-management applications are an outlier or that the current existing mobile applications have not yet explored the benefits of this gamification component. The latter option is supported by Priesterroth L. et al. who conclude that both gamification techniques and behaviour change techniques are only scarcely used, and that these applications have still not reached their full potential. It should be noted that this Avatar component is respective to the representation of oneself in-game. The authors also mention that most of the studies related to gamification focus on relative short periods of usage time, which prevents further conclusions on gamification long-term effects.

Lastly, the authors must mention the gamification approach by the, previously mentioned, mySugr, This mobile application implemented a light level of gamification consisting of a point system, feedback and a monster cartoon avatar that gives encouragement to users. This mobile application shows after 28 weeks, user retention values measured at 70% (Rose et al., 2013). Although it is not possible to correlate the application's success to its implemented gamification elements one could argue, given the successes of similar implementations, that they do have an active role.

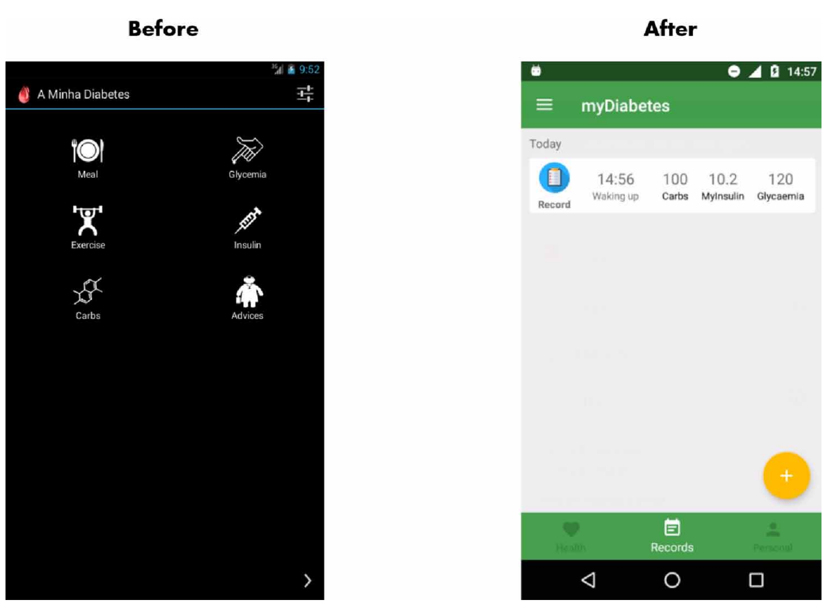
MATERIALS AND METHODS

MyDiabetes is an Android mobile application that is being developed to help type I diabetics to manage their disease. The first MyDiabetes design prioritized functionality. The application was composed of a black background with white letters, to maximize contrast. This facilitated its use by older, poor sighted diabetics. The only colour elements were the red blood drop icon and the blue lines used to separate parameters.

1st Phase

In Parra, R. (Parra, 2017), the project's first gamification phase, the application underwent a redesign to make the application more appealing. In this study, the application's colour pallet was altered, as the previous colour scheme was not considered ideal. According to (Morton, 1997), black has a physiological symbolism connected to mourning and depression. This connotation does not imply a prohibition of the use of black, rather suggests its controlled use. In consonance with this notion, the background colour was altered to green and white. Green is a colour associated with peace, health, hope, and youth (Morton, 1997) and white to innocence, newness, and cleanliness (Morton, 1997). By maintaining the font colour black, the authors maintained the contrast and lightened the application's mood.

Figure 3. User interface evolution



During this work, the first gamification elements were introduced in the MyDiabetes application. Acknowledging Werbach and Hunter's pyramid, the first considerations were which game mechanics should be applied in a health context while creating the framework's proposed dynamics. The most evident mechanics to include were challenges and rewards. As referred to in the background, motivation originates from the desire to achieve a goal, this, in the authors' opinion, makes the challenges' mechanic indispensable.

In an attempt to increase the number of user records, the implemented challenges were related to the input of new data e.g. registering 10 records of glycaemic data would earn you a logbook badge. Rewards are extrinsic motivators present in the majority, if not all, the gamified systems as a complement to the challenges' mechanic. In the MyDiabetes application, the main sources of rewards will be badges. Badges, obtained by completing objectives, function as feedback and are an incentive for users to achieve certain goals (Kapp, 2012). Users aligned with the **Achiever** player type, can feel specially compelled by this game mechanic (Zichermann & Cunningham, 2011).

Challenges and rewards can inspire emotions e.g. feeling of self, of accomplishment and sets some initial constraints in the sense that the user must fulfil an objective to receive a reward. This system does not transmit a sense of progress, besides the gradual perceptible advance in the conclusion of the objectives.

To raise the sense of progression, the application implemented points and levels. Levels and points are gamification components from the Werbach and Hunter's pyramid's base that serve as a quantifier of the user's success in the game. The authors connected these mechanics to the challenges to give points and levels a deeper value, and to introduce the content unlocking component. Completing objectives and inserting new records rewards the user with points and badges.

After reaching a certain amount of points, the user will level up and unlock harder objectives. As badges serve as an immediate reward, unlocking difficulty levels serves as a long-term motivator for the user. While developing the badge system, a concern that rose was daily motivation. The objectives set were designed to be achieved after continuous use. To promote a daily commitment, the authors created a second type of badges, called daily badges. These badges refresh every day, giving users a daily goal to strive for.

At this gamification stage, as the main goal was to maximize the number of user records, all the objectives prompted the insertion of data. Every badge is associated with a record type, and all record types have objectives associated. Different record types have different record frequencies, considering this, the objectives associated with the records have a proportional requirements e.g. while, to win a beginner exercise record badge the user has to record 3 exercises, to win a logbook badge (glycaemia, meal, insulin) the user has to do at least 10 records.

The implemented gamification system with the interactions between the implemented elements is represented in Figure 4.

The competition mechanic and the relationship dynamics were also considered at this first gamification stage. Due to the topic's sensitivity, it was decided to first survey the user's opinion and, if favourable, implement these mechanics in a future work.

In terms of interface, the previous MyDiabetes version was composed of two view panels. The main page contained a logbook access to consult previous records, and the main diabetes related record types: glycaemia, insulin, carbohydrates, and exercise. The secondary page contained other less frequent records such as other diseases, HbA1c, arterial pressure, cholesterol, weight, and medication.

Figure 4. Representation of the connection between the different game elements

In the new MyDiabetes version, the record interface was reorganized. As a means for the user to access both personal and "game" information, a new panel was introduced. At this stage, the new panel, named Personal, was designed to be primarily a summary of the user's game progression. This new page, shown on Figure 5, displays two display boxes, designated as card views. The first groups information about the user: the username, age, current level, and the current earned points together with the required cap to level up. There is also a central yellow circle with an avatar with a plus symbol, which once clicked, offers the user the option to add a profile picture. Although not essential, the ability to personalise is important for some users. Around this element, there is a progression bar that reflects the progress made and needed by the user to level up.

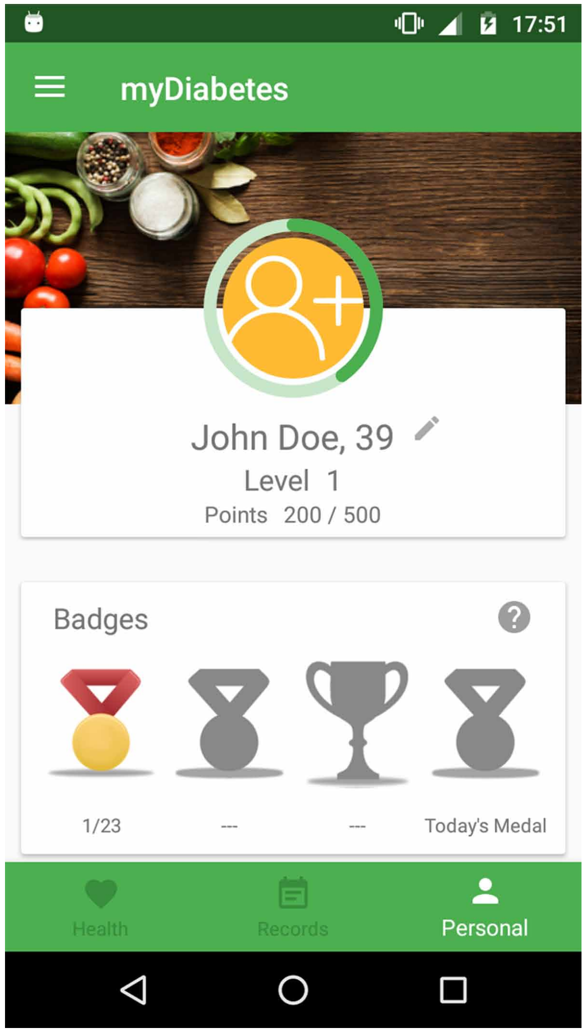
Under the first card, a second card displays a summary of the won badges. The three first badges represent the three difficulty level badges the user can win. Under these badges, there is a reference to the number of badges won, of that difficulty, and the total number of existing badges. If the medal symbol appears in grey, it means that the user did not complete any medal from the respective difficulty level. At the end of this card, the last medal represents the number of daily badges won. By clicking on this section's card, the user will open a new Android activity that displays all the existing objectives and the badges won so far. This allows users to both perceive their progress, learn about the existing objectives and how to achieve them.

With the addition of the personal panel, the MyDiabetes application now comprises three panels where the main panel is the one on the centre. This way the user can easily travel with a single swipe to adjacent, secondary panels.

The main page was redesigned to display the records made on the last seven days. This way, the user has available on the main page useful information about their current diabetes management. The main records: glycaemia, insulin and carbohydrates were grouped into a new record activity accessible by the plus symbol on the main screen. This plus symbol known as Floating Action Button, is a common element on Android and specifically google applications. The authors believe that the MyDiabetes users (Android users) will be able to recognise this element and its function by familiarity with other applications. As such, the change will be easily integrated in the application's usage.

The previous secondary page was converted into a "health" page and is now located at the left of the main page. In terms of elements, this page remained with most of the previous records. The medication record was removed since it was unused and not essential, and the exercise record was transferred to this panel. Exercise is essential for good diabetes management, despite this, it is rare for users to record their physical activity. Given their importance, but since exercise records are uncommon, the authors decided that this record option should be placed in the (secondary) health section. With this decision the authors

Figure 5. Representation of the user Profile page



are not neglecting exercise. The main page was planned to be an immediate vehicle of feedback, and the main record group is composed of the main records people with diabetes do (glycaemia, insulin and carbohydrates). As such, exercises were transferred to the health group. Nonetheless, to incentivize the record of exercises, challenges and badge rewards were created associated with them.

At the end of this first gamification phase, a small survey, composed by 14 participants, was conducted. The participants' age ranged between 21 and 54 years. Given the small sample size, this survey was illustrative, but not representative of the user's opinions.

In this survey, the authors displayed to the participants both the new design and the previous design. The new design was endorsed by 13 participants (93%), enforcing the authors' theory that a modern, lighter theme is overall more appealing.

The first elements to be evaluated were the points and levels. This system is seen as important but, by itself, not motivational. Only 9 participants (64%) admitted feeling compelled by winning points and increasing levels. 10 participants (71%) considered badges important but, when asked if they felt compelled to win badges, only 9 (64%) admitted that they did. This number decreased to 8 (57%) when asked if they felt compelled to unlock new badges. Interestingly, 7 participants (50%) thought that losing points for not achieving daily objectives was a good mechanic to be included. This idea is the most controversial, as it can serve as much as a motivator as a disincentive, but it complies with the psychology of loss and risk aversion, studied in economics (Kahneman & Tversky, 1982).

In this phase, neither the social network integration nor the competing elements were implemented. The survey was seen as an opportunity to understand the users' opinion on the matter. For the social network integration, only 2 participants (14%) liked the idea. Given the sensitivity of the topic, the majority of the participants considered their diabetes to be a personal matter and did not see a benefit in this component. Contrasting with the previous idea, 11 participants received well the idea of including an anonymous competition element.

2nd Phase

The second phase of this work by Carvalho, R. (Filipe da Costa Carvalho, 2019), started with the recruitment of volunteers to use the MyDiabetes mobile application. The recruitment process was followed by a short survey, aimed to understand the target population's needs. This process was carried for one month (two mornings per week) on the endocrinology service of the S. João's Hospital after the candidate's medical appointment. During this time, it was possible to gather 30 participants, with 17 of these accepting to test the mobile application. The survey was conducted by two interviewers who presented the study and explained to the participant the surveys terms and conditions. The participant then would be given a mobile device containing the survey. The questions were answered without any further intervention from the interviewers. The survey was composed by 9 questions:

- Do you record your diabetes related data?
- For which motive, do you record your data?
- How many records do you do daily?
- Where do you record these records?
- Which of the following applications do you use daily? [Facebook, Facebook messenger, Instagram, WhatsApp, YouTube, Gmail, others]
- Do you have games installed on your mobile device?
- Do you use any mobile application for diabetes management?
- Do you know of any mobile application for diabetes support?
- Which of the following records do you consider most important for diabetes management? [glycaemia, carbohydrates, arterial pressure, weight, insulin, medication, other diseases, stress episodes, hbA1c, exercise, reports/graphics, others]

The survey revealed that most of the participants (71%) use their glycaemic monitor devices to store their glycaemic values. Only 11% of the participants used their smartphones to store their glycaemic values.

18 participants (60%) do their daily records by medical obligation. Only 9 participants (30%) report to record their glycaemic data by their own initiative. This fact may be indicative of the lack of intrinsic motivation to do new records by the users. Therefore, it is important to introduce gamification elements that intrinsically motivate the user.

In terms of daily records, the average number was 8 records. The most common number of records was of 5 daily records (by 30% of participants). There were 3 outliers that reported to do 20 and 30 daily records. It should be noted that it is likely that these participants use continuous blood glucose monitors. These devices allow users to constantly monitor their glycaemic values without the need of glucose finger prick testing. The lowest number of records reported was of 3 daily records.

Contrary to what would be expected, 14 (83%) participants did not have games installed on their smartphone. 13 (76%) participants were not using any mobile application to help manage their diabetes.

Concerning the use of mobile applications for diabetes management, the majority of the participants (76.7%) reported to not use any. This number may be connected with the use of insulin pumps by some of the participants. These devices, nowadays, have several capabilities comparable to most mobile applications with the bonus of being able to administer insulin.

Regarding the participants' knowledge of other mobile applications for diabetes management, the most referred applications were:

- FreeStyle LibreLink
- DiabetesM
- Liapp[1]
- MyFitness Pal

The referred applications are mostly for diabetes management, similar to the MyDiabetes application. The only application that is not specifically targeted for diabetes management is MyFitnessPal. In this case the user later explained to use this application for its food database and other features to manage meals.

With regards to knowing mobile applications for diabetes management, 40% of the participants responded positively. Besides the above-mentioned mobile applications, the users also referred to Glimp and MySugr.

Finally, with regards to the record types the users find important, all the users considered glycaemia as important. Insulin and carbohydrates were also considered essential by almost all participants. Almost half of the participants referred exercise and HbA1c to be important records to have. Reports/graphics were considered important by 30% of the participants Only the disease parameter was not considered as important by any of the participants.

Focusing on Health Parameters

During the survey, while interacting with the participants, one element was mentioned as missing in the MyDiabetes application, it was feedback about glycaemic control. As discussed before, at first, the gamification objective was purely to increase and motivate new records. Given the application's nature and the needs reported by the volunteers, this focus was shifted to contain a stronger medical component. In this new gamification phase, the authors intended to increase the number of user records, by promoting better diabetes management.

This led to the development of the MyDiabetes application's widget. The widget functions as a complement to the main application. It is composed of a graphic display with the last 5 glycaemic values in the last 24 hours, information about the last record made and a quick access button to the new record activity. The widget includes two other quick access shortcuts: one on the graphic to the logbook and one on the last record information panel to the new record activity. This element does not represent any typical gamification mechanic or element, instead, this component functions as a facilitator, which, according to B.J. Fogg, will decrease the motivation needed by the user to do new records.

In the application, a new information panel was added containing a summary of the current glycaemic control. The summary is composed by the current glycaemic value average and the value's variability. These values, according to medical experts, reflect the quality of the user's diabetes management. The authors, in concordance to the expert's opinion, defined a minimum threshold of at least three glycaemic records to start calculating these values and give feedback. Although, to have accurate measurements, the system requires at least six glycaemic measures, it was decided that it is beneficial for the diabetic patients to receive feedback about the current glycaemic control. Even if not accurate, this feedback can indicate current issues that the user may have to address.

Any number of records inferior to the defined limit will not reasonably reflect the user's diabetes management. For this reason, the values will only be calculated and appear when the user surpasses the minimum requirements. When visible, the glycaemic value average and variability will have a respective colour associated. Colour is an important source of information, capable of influencing a person's mood and attitude (Singh, 2006). Enriching values with colours, allows for an easier and better interpretation of the values meaning.

The glycaemic value average has 5 possible levels: values under 54 mg/dL are considered very low and are represented as a dark red; values from 54 to 69 mg/dL are considered low and are represented as red; values from 70 to 180 mg/dL are considered to be the recommended interval, also known as time in range, and are represented as green; values from 181 to 250 mg/dL are considered as high and represented as gold yellow; finally, values above 250 mg/dL are considered very high and represented as red.

In respect to the glycaemic variability, studies determined that it should be under 37%, even if the standard is 36%. The authors decided to define three intervals, under 33% as green, values from 33 to 36% as golden yellow and above 37% as red, even if values of 36% are considered to be stable (Battelino et al., 2019; M. L. Johnson et al., 2019).

As referred previously, according to the expert doctors working with the authors, these values can only be measured with acceptable accurateness if the user does at least the recommended six glycaemic reads.

This challenge motivated us to include the streak game mechanic. Streaks are sequences of completed objectives, normally rewarded with a prize equivalent to the streak's length. In the case of MyDiabetes, the reward for a successful streak is a point multiplier equal to the streak's length. If the user never breaks the streak, the multiplier could potentially break the point system. To prevent this, but still reward the user, the authors set a multiplier limit. The user can increase their reward multiplier up to 7 by completing the given objective for seven consecutive days. Reaching this stage, the multiplier will remain at 7. To maintain the streak at its highest, the user must continue to complete the proposed objective for as long as possible, until, on a failed attempt, the streak will reset to 1. It should be noted that the penalty of falling from 7 to 1 is much smaller than if there was no streak limit. Considering an application with no streak limit, if the user, for example, breaks a 20 or higher streak, the sentiment of loss could be enough to induce the user to give up. With this mechanic, the user is motivated to do the recommended reads to obtain an accurate summary, but also to complete an objective and with it, gain points and continue the current streak.

Another mechanic considered to be valuable was competition, namely in the form of social comparison. The phenomenon of social comparison is known for its persuasive power (Hamari, 2017). When public competition is available, users tend to benchmark themselves. This action can have a persuasive role and affect the user's behaviour. Another known effect of social comparison is engagement by empathy, meaning that users are more prompt to participate in activities that other users are also involved in (Hamari, 2017). Considering this and the results from Parra, R.'s work about competition (Parra, 2017), the authors decided to implement a social comparison system. This system is optional, in order to participate, the user has willingly to open the "Community statistics". This window, represented in Figure 6, displays a summary of the user's best points and streak obtained so far (on the top) together with an anonymous community ranking containing in-game and health statistics (on the bottom). It is important to mention that two types of variables were selected: pure-play related variables (points and streaks) and health-related variables (glucose and hyperglycaemia/hypoglycaemia). This selection aimed to satisfy as many people as possible, allowing the user to compare what is more relevant to them. The comparison mechanism preserves privacy, as personal information is removed, and there is no data sharing between users.

This gamification stage is defined by a shift in focus to motivate better glycaemic control. With this in mind, three new objectives, with three different difficulty levels, were created: the user must maintain the glycaemic average under 154 mg/dL (Nathan et al., 2008); the user must have a glycaemic variability under 36% and the last objective is to keep the time-in-range (glycaemic values between the limits defined by the medical expert) above 65% (Vigersky & McMahon, 2019). The number of days required to complete the different objectives depends on the difficulty level and can range between 7 to 30 days. These badges give users a more intrinsic motivator to continue using the MyDiabetes application.

In terms of redesign, the badge's notifications contained an abstract message, and the pop-up design was not appealing. The authors have implemented four types of achievement notifications. The notification's evolution is displayed in Figure 7 where all the new notifications are represented. The authors separated the achievements notifications into health badge notification, streak notification, daily objective notification and logbook entry notification. This division was necessary as the user can win more than one badge at the same time. This way, no new achievement is omitted. All achievement notification types have different colours, which helps to distinguish and recognize the different notifications.

The authors were not yet able to conduct a full trial to correctly validate the patient-related outcome measures in concordance with the consensus report by the European Association for the Study of Diabetes (EASD) and the American Diabetes Association (ADA) Diabetes Technology Working Group (Fleming et al., 2020). To support the developed work, the authors conducted a survey in the endocrinology service of the S. João's hospital, for one month (two mornings per week), after the participant's respective medical appointment. 23 participants constituted the survey with ages ranging from 18 to 51 years old, with a mean of 30 years of age. The participants were introduced to the MyDiabetes application by two interviewers who presented the application's new features using a smartphone, and asked to evaluate each feature with a score from 1 (the worse) up to 5 (the best score). This score was then registered in a mobile app by the interviewers on another mobile device.

RESULTS

In this section the authors present the results of the latest survey that evaluates the implementation of the new gamification elements. The results' summary is represented on Table 1.

Participants, when asked if the new widget would have an impact on their diabetes management, responded positively with 12 fours and 11 fives. The participants appreciated this immediate feedback about the flow of values. They also appreciated the shortcut feature to register new values but considered it secondary.

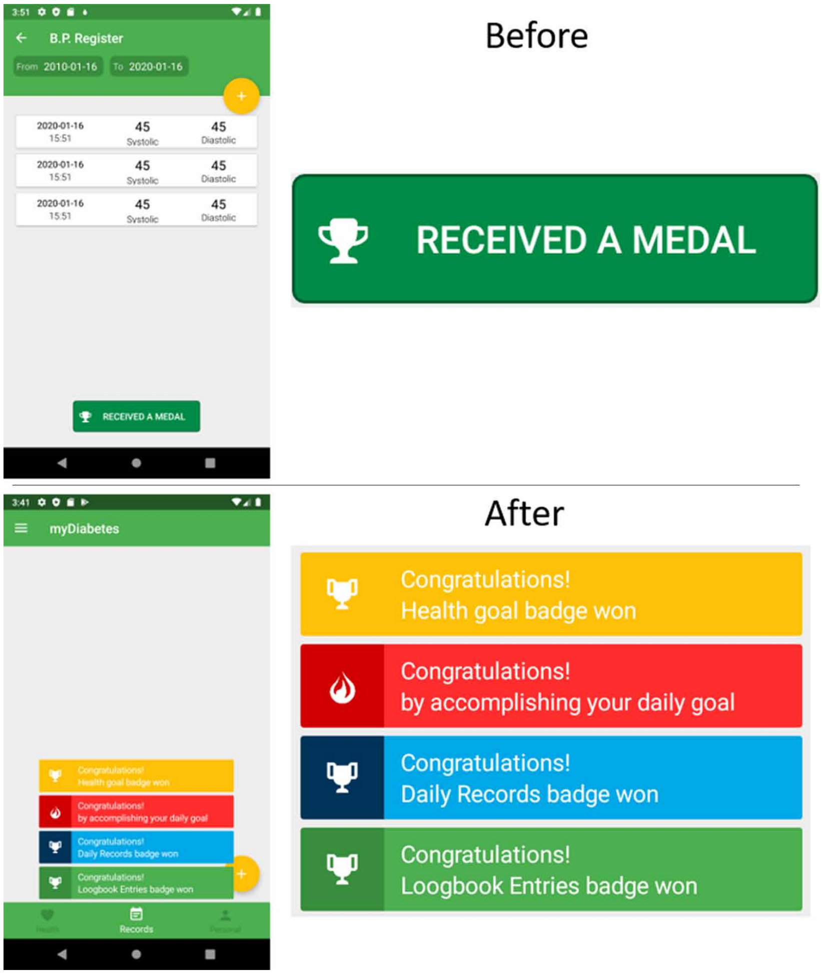
Figure 6. Community stats section

Regarding the medical feedback ("Daily Information"), 13 participants gave this feature the best possible score, 6 evaluated this feature with a four and finally 2 participants evaluated it with a three.

Focusing on the new implemented mechanics, the interviewer asked the participants to evaluate the streak of records. This mechanism divided opinions. 2 participants evaluated it with a one, affirming that this mechanic was demotivating. Other 2 participants evaluated the streaks with two, justifying that they did not consider this mechanism useful. 7 participants chose the neutral value (three). The two best scores had both 6 votes each. Considering these results, most users found this mechanic important and motivational, although a few considered it demotivating.

The next two questions addressed the Community statistics. This new competition feature, in order to rank users, contemplates both in-game points and glycaemic value quality. In these questions, participants had to evaluate the new feature's ability to motivate users to both insert more records and improve glycaemic values, in order to reach a higher in-game rank position.

Figure 7. Representation of notification's evolution (top is before and bottom is after)



In terms of motivation to register more, 4 participants responded negatively (3 ones and 1 two). 2 of these participants responded that they did not like the competition aspect of the feature. The other 2 responded that they would continue to record the same amount of records. For these participants, competition is not motivational. This apprehension to competition, in some cases, is connected to the user's diabetes management self-consciousness. 7 users voted for a neutral grade and 12 participants voted for a positive impact on motivating to record more. 4 of these 12 votes were fives.

In terms of motivation to improve glycaemic control, 3 people maintained their previous negative vote (1 one and 1 two), 4 people chose the neutral answer and 16 people answered positively (10 fours and 6 fives). This question allows us to verify that people accept more naturally a feature, even if it is disliked, when it is targeted to their well-being. As described previously, Community statistics' is "hidden and to access it the user must explicitly press its button. This caters for users that do not want this competition element.

The following two questions compare the old gamification badge implementation against the new health related badges. Once more, the survey's participants were clear to choose health as a main motivator. The record badges received 1 one, 2 twos, 7 threes, 10 fours and 3 fives. On the other end, the health badges received 1 two, 1 three, 8 fours and 13 fives. The positive levels of acceptance increased from 56.5% to 91.3%.

Lastly, considering the importance of feedback, the authors displayed the new achievement notification and asked the participants to evaluate how perceptible the notification was. The notification was considered to be perceptible by most participants (9 fours and 12 fives), but there were two users who had issues. It should be noted that 1 of these users, who gave a one score, had cataracts and, for this reason, was not able to read the notification. The other user, who voted with a three, saw the notification, but could not say what type of badge was won. This user feedback was important to reconsider colour schemes, contrast, and the animation of the achievement notifications.

Table 1. Summary of the survey's results with number or answers per choice.

		1 (dislike)	2	3 (neutral)	4	5 (likes)
User's Widget evaluation		0	0	0	12	11
User's 'Daily Information' evaluation		0	0	2	6	13
User's Streaks evaluation		2	2	7	6	6
User's 'Community Statistics' evaluation	**Motivation to record more**	3	1	7	8	4
	Motivation to improve glycaemic control	2	1	4	10	6
User's Badges evaluation	**Record**	1	2	7	10	3
	Health	0	1	1	8	13
User's Feedback evaluation		1	0	1	9	12

SOLUTIONS AND RECOMMENDATIONS

Considering the results obtained, the authors compiled a set of solutions and recommendations for the implementation of gamification in mHealth. Even though these are not strict rules one must follow to have a gamified successful implementation, developers should consider the following conclusions to understand the user's point of view and better their own systems.

Challenge and rewards are a basic, but essential combination to any gamified application. According to the Fogg's Behaviour Model (FBM), the challenges should always be within the user's ability to be successful. Activities that depend on the user's will to be achieved must have a motivational aspect, strong enough to compensate the user's efforts.

Points and levels can give the user a good sense of progress. In this work's approach, to give further depth to these components, the authors connected points and levels to another component, content unlocking. Without this association, the points and levels would feel empty and valueless, as the user would not see any benefit to gather points and increase their level. Although this association proved to be successful in this work, when implementing these components, the developers should be mindful of their application context. In certain cases, e.g. where consistency in obtaining points and levels is necessary, it may be more beneficial to associate these components to a stronger reward. Once again, the relationship between objective and reward should follow the Fogg's Behaviour Model (FBM), to be successful.

Social networks or exposition of medical conditions and/or parameters is almost unanimously not accepted by users. Privacy is a precious element for users in terms of health. The authors believe that social elements, such as competition, when related to health, must be anonymous.

The anonymous competition aspect, enforcing social comparison, although not consensual, was endorsed by most of the study's participants. Users related to the killer player type are prone to enjoy this type of mechanic. The authors believe that, once used, the social comparison phenomenon present in this feature, will motivate users to improve their glycaemic control, thus increasing the number of daily records. As an optional feature, the users are free to choose to participate or enjoy other, also relevant but more individual, game options. The users game experience should never be fully dependent on a single feature, especially if it is not consensually accepted.

The authors regard elements such as competition and cooperation to be useful when applied to health-targeted applications, albeit these elements may not please the entire user population. Similar to the Relationships mechanic, the competition mechanic should be analysed with the target population before its integration.

In terms of setting goals/objectives, the authors recommend that mHealth applications associate their goals/objectives to the health topic in question. It is possible, and even desirable to have objective variety, notwithstanding, health should always be a present topic. Recalling the author's survey conclusions, the participants were more willing to accept gamification components initially disliked, when these components were related to the health topic in question.

Overall, gamification is a tool that can help the continued use of mHealth applications. Its acceptance should be tested and developed with the feedback from users. Ultimately multicentre studies need to be undertaken to evaluate its efficacy. This type of applications, and for diabetes in particular, even if used often and correctly, are a means to help people self-manage their disease. For now, they should not be seen as a substitute for the patient's own care.

CONCLUSION

In this work, the authors discussed the MyDiabetes mobile application's gamification system that aims to increase user adherence and motivation. The component updates and new implementations were developed, having into account the valuable works referred in the background section. These studies were essential to understand better the user's motivation and behaviours. Feedback from diabetic patients and endocrinology experts was indispensable to comprehend more accurately diabetes' management and its necessities.

The feedback from the conducted survey was overall positive. Although some implemented gamification elements were not unanimously well received, the majority of participants showed clear signs of motivation to the new implemented gamification elements. The authors implemented a variety of game components and mechanics with the intention of captivating the higher number of personalities. Users are given the option to choose the gamification elements that reflect their personal taste.

Unfortunately, the authors feel that the lack of communication between the MyDiabetes application and proprietary diabetes sensor brands that diabetic patients, nowadays, commonly use, is an enormous obstacle for users.

The authors believe that no amount of gamification can compensate for the lack of features that already are part of the user's daily life. Most diabetic patients, using glycaemic continuous monitors, already use mobile devices capable of transferring the sensor's values automatically. This feature is seen as essential by most diabetic patients who already have the burden of administering insulin and finger-prick testing their glycaemic values at least six times every day. Adding the need to input manually every measured glycaemic value, insulin dose administered, carbohydrates consumed among other important diabetic related facts to these tasks is seen as an overwhelming effort.

FUTURE RESEARCH DIRECTIONS

In a future work it is important to conduct a trial with the patients using the application for a period longer than a month, to quantify the usage of the application and its improved adherence regarding past trials.

An important step would be to first integrate an automatic method of continuous glycaemic control. Given the importance of this feature for users, the authors believe that any evaluation of the application's gamification success without this element would be unfair. The inclusion of continuous glucose monitoring would allow for a neutral evaluation of the gamification techniques since the contrasting factor to other existing applications would be the gamification's quality.

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[1] Liapp is an unofficial application for reading the Libre Sensor from Abbott. It is not currently in the Google Play store, but may be found in https://apkpure.com/.

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About the Contributors

Pedro Cardoso is a Designer and an Assistant Guest Professor at the Faculty of Fine Arts of the University of Porto where he pursues studies in the contexts of Game Design, and Interaction and Experience Design. His work is focused on the study of games as instruments of communication and thought for creative work, health, education and research, in the scope of pervasive, serious, critical, and art games.

Luís Coelho has a degree and MsC in Electronics Engineering and a PhD in Signal Processing. He currently teaches signal and image processing courses. He has been involved with the coordination of the Biomedical Engineering degree and of the Healthcare Management course. He is/was involved in several national and international projects and has supervised more than 200 interships. He has also worked as a consultant in private organizations contributing with knowledge and experience in signal processing related projects. As a researcher he has published more than 60 scientific articles in conferences and journals. He actively collaborates with the scientific community as participant, reviewer, or organizer of scientific conferences. His main research interests are signal and image processing and human-computer interaction.

Venugopal D. completed PhD from Anna University. He has published papers in 17 international journals. Presented 18 conference papers in various places of the country. Published one patent and one book chapter. Got 17 years of teaching experience in engineering institutions and organized many technical programs as convener. His h index is 4 and i10 index is 3.

Karla Da Silva has a BSc in Occupational Therapy since 2012 from Alagoas Scienc of Health University, Brasil.

Liliana de Castro is a Medical Doctor, Specialist in Psychiatry, working in a specialized psychiatric Hospital in the north of Portugal (Hospital Magalhães Lemos EPE). She completed her Master in Affective Neurosciences in the University Maastricht and her PhD in Clinical Psychology in the University of Minho. She is an invited assistant professor at ICBAS, University of Porto, teaching Psychiatry to medical students. Currently collaborates in research in the field of Psychiatry and Mental Health, belonging to CINTESIS.

João Donga has a degree in Computing and Systems Engineering, a Title of Specialist in Media and Audiovisual Production is a member of Multimedia Department at School of Media Arts and Design, Polytechnic of Porto, a member of LabRP, Psychosocial Rehabilitation Laboratory affiliated with the

School of Health of the Polytechnic of Porto and the Faculty of Psychology and Education Science of the University of Porto and member of Elearning department of Polytechnic of Porto. Research interests centre on multimedia, virtual worlds, neurofeedback and elearning. At present is Pedagogic Council President at School of Media Arts and Design.

Artemisa Dores has a Ph.D. in cognitive neurosciences. Specialist in Clinical and Health Psychology, and in Neuropsychology. Professor at the Polytechnic of Porto, School of Health, and member of the Rehabilitation Research Center (ESS - P.Porto) and of the Neuropsychophysiology Laboratory (FPCEUP).

Özüm Eğilmez is currently working as an Assistant Professor in the Department of Business Management, Bilecik University, Bilecik, Turkey. She did her Ph.D. in the Department of Management and Organization, Anadolu University. She has research on Strategic Management and MCDM methods.

Andreia Geraldo has a master's degree in Clinical and Health Psychology. Specialist in Clinical and Health Psychology, with pre-specialization in neuropsychology. PhD student in the doctoral program of psychology at the Faculty of Psychology and Education Sciences of the University of Porto, focused on cognitive and affective neurosciences.

Bruno Giesteira is a Professor at the Faculty of Fine Arts, Design Department, of the University of Porto pursuing studies in Cognitive Ergonomics and Human Factors in the context of Human-Computer Interaction. With an extensive experience in managing HCI's research teams, he has been widely published contributing to a better understanding of the cognitive and sensory dimensions of the human being when mediated by interactive artifacts. Examples are the participation on various international projects in the area of health and well-being in developed and developing countries. He is the supervisor of several Human-Computer Interaction courses and director of postgraduate studies in Interaction Design and Games.

Paulo Veloso Gomes is MSc in Information Management and has an Advanced Studies Diploma in Social and Medical Sciences and Scientific Documentation. Researcher in Psychosocial Rehabilitation Laboratory affiliated with the School of Health of the Polytechnic of Porto and the Faculty of Psychology and Education Science of the University of Porto. Experienced Professor in the School of Health of the Polytechnic of Porto, with a demonstrated history of working in the higher education industry. Strong education professional skilled in Computer Science, Health Communication, Health Literacy, Virtual and Augmented Reality, Web Creation Contents, Knowledge Management, Information Management, Information Systems and Digital Media Art.

Gözde Koca is currently working as an Assistant Professor in the Department of Business Management, Bilecik University, Bilecik, Turkey. She did her Ph.D. in the Department of Econometrics, Dumlupinar University. She has research on MCDM methods.

Helena Martins is a Lecturer in Higher Education in the areas of organizational behavior, human resources management, soft skills development and research methodology. Her research has always been on the human side of work and the role of soft skills in jobs; recently she has been focusing the development of soft skills for crises events.

Ana Filipa Mesquita has a BSc in Occupational Therapy since 2014 from Polytechnic of Porto - School of Health and currently is Occupational Therapist in Lamego Hospital (CHTMAD), Portugal, with interest in physical and rehabilitation medicine.

Viviane Piçaibes is a Researcher at ID + and collaborator at CINTESIS, PhD student in Design at the University of Porto, Master in Strategic Design and Bachelor of Design from the University of Vale do Rio dos Sinos - UNISINOS / Brazil. She has experience in the areas of Strategic Design, Graphic Design, Product Design, Service Design, Social Design, Design Thinking, Game Design and Design for Health. She received the Top Citizenship 2013 (Student Category) and Top Human Being 2014 (People Management Category - Academic) of the Brazilian Association of Human Resources - ABRH, Bornancini Award 2014 (Universal Design Category).

Vanessa Solange Quental has a BSc in Gerontology since 2018 from Social Service Institute of Porto, Portugal.

Vítor J. Sá has a degree in Systems and Informatics Engineering, Master in Informatics (pre-Bologna) and PhD in Information Systems and Technologies. Teaching activity in several higher education institutions (University of Minho, Portuguese Catholic University, Polytechnic Institute of Porto and Polytechnic Institute of Viana do Castelo). Development of multimedia product launched in the Portuguese market by Porto Editora. Consulting/training in various national and international companies. Visiting Researcher at the Institute of Computer Graphics (Fraunhofer IGD) in Darmstadt - Germany, in the area of Multimodal Interaction and Ambient Intelligence. Member of the Order of Engineers, the Project Management Institute (PMI) and the European Association for Computer Graphics (Eurographics). Member of the scientific committee of several international conferences, publication of several articles, books and book chapters. Organization of international conferences such as the Eurographics Symposium on Parallel Graphics and Visualization (EGPGV 2006), the International Conference on Global Security, Safety and Sustainability (ICGS3 2010) and the International Conference on Digital and Interactive Arts (ARTECH 2019). Currently, Assistant Professor at the Portuguese Catholic University, with research activity at the ALGORITMI Center of the University of Minho. He was a member of the advisory board by the Portuguese Catholic University for Braga to UNESCO Creative City contest in the Media Arts category. Founding partner of Khnum Inovação, Lda.

Teresa Sarmento has a PhD from Faculty of Engineering, University of Porto FEUP since 2013- where she developed her thesis on Service Design and Mobile Service Experiences. She has been lecturer since 1999 as a professor and guest professor in several contexts from Design, Creativity, Human Factors or Marketing. At the moment she is PostDoc researcher at Faculty of Economics of Porto University. Currently her research work focuses on new methods for multidisciplinary thinking in service experiences, considering the important role of Design. As a research leader, she feels comfortably challenged in involving people from different backgrounds, as in the 2PH research for the Pediatric Service of Hospital Pedro Hispano In Matosinhos Portugal. Recently, she has been personally involved on projects for social innovation, exploring collaborative approaches for accessible products. Regularly participates in international conferences, such as Service Design Conferences 2009-Oslo, 2010-Berlin, 2014-Lancaster, Frontiers in Services 2011-Ohio-2014 Miami, SERVSIG 2010-Porto, 2012-Helsinki IDEMI-2015 Florianopolis, Brazil or Senses & Sensibility - 2017 Madeira, Portugal, among others.

Joana Silva is a Designer. She has a bachelor in Communication Design (ESAD – Higher School of Arts and Design, Matosinhos) and a specialization post-graduation in Interaction, Web and Game Design (FBAUP – Faculty of Fine Arts, University of Porto). She has recently concluded a research grant for designing a series of eHealth short games for rehabilitation recovery (FEUP – Faculty of Engineering, University of Porto). Now, she pursues a carrier in Interaction and Experience Design, involving games as ludic, entertaining and emergent communication tools able to bridge both analogue and digital universes, in cultural, political, health and educational fields.

Vitor Silva has a PhD in Education and Behavioral Science since 2015 and currently is Occupation Therapy professor in School of Health of the Polytechnic Institute of Porto (ESS-P. Porto), Portugal, with interest in pediatrics, youth, disability and lifestyle fields. Is also a collaborating researcher at the Psychosocial Rehabilitation Lab (LabRP) of the Center for Rehabilitation Research (CIR) of ESS-P.Porto, integrating the Recovery and Social Innovation investigation group. His main research areas include the well-being in cases of several diseases and the paper of virtual reality and technologies of support to the treatment. Has several contributions to national and international research projects.

Raquel Simões de Almeida has a PhD in Psychology, area of Human Relations, Health and Well-being (FPCE-UP). Undergraduate degree in Occupational Therapy by ESS-P.PORTO and Master's degree in Psychosocial Rehabilitation and Mental Health by FPCE-UP. Advanced training in Coaching for the development of personal and professional skills and Training in Mindfulness in health contexts. Interests: new technologies transforming healthcare - VR, AR, AI, mHealth; lifestyle redesign; active living; mental health.

Seetha V. completed her B.E in EEE from PSG college of Technology, Coimbatore and M.Tech in Applied Electronics and Ph. D in ICE from Anna University in 2015. She has teaching experience of 20 years and published various international journals and conference papers. Her research interest is Wireless Sensor and Adhoc Networks and Routing.

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