A framework for agile design of personalized gamification services

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Toluca Lake. It’s thirty minutes away. I’ll be there in ten...
(Winston Wolfe, Pulp Fiction, 1994)

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements.

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Abstract

The interest of the application of gamification techniques in different contexts has increased during the last years, becoming a promising trend in many areas such as Human-Computer Interaction (HCI) or Educational Technologies. Unfortunately, many design instances do not meet their objectives of motivation, mainly due to poor design in a "ad-hoc" manner. Findings reveal that a formal design strategy in gamification is the key to success.

This thesis presents the development and validation of a framework for the design of personalized gamification services. The framework, called FRAGGLE (FRamework for AGile Gamification of personalized Learning Experiences) is based on the use of the Agile methodologies to obtain a fast design ready for testing and being able to iterate. It is aimed to the application of different techniques all the way down to the lowest levels of abstraction through a guided step-by-step process, including a design validation process of the intrinsic motivation (SPARC).

This approach has been tested and assessed in two courses at an e-learning Bachelor in Computer Science with the aim of encouraging learners in solving non-graded formative activities and increasing their sense of kinship to the class group. A first case has revealed a moderate positive effect of the designed gamified experience on student engagement in a "one-size-fits-all" proposal, meanwhile a second case study has allowed to know the impact of each design element in the student engagement. Results in a further case study has also revealed that personalization works better regarding students' behavioral and emotional engagement than the previous cases analyzed.

Finally, the knowledge transfer has been implemented in an industry case through the design and development of Preventive Neuro Health, a gamified crowdsourcing-inspired tool for cognitive impairment prevention of healthy older adults. It has enabled a high degree of personalization both from clinical and engagement perspectives with the purpose of improving the adherence to cognitive training programs.

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Nomenclature

Acronyms / Abbreviations

6D Six steps: Werbach & Hunter's Gamification Design Framework

ANOVA Analysis Of Variance

API Application Programming Interface

BDD Behaviour-Driven Development

CDI Cisco Dharma Initiative

CN Computer Networks course

FFM Five Factor Model

FRAGGLE FRamework for AGile Gamification of Learning Experiences

HCI Human-Computer Interaction

KPI Key Performance Indicators

LMS Learning Management System

MBTI Myers-Briggs Type Indicator

MCI Mild Cognitive Impairment

MDA Mechanics Dynamics Aesthetics

MDE Mechanics Dynamics Emotions

MUD Multi User Dungeons

MVC Model View Controller

MVP Minimum Viable Product

PAT Person Artifact-Task

PEOU Perceived Ease of Use

PNH Preventive Neuro Health

PU Perceived Usefulness

RAMP Relatedness Autonomy Mastery Purpose

RE Requirements Engineering couse

SDT Self Determination Theory

SPARC Sense Purpose Autonomy Relatedness Competence

TAM Technology Acceptance Model

TDD Test-Driven Development

UCD User-Centered Design

UML Unified Modelling Language

UOC Universitat Oberta de Catalunya

User Experience User Experience

VPN Virtual Private Network

WHO World Health Organization

WOS Web Of Science

XP Extreme Programming

Chapter 1

Introduction

1.1 Overview

Difficulties in user motivation are recognized as an important concern in diverse environments. User engagement has become increasingly relevant for organizations, such as enterprises or educational institutions, to achieve their business or learning objectives. High-motivated people trigger to high-quality performances in the organizations and a better overcome of daily challenges. However, to achieve this state of engagement, many variables are involved. Large theories on incentive and motivation systems has appeared in the last century [68] with a clear purpose of answering why human needs change over time and what motivates people.

A variety of strategies to improve user motivation have been developed, from the Maslow's hierarchy of needs basis [116] or Herzberg's two factor theory [66] in the 50's to more recent theories, concerned with supporting the natural or intrinsic tendencies to behave in effective and healthy ways [162]. Thus, motivation could be affected by incentives, reinforcements, rewards, etc., ensuring that the workplace or the learning environment meets the basic needs and requirements for each person. Among the techniques to promote user motivation, those related to the use of games design elements seem to be very promising, becoming a relevant research field in the academic community during last years.

This way, the evolution of digital technologies, especially in the path from traditional games to video-games, has been relevant to the growth of user enjoyment and engagement [15]. Actually, the presence of games in our daily lives is more than an evidence in the 21st century society, with the widespread adoption of social media and mobile technologies. Nevertheless, games are universal activities, being present in all human civilizations. Accordingly, human beings have even been defined as *homo ludens*, a concept proposed by the philosopher Huizinga in 1955 [70]. Based on this premise, he inferred the concept of game as "a free activity standing quite consciously outside of ordinary life, as being not

serious, but at the same time intensely absorbing". From an anthropological viewpoint, Caillois also described the term of "Paidia" as a "an spontaneous of free improvisation, like children creating rules in real time at the backyard, uncontrollable imagination giving life to fantasy worlds using cardboard boxes". "Paidia" is the childhood essence that arises in some moments of the adult lives [19]. Moreover, he described "Ludus" as "a controlled play considering it as an activity with the following characteristics: fun, separate, uncertain, non-productive, governed by rules, and fictitious".

Taking into account the omnipresence of games and their internalization by diverse cultures and society, a new concept called "gamification" emerged, almost organically, as a way to extract characteristics from games in order to incorporate them into non-leisure environments with a motivation purpose. Nonetheless, the earliest approach of this term came from Pelling in 2002 [146] who defined it as "the application of game-like accelerated user interface design to make electronic transactions both enjoyable and fast", little far away of the clear motivational purpose. However, the concept has evolved since then, resulting in a wide breadth definitions available in the literature [111], encompassing diverse contexts [60].

Nevertheless, probably the most widespread and cited definition available in the literature came from Deterding et al. in 2011 [33], as "the use of game design elements in non-game contexts". In a disaggregated way, they broke down the term gamification to the "use (rather than the extension) of design (rather than game-based technology or other game-related practices) elements (rather than full-fledged games) characteristics of games (rather than play or playfulness) in non-game contexts (regardless of specific usage intentions contexts, media of implementation)" [33].

It is worth noting that other related techniques have arisen from games, such as "serious games", games that have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement [1]. Thus, Zyda defined them as "a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" [200]. Another related approach is "playful experience", which relies much more in the concept of "Paidia", instead of "Ludus", as an engagement method. However, beyond the goal of a pure entertainment or serious purposes, Deterding et al. made an explicit distinction of "gamified" systems from these other game-based modes of experience [33], as can be seen in Figure 1.1. Thus, it becomes relevant not to mix up these terms and the scope of the present work.

Regarding the design process of gamification, it is differently conceived, since its purpose is quite different from games. The former, is used to enhance the engagement in different contexts, whereas the latter is directed towards pure entertainment. This way, Marczewski

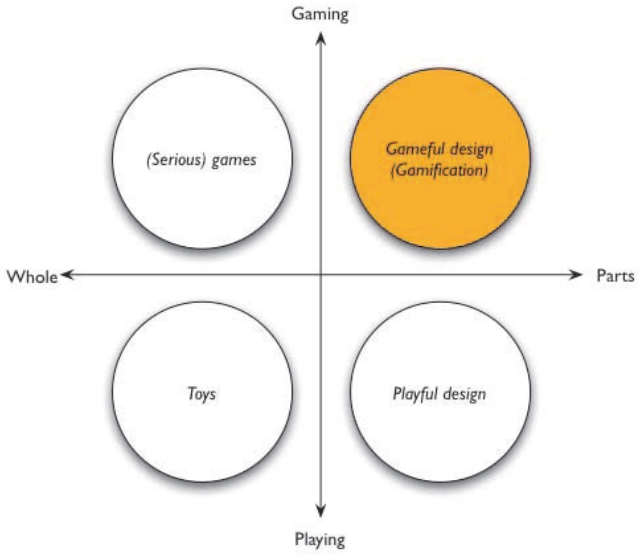

Figure 1.1 Gamification scope

made an explicit distinction between game and gamification design and its main features [113]. First, from his viewpoint, game design commonly starts on the basic idea of enjoyment, while gamification points towards a behavioural objective. Secondly, the definition of metrics or game lines should happen in different stages of the design process. Nevertheless, the basics of gamification heavily rely on the principles of game theory. Accordingly, a deep knowledge of the game design becomes essential.

Thus, deepening into the concept of games, Juul [80] made a complete definition of games based on six points: rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned to different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable. Moreover, Suits [179] deepened into the rules perceiving playing a game as to engage in an activity directed towards bringing about a specific state of affairs, using only means permitted by rules, where the rules prohibit more efficient in favor of less efficient means, and where such rules are accepted just because they make possible such activity. However, Whitton [192], disagreed on a single definition due to many different contexts and considered more useful to talk about game-like properties, instead of defining what is a game or not. Accordingly, games may contain a subset, but not necessarily all, of the following features: competition, challenge, fantasy, exploration, goals, interaction, outcomes, people, rules and safety, as well as fun. The concept of fun was also analyzed by Lazzaro [100] who described four different kinds of fun: hard, easy, altered state, and social.

Taking into account these game design principles in non-game contexts, the need for a formalization to guide and streamline the process of gamification design becomes clear.

In this regard, the publication of the Hype Cycle of emerging technologies by Gartner in 2013 [45] was enough to realize that the term had reached the top of the wave at that time. However, Gartner also predicted that, by 2014, 80 percent of the gamified applications would fail to meet their objectives, primarily due to poor design [47]. Gartner's 2014 report [46] moved gamification towards the so called "Through of Disillusionment", indicating that it will take from 5 to 10 years to stabilize and reach what the "Plateau of Productivity", when the approach is finally considered mature. We are in this period of stabilization at this moment.

Thus, the moral of the story from Gartner's point of view was obvious to the community: a clear design strategy is the key to success in gamification. In the early stages, many case studies were applying gamification design in an "ad hoc" manner, that is, without considering a formal process of proven design support, revealing great efforts and difficulties in relation to the expected benefits [138] as well as unwanted effects [14]. Thus, not only the definition of a design framework and its empirical validation becomes a starting point of research but how personalization can be applied to be more effective.

Nevertheless, most of the case studies have not been designed considering the characteristics of each person (conceiving gamification as a User-Centered Design process). Diverse psychological viewpoints agree that people are not similar, therefore, all of them could not be effectively motivated in the same way. Personalization is an approach of gamification design to motivate people more effectively, however it has been minimally explored and less applied [17]. Therefore, acquiring knowledge about the users with the purpose of building personalized gamified experiences is perceived as a relevant goal. It is conceived as a dynamic process where user motivations do not keep invariable along the time and the application of Agile paradigm [42] in the design could fit in. Agile methodologies relies on incremental developments with very short iterations, giving greater value to the individual issues with high effectiveness in unclear and changeable environments such as gamified experiences.

Consequently, this work aims to develop and validate a formal approach for the gamification design process under the tittle "A framework for agile design of personalized gamification services".

1.2 Objectives

The main purpose of this thesis is the proposal and evaluation of a framework for the agile design of personalized gamification services in different non-contexts environments such as learning and health. Thus, the following specific objectives are described:

- Identifying the gamification design frameworks available in the literature from both academic and non-academic sources and making a classification by the context of application. (OB1)
- Identifying the game design principles described in the frameworks taken from the literature. (OB2)
- Examining the relationships between users' preferences and the different gamification design components. (OB3)
- Developing a conceptual framework for the gamification design process based on the agile paradigm including the most relevant design principles. (OB4)
- Analyzing the effects of gamification in different case studies, such as education. (OB5)
- Evaluating the differences in user engagement in a personalized gameful experience versus a "one-size-fits-all". (OB6)
- Applying the gamification design framework in an industrial environment. (OB7)

1.3 Research questions

Thus, the current study aims to answer the following research questions:

- Which gamification design frameworks are available in the literature and which design elements are considered? (examined in Chapter 2)
- What are the users' preferences for different gamification design elements and the way its implementation affects their motivations? (examined in Chapter 3)
- Which components should be considered in a gamification design framework? (examined in Chapter 4)
- How are users motivated in a gamified learning experience developed through a formal design process? (examined in Chapter 5)
- Which design components are the most relevant to user engagement in a gamification learning experience? (examined in Chapter 6)
- What is the effect of a personalized design versus "one-size-fits-all" in user engagement in a gamified learning experience? (examined in Chapter 7)

- How is the applicability of the gamification design framework in an industry case? (examined in Chapter 8)

1.4 Research methodology

Different aspects as rigour, encompassing both a systematic conduct and validity, ethics and relevance are present throughout this thesis. During the research process conducted, the following factors were considered as values.

1.4.1 Motivations and benefits

The main motivation of this thesis is the acquisition of knowledge about the key elements and steps which are necessary to develop a valuable gamification design process, with the aim of maximizing the user engagement through personalization. Both technological and analytic perspectives have been taken as basic focuses. The research process about gamification design has intended to improve the current design processes available in the literature to enhance the objectives reached. Thus, the overall benefits of this research process are grouped and listed as follows:

- **Personal**: by developing personal interest on this research, skills as analytic and critical ones, responsibility, ethic, etc.
- **Professional**: by exploring new ways (a depth study on a specific topic of interest), taking on the challenges, applying the theoretical concepts into practice and enhancing professional skills as communication, collaboration and solving-problems.
- **Educational**: by learning traversal literature, new methods, issues, etc. from different media and mentors, and upgrading the academic values.

1.4.2 Design

The study has employed an iterative (non-linear) research process based on Agile methodologies [42]. By means of a Scrum methodology [169], the project management has been organized in iterations, called sprints, typically with a duration between two and four weeks. At the beginning of each sprint, a list of requirements called back-log are established and must be completed before it ends. Daily, short meetings or communications have been held, notifying the progress and the different problems encountered in the research process. The discussion about viable ways to solve these problems have been very common activities.

Thus, the whole research process have been iteratively conducted under the following four phases:

- **Analysis**: a literature review on works indexed in Google Scholar, Scopus, and Web of Knowledge as well as in other databases has been conducted. Case reports, surveys and studies found by keywords, the references taken from bibliography, and definitions have been short-listed. An additional informal review through non-academic frameworks and design has been complemented: academic researches journals, articles, conference papers, dissertations, thesis, etc. which have already been written about the topic of research.

- **Design**: this phase consists of the proposal of a framework for personalized gamification design. It has been assumed that most of current approaches in the literature are lack of validation and do not consider personalized issues as necessary keys and procedures to get a more effective result by means of the gamification techniques.

- **Evaluation**: the developed framework has allowed to design experiences that have been empirical evaluated, firstly, in learning environments (various case studies in computer science degree in an e-learning mode). Ethnography, it has been focused on the improvement of motivation of the computer science degree students in their studies. For this reason a quantitative and/or qualitative data analysis has been run; user's feedback and system logs have provided us a quantitative and qualitative input. Different hypotheses have been proposed and experiments with control groups have been developed.

- **Dissemination**: it has been an ethical and professional responsibility to ensure that these results are disseminated to the community. For this reason, diverse manuscript have been published in the proceedings of international conferences and journals. In addition, the participation and dissemination of the research findings have been carried out through the organization of academic and non-academic events.

1.5 Thesis structure

This thesis is divided in three different parts. First, the theoretical and empirical foundations starting from the state of art and the analysis of the motivational principles are presented (to conceptualize the gamification design framework). The evaluation through the development of diverse case studies are conducted in the second part. The third part is devoted to sum up the conclusion of this thesis and the research questions and answers. Finally, Appendices

provide additional information supporting this thesis, such as the information regarding the dissemination conducted through the organization of the First International Workshop on Gamification and Games for Learning (GAMILEARN'17), which was held in June 5-6, 2017, Puerto de La Cruz, Tenerife, Spain.

Part I

Foundations

This first part comprises Chapters 2, 3 and 4. It starts with a literature review and a benchmarking of the gamification design frameworks in Chapter 2. This study is based on a systematic review of the gamification design frameworks discussed in the literature, where a total of 2747 unique works were initially identified making queries in databases, libraries, journals and search engines. This has provided a useful resource to researchers and practitioners. Then, Chapter 3 presents the results of an exploratory study that investigates the different interaction types with gamified digital applications based on user types and preferences for different game design elements. Outcomes revealed relationships between gender, age, and culture among user types as well as the different game design elements influencing users' preferences. Findings has supported the proposed gamification design framework with the development of a design toolbox. Finally, the knowledge acquired from previous chapters has allowed the proposal of a conceptual framework for designing the gamification of learning experiences in Chapter 3. Its purpose is to allow the application of different techniques all the way down to the lowest levels of abstraction through a step-by-step process.

Chapter 2

A systematic review of gamification design frameworks

2.1 Overview

Gamification, understood as the "use of game design elements in other contexts" [33] for the purpose of user engagement, has become a topic of interest in the recent years. However, there is also a cautionary tale to be extracted from Gartner's report [46] about the design concern: many gamification-based solutions fail because, mostly, they have been created on a whim, or mixing bits and pieces from game components, without a clear and formal design process. Thus, the application of a definite design framework could be a path to success. A wide range of them are available in the literature. Therefore, as has happened with game design process, it seems that gamification also requires a specific and formal design process. Although its purpose is different to that for games, it takes the game design basis. Consequently, given the contrast to traditional game-design processes, it seems appropriate to carry out a systematic review and analysis in order to identify the gamification design frameworks available in the literature and their main features.

Thus, from the origins, "game design" could be defined in a simple manner as "the action of making sense of things related to a game". This definition is not so far away from Schell's description [167], "the act of deciding what a game should be". In this regard, Salen and Zimmerman [164] defined a set of game design fundamentals, which should be run using an iterative process. They consisted of understanding design, systems, and interactivity, as well as player choice, action, and outcome, including a study of rule-making and rule-breaking, complexity and emergence, game experience, game representation, and social game interaction.They highlight not forgetting the addition of the powerful connection

between the rules of a game and the play that the rules engender, the pleasures games invoke, the meanings they construct, the ideologies they embody, and the stories they tell.

Accordingly, Brathwaite and Schreiber [12] assert that, once the different game pieces have been identified, it is necessary to reflect about how to incorporate them. From a chemical perspective, they define game atoms as "the smallest parts of a game that can be isolated and studied individual". Therefore, from this analytic viewpoint, the process of designing games as using a collection of atoms becomes clearer. This idea is also used by Reeves and Red [154] that introduce ten ingredients to make a successful game design: self-representations, three-dimensional environments, narrative, feedback, reputations ranks and levels, marketplaces and economies, competition under rules, teams, communication and finally time pressure. Thus, once the game elements are already presented into game design fundamentals, a standardized concept, practices and criteria are necessary for assembling them rationality under a framework. Typically, a framework is "a standardized set of concepts, practices and criteria to focus on a particular type of problem that serves as a reference, to confront and solve new problems of a similar nature set" (according to the American Heritage Dictionary).

Nevertheless, it should be noted that some authors, such as Crawford [29], have concluded that game design is an activity too complex to be reducible to a formal procedure. In this regard, Julius and Salo [79] assert that it should be treated as an agile process that does not always follow a specific design framework, although they propose one. In contrast to them, the need for a formal and recognized proposal in game design contexts led to the development of the MDA (Mechanics, Dynamics and Aesthetics) framework [71]: "a formal approach to understanding games,which attempts to bridge the gap between game design and development, game criticism, and technical game research". In this regard, games can be broken down into three elements: rules, system, and fun. These elements are directly translated into the following design components, which must be defined when designing a game using this same order as described as follows:

- Mechanics, describing the particular components of the game, at the level of data representation and algorithms.
- Dynamics, describing the run-time behaviour of the mechanics acting on player inputs and each others outputs over time.
- Aesthetics, describing the desirable emotional responses evoked in the player when interacting with the game system.

Thus, deepen into the game experience, Calvillo et al. [20] reveal that a model is only a fraction of the whole in their "Core Elements of the Gaming Experience (CEGE)". They set the necessary conditions to provide a positive experience while playing in the design process: interface design pattern, design patter and dynamics, design principles and heuristics, models (i.e MDA and design methods).This way, Zichermann and Cunningham [198] argue that game and user experience designers have been implementing these techniques for decades to create addictive games and engaging player experiences. Deterding et al. [33] also describe the necessary game design actions for gamefulness in a set of levels: game interface design patterns, game design patterns and mechanics, game design principles and heuristics, game models and game design methods. These principles will help us understand the characteristics of the gamification design frameworks identified by means of the systematic review.

2.2 Methodology

A systematic review of the works about gamification available in the literature has been conducted, focusing on current scientific knowledge about gamification design within any research context. The review is based on works indexed in relevant databases such as Scopus, Web of Science (WOS), and Google Scholar, as well as digital libraries such as ACM Digital Library, Science Direct (Elsevier), IEEE Xplore and Springer. In accordance with the scope, a complementary manual search has been conducted looking for works published in relevant journals in the research areas described. Additionally, a manual search for non-academic works has been conducted using the following search engines: Google, Yahoo, and Bing. It has been considered that relevant non-academic sources from recognized experts in the field may be brought into literature reviews occasionally. The inclusion of grey literature can broaden the scope to a wider range of relevant studies, thereby providing a more complete overview of available evidence [108].

Accordingly, publications have been identified using three levels of specificity regarding the search keywords "gamification", "gamification design", and "gamification design framework" in the all fields available by the query when possible (tittle, abstract and keywords). The number of matches for each level in the different databases is shown in 2.1. The table depicts a decrease in the number of matches for the 2nd and 3rd level when moving from a less specific keyword (level 1, "gamification") to more specific ones (level 2, "gamification AND design"; level 3, "gamification AND design AND framework"). The literature search has not been restricted to a particular time period, even though most references were published after 2011. This review has been conducted during a period ending on 1st February 2017.

Table 2.1 Systematic review's query matches

Source	Level 1 query	Level 2 query	Level 3 query
ACM DL	941	545	75
Science Direct	932	847	441
IEEE Xplore	1417	1283	763
Springer	3036	2685	1468
Scopus	3001	1279	239
WOS	2020	918	149
Google Scholar	37600	27000	17700

The more specific search queries, Level 3, have been carried out independently by two researchers before being merged, revealing a total of 2747 unique "potential" works after filtering duplicates and publications that were not originally published in English (Criterion 1). Based on those unequivocally addressing a process of gamification design (Criterion 2), a total of 2392 records have been excluded through the manual revision of abstracts, leading to 355 potential publications being recorded. Following this, another 308 publications have been excluded based on Criterion 3, which ensures that the work meets minimum requirements in order to be considered a framework. Thus, a total of 47 frameworks (hereafter referred to as "reviewed initial frameworks") have been included in this review. The systematic process carried out can be visualized in Figure 2.1. An additional filtering process is explained in Section 2.4, in addition to a comparative study taking a list of reviewed final frameworks whose homogeneity allow to do it.

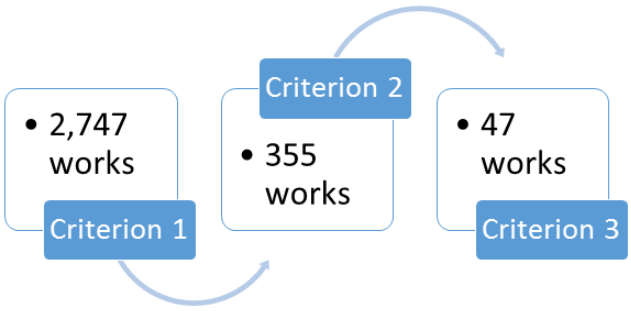

Figure 2.1 Systematic filtering process

A summary of the sources from which the 47 reviewed initial frameworks were drawn are shown in Figure 2.2. This suggests that publications from conferences and journals (in this order) are the largest contributors to this review. Nevertheless, minor works are also included since none of the other sources (such as web-sites) are disregarded in this systematic

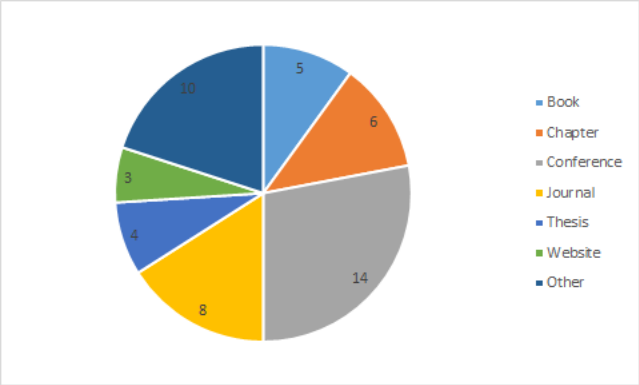

Figure 2.2 Sources from initial frameworks

study. The following section presents a classified description of the 47 gamification design frameworks recorded.

Thus, the frameworks obtained in the reviewed initial frameworks list through the systematic process previously described are now discussed. When observing the publication date of the reviewed initial frameworks (see Figure 2.3), it can be seen that the year with the highest scientific production on the research topic was 2013. It is probably not a coincidence that this is the same year that Gartner [45] positioned gamification at the Peak of Inflated Expectations in its yearly report. The number of contributions decreased in 2014, when Gartner [47] positioned gamification at the Trough of Disillusionment stage. In 2015, there was a slight increase to decrease again in 2016. Year 2017 should not be considered since it is based upon the results for the period until 1st February 2017.

Concerning the main areas of application of the reviewed initial frameworks, four categories were defined: generic (not specific to a concrete environment), learning, business and health. The largest number of reviewed works focus on a business environment, while

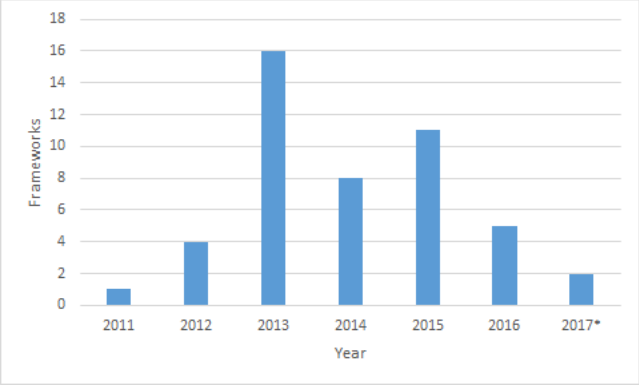

Figure 2.3 Date from initial frameworks

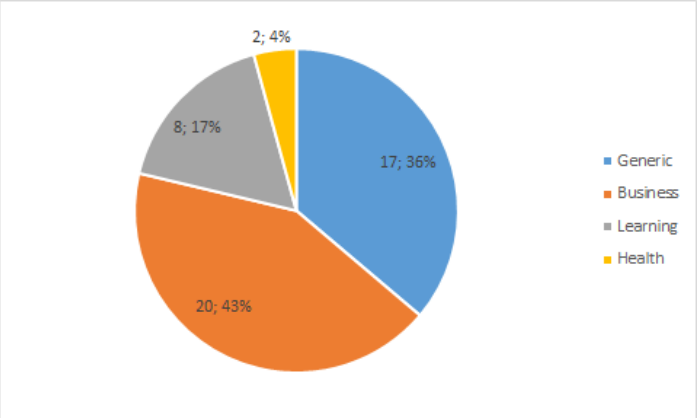

Figure 2.4 Scope from initial frameworks

generic design frameworks (prior, suitable for any context) can be applied to a wide range of environments, as can be seen in Figure 2.4. It is noteworthy that the design frameworks presented that focus directly on learning processes only add up to 17% of all the works considered. This can be explained by the fact that educational approaches that implement gamification are highly focused on "ad-hoc" design process [186] and describing specific experiences and guidelines [82]. As far as focused design frameworks are concerned, the health sector was the least developed, and is an area of application that has received great interest from an academic point of view in recent times.

2.3 Review

A total of 47 frameworks are presented as initial reviewed candidates, being described and ordered by categories and publication date. Three fields have been defined: reference (authors, citation and year), definition (how gamification is described) and description (a brief summary of the approach).

Generic-purpose frameworks

Gamification can be applied to different non-game contexts. Therefore, diverse authors have developed frameworks for specific environments, others are suitable for any context. Table 2.2 shows the frameworks for general purposes (being applicable to any non-game context):

Table 2.2 Summary of reviewed initial frameworks: generic

Reference	Definition	Description
DiTommaso [34], 2011	The use of game design elements in non-game contexts.	A framework based on the SDT [162] which includes the following steps: discovering, identifying players' profiles and motivational drivers, setting up goals and objectives, describing skills, tracking and measuring, defining lenses of interest, desired outcomes, play-testing, and polishing.
Nicholson [136], 2012	The use of game-design elements in non-game contexts.	A theoretical framework for meaningful gamification design which comprises the following issues: organismic integration theory, situational relevance, situated motivational, universal design for learning and player-generated content.
Sakamoto, Nakajima, & Alexandrova [163], 2012	N/A	A conceptual value-based gamification framework for increasing intrinsic motivation in every-day life and based on five values: informative, empathetic, persuasive, economic and ideological.
Kappen & Nacke [83], 2013	The application of game-design elements in non-game contexts.	A design framework and design analysis tool for gamification based on games design and SDT [162]. It comprises a set of layers: effective gamification core, motivated behaviour, game experience, game-design process and perception of fun.

Marache-Francisco & Brangier [110], 2013	An informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement.	A design guide and a toolbox for the gamification design process based on the Human-Computer Interaction (HCI) principles in order to identify the factors involved. Three dimensions are described: sensory-motor dimension, motivation emotion and commitment, and cognitive dimension of interaction.
Francisco-Aparicio, Gutiérrez-Vela, Isla-Montes, & Sanchez [43], 2013	The use of game design elements in non-gaming contexts.	A method based on the SDT [162] for applying gamification as a tool to improve the participation and motivation of people in performing different tasks, considering a structure formed by game core, engine and interface.
Marczewski [112], 2013	The application of gaming metaphors to real-life tasks to influence behaviour, improve motivation and enhance engagement.	A simple framework, called GAME, based on two main phases: planning tasks to be developed, including the tasks of gathering information, purpose and knowledge from the players, and the tasks related with the design by using appropriate game elements, analytic and metrics, testing, feedback, and releasing.
Merino de Paz [119], 2013	The application of game elements and theories to non-game contexts with the intention of modifying behaviours, increasing fidelity or motivating and engaging users.	A guideline consisting of three phases: setting up of business goals (suitability, teaming, objectives, outcomes and player profiling), design (desired behaviours, game components and game design), and implementation and maintenance.

Versteeg [189], 2013	A persuasive technology that can influence user behaviour.	A framework for gamification design as a persuasive technology perspective and based on the moral design framework [9]. It incorporates a methodology for analyzing the ethics based on: definition of moral principles and values, conceptual investigation, stakeholders' involvement, and evaluation and iteration.
Manrique [109], 2013	A design experience based on happiness and motivation.	A model based on an iterative process for designing gameful experiences for fun and motivation. It conceives four main variables in design: goals, actions, players and system.
Chou [25], 2015	The act of making something game-like.	A framework called Octalysis based on an octagon which comprises eight "gameful" shapes: epic meaning/calling, development/accomplishment, creativity/feedback, ownership/possession, social influence/relatedness, scarcity/impatience, unpredictability/curiosity, and loss/avoidance.
Fitz-Walter [41], 2015	A design strategy where game elements are used in non-game systems to promote behaviour change and hedonistic qualities of user experience.	An iterative framework for designing gamification based on the following relevant elements: user experience, motivation and gamification experience, considering the main steps of justifying, designing and evaluating.

Liu & Santhanam [105], 2015	The application of game-based thinking to everyday tasks to make them more engaging.	A framework for the design and research of gameful systems information (SI) inspired by the Person Artifact-Task model (PAT) [40], commonly used for the study of the experiences in computer environments (persons, tasks and technology artifacts including game-design elements).
Almarshedi, Wills, Wanick, & Ranchhod [3], 2015	The use of game elements and techniques in a non-gaming context.	A framework for sustainable gamification that aims to increase the sustainability of the desired impact of gameful applications based on the following three components: Flow Dimension Theory [30], Drive motivation elements [148], and SDT [162].
Klapztein & Cipolla [87], 2016	The use of game design elements in non-game contexts.	A Gamification Service Framework based on a IT artifact designed to solve a class of problems related to the service field. It is based on the following stages: problem formulation, building, intervention and formulation, reflection and learning, and formalization of learning. The stages are broken down into principles.
Morschheuser, Hamari, Werder, & Abe [130], 2017	A process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation	A method for gamification design and derived requirements for successful gamification projects based on the gathered data from experts. It is divided into seven phases: project preparation, analysis, ideation, design, implementation, evaluation and monitoring.

Marczewski [115], 2017	N/A	A revised Gamification Design Framework and Toolkit based on three main phases: Define (problem, user, success), Design (User Journey, solution, action feedback loops) and, Build and Refine. Each phase contains iterative steps to be considered to build a solution.

To summarize the presented works in the previous table, some issues related to generic design frameworks are highlighted:

- All non-theoretical generic frameworks reviewed explicitly consider iterative processes as a main design principle.
- User-Centered Design principles are explicitly featured in most of the frameworks, some exceptions [119, 109, 87].
- Two frameworks reveal a clear technological approach [105, 119, 87].
- Cross-references reveal that the MDA framework is conceived as the source of two approaches [83, 41], while the 6D [191] is only inspired in one of the approaches [119].
- A few of the frameworks rely heavily on psychological and motivational theories [136, 43, 25].

Learning-purpose frameworks

As follows, Table 2.3 shows the frameworks addressing the specific non-game context of learning:

Table 2.3 Summary of reviewed initial frameworks: learning

Reference	Definition	Description
Simões, Díaz Redondo, & Fernández Vilas [175], 2012	The use of elements from video games in non-game applications.	A social gamification framework to be applied in social learning environments. It aims to assist educators with most usual game elements present in social games including game-thinking to improve students' motivation and learning outcomes.
Nah, Telaprolu, Rallapalli, & Venkata [134], 2013	The process of game-thinking and game mechanics to engage users and solve problems.	A framework which provides guidance to software designers and researchers in order to gamify educational applications. It is focused on five main principles: goal orientation, achievement, reinforcement, competition, and fun orientation.
Huang & Soman [69], 2013	The addition of game-like-elements, also called game mechanics, in non-game settings.	A framework for gamification design of education which can be extended easily to other domains where interventions to increase engagement and retention are required. It is based on a five-step process: understanding target, defining learning objectives, structuring the experience, identifying resources, and application.
Wongso, Rosmansyah, & Bandung [194], 2014	The implementation of game mechanisms and elements in non-game applications like e-learning.	A framework based on social engagement which can be applied to e-learning environments and based on the Design Science Research Methodology [145]. It comprises five iterative phases: analysis, design, development, implementation and evaluation.

Kotini & Tzelepi [92], 2015	A powerful strategy that influences and motivates groups of people.	A gamification-based framework for developing activities of computational thinking which provides a student-centred design for enhancing their involvement in the learning environments. It proposes ways to introduce and set game-design elements, as appropriate, into a learning environment.
Klock & Cunha [88], 2015	The use of game elements for purposes unrelated to games in order to get people stimulated and engaged to achieve a specific goal.	A conceptual framework, based on the MDA [71] and 6D frameworks [191], for engaging students, and its application in adaptive e-learning systems. By the definition of a set of dimensions, it provides information on what game elements, actors, data and behaviour should be involved in the gamification process.
Mora, Zaharias, González, & Arnedo-Moreno [127], 2016	The use of game design and game elements in non-game contexts.	An iterative framework for agile gamification of the learning experience. It is based on Lean UX [58] and Behaviour-Driven Development [23] principles and structured in four phases: declaration, creation, execution, and learning.
Baldeón, Rodríguez, & Puig [4], 2016	Game-based thinking and game mechanics within the classroom, serving the purpose of motivating and engaging students during the process of learning.	A LEarner-centered GAmification Design Framework (LEGA) focused on learner/player and aligned both course's intended learning outcomes and gamified learning activities. Six stages: identifying learning outcomes, knowing learners/players/context, designing gamified learning activities/metrics, deploying and evaluating.

To summarize the presented work in the previous table, some issues related to design frameworks in a learning context are highlighted:

- Social relevance is shared by a few frameworks [175, 194].

- In contrast to other publications, one of the frameworks is focused on researchers and software designers, making it unsuitable for application by teachers [134].
- Two frameworks explicitly recognize the use of an e-learning platform as a necessary environment to conduct the gamified experience [194, 88].
- Four frameworks explicitly stress the relevance of an iterative process [69, 194, 127, 4].
- The MDA framework is implicitly or explicitly considered in several frameworks [88, 127] as well as 6D framework [88].

Business-purpose frameworks

Following, Table 2.4 shows the frameworks addressing the specific non-game context of business:

Table 2.4 Summary of reviewed initial frameworks: business

Reference	Definition	Description
Werbach & Hunter [191], 2012	The use of game elements and game-design techniques in non-game contexts.	Commonly known as 6D, it is the most popular and referenced gamification design framework. It conceives the following steps: defining business objectives and expected behaviours, describing the players, devising the activity loops without forgetting the fun, and finally, deploying the gamification system with the appropriate tools.
Kumar [95], 2013	It is the application of game-design principles and mechanics to non-game environments.	A UCD process for designers and developers to incorporate the principles of gamification into a software. It is based on eight steps: understanding the player, mission, human motivation, applying game mechanics, setting the game rules, defining engagement loops, managing-monitoring-measuring, and considering legal and ethical issues.

Gears & Braun [49], 2013	A process that incorporates game-design elements in non-game contexts to improve the user experience.	A role-motivation-interaction framework to facilitate the architecture of gameful interactions. It is based on a model and method of usage, taken from UCD. A set of elements are considered: objectives, business rules, behavioural norms, preconditions, actors and the course of these actions.
Julius & Salo [79], 2013	The use of game-design elements in non-game contexts.	A framework for gamification in a business context focused based on the 6D framework [191] with the addition of a new stage, called "market research".
Jacobs [74], 2013	Achieving goals using an engaging set of metrics-based interaction.	A framework for implementing enterprise gamification within an organization through a goal-model design. Five phases are considered: understanding the goals/impact, defining goals, considering user and social media, feed-back and analysis, and running the loop engagement.
Popa [149], 2013	N/A	A UCD gamification framework which provides methods and tools to facilitate the creation of emotional experiences to the user. It provides the definition of gamification "Personas", which encapsulates and defines the issues regarding the user's goals, emotional states and personality types.

Jiménez [78], 2013	The use of game-thinking and mechanics in non-game environments for troubleshooting.	A business centred approach known as Gamification Model Canvas based on the Business Model Generation Canvas [144] and the MDA [71]. It is an agile, flexible, and systematic tool that considers the following items: revenues, players, behaviours, aesthetics, dynamics, components, mechanics, platforms and costs.
Herzig [67], 2014	A novel method to improve engagement, motivation, or participation in non-game contexts using game mechanics.	A conceptual framework of gamification based on literature review for the gamification development as a technology-centred design process. It considers different phases: business modelling, requirements, iterative design, provisioning, implementation, testing, deployment and monitoring.
Raftopoulos [153], 2014	N/A	A conceptual framework focused on sustainable gamification design that yields a minimum viable design for gameful enterprise applications. It includes the following stages: discovering, reframing, envisioning and creating.
Burke [16], 2014	The use of game mechanics and experience design to digitally engage and motivate people to achieve their goals.	A player experience design process to build a gameful application and the task structures in a logical order, considering: business outcomes and success metrics, target audience, player goals, engagement model, play space and journey, game economy, and play, tests and iterations.

Harms, Wimmer, Kappel, & Grechenig [63], 2014	The use of design elements characteristic for games in non-game contexts to produce desired psychological and behavioural outcomes.	A structured design process for gamification of surveys based on the MDA [71] and form design layers. It proposes four steps: aesthetics and the relationship layer; dynamics and the conversation; mechanics and the conversation and appearance; and prototyping, evaluation and iteration.
Schönen [168], 2014	The use of game mechanics and game-design elements in non-game contexts.	A theoretical framework which provides a guidance based on an adaptation of the 6D framework [191] and empirical findings. It purpose is to determine the best point in time at which to apply gamification in the change processes and the decision criteria for applying gamification.
Li [101], 2014	The use of game-design elements in non-game contexts.	A theoretical model for gamification in the workplace in an information system context. It is based on the Technology Acceptance Model (TAM) [31] which serves as a determinant of both Perceived Usefulness (PU), Perceived Ease of Use (PEOU), and the impact.
Neeli [135], 2015	An informal umbrella term for the use of game elements in non-gaming systems to improve user experience and user engagement.	A prescriptive method for designing a gamification environment for companies, from conceptualization to implementation in six phases: setting the goals and objectives, understanding challenges and motivations, analyzing motivations, designing, measuring and improving, and engaging boosters.

Brito, Vieira, & Duran [13], 2015	The use of game-design elements in non-game contexts.	A conceptual framework to guide the design of gamification in crowd-sourcing-based systems. It comprises a guideline where four main phases are proposed: gathering, analysis, modelling and execution.
Ruhi [161], 2015	Game-thinking and game-based tools used in a strategic manner to integrate with existing business processes or information systems.	An adaptation of the MDA framework for enterprise gamification to accomplish the connections between end-user motivations, interactive gameplay elements, technology features and functions. A set of guidelines for design and for management are also proposed.
Robson, Plangger, Kietzmann, McCarthy & Pitt [156], 2015	The application of game-design principles in non-gaming contexts.	A framework based on mechanics, dynamics and emotions (MDE), an adaptation of the MDA framework to aid the design process considering mechanics, settings, contexts and interactions, dynamics, and emotions.
Herranz, Colomo-Palacios, de Amescua Seco & Sánchez-Gordón [65], 2015	The use of game elements in non-game contexts to modify and influence the behavior of people.	A framework adapted to software professionals to encourage motivation in the Software Process Improvement process. It consists of eight phases: feasibility, business goals, player definition and motivation, activities and behaviours to enhance, proposal, implementation, measurement, learning, and refining loop.

Wiklund & Wakerius [193], 2016	The use of game elements in non-game contexts	A framework based upon the existing body of literature on gamification to more easily describe in seven steps the processes to be developed: defining business objectives, identifying target, matching player with motivation, building the experience, considering journey, testing and, control and adjusting.
Rosmansyah [159], 2016	The use of game elements and game-design techniques in the not game context	A conceptual framework which implements gamification design in integration of online training and collaborative working environment. It consists of six main stages that are define objectives, delineate scenario, describe user needs, system specification, implementation, and evaluation.

As a summary, some issues related to business-focused approaches must be noted:

- Most of the presented non-theoretical frameworks explicitly highlight iterative processes as a main design principle with two exceptions [49, 159].
- User-centred design principles are prominently featured in many of the frameworks [16, 49, 95, 101, 149, 153, 65, 193, 159].
- Technology is relevant to many frameworks [13, 63, 67, 95, 101, 153, 161, 65, 193, 159].
- The MDA game design framework [71] inspires four frameworks [63, 135, 156, 161], while the 6D framework is the basis for many of them [13, 79, 65, 193, 159].
- Only one framework reveals great relevance to psychological and motivational theories [49].

Health-purpose frameworks

Table 2.5 shows the frameworks addressing a health context, as follows:

Table 2.5 Summary of reviewed initial frameworks: health

Reference	Definition	Description
Rojas, Kapralos, & Dubrowski [158], 2014	Employing game-design elements for non-gaming applications to make them more fun, engaging and motivating	A framework which seeks to provide researchers with the necessary guidelines for the implementation of gamification in health services, public health, and social policy related to health. It comprises four main stages: theory and modelling, piloting, evaluation, and implementation.
Charles & McDonough [22], 2014	The application of game elements and metaphors, game-design patterns, or game technology to the design of systems that can positively influence behaviour and improve motivation and engagement of people with non-game tasks and processes	A framework for guiding the design of gameful rehabilitation systems placing emphasis on people, aesthetics, context and technology. From design to development process four dimensions are defined: people, aesthetics, technology and context.

To summarize, some issues related to frameworks in health environments are highlighted:

- Design frameworks for health present great relevance to prototyping and experimenting, in addition to measuring and iterating. Additionally, it is remarkable that design steps are very specifically defined.
- Gamification design issues and elements reveal theoretic issues and diverse implementation targets, including both designers [22] and researchers [158].

2.4 Discussion

The gamification design frameworks presented above are discussed in more detail in the following paragraphs. It is noteworthy that there is no consensus in the literature about a specific definition of the term gamification and its scope, although the most widespread definition of gamification clearly comes from Deterding et al., [33] as "the use of game-design elements in non-game contexts". At least half of the reviewed publications (49%) conceive gamification under this definition or in a similar fashion (with minor connotations), such as the application of game elements and theories to non-game contexts with the intention of modifying behaviours, increasing fidelity or motivating and engaging users [119]. These definitions differ from the first one that describes gamification as "the application of game-like accelerated user interface design to make electronic transactions both enjoyable and fast" [146]. In some papers, it should be note that there is not a definition of gamification explicitly described or referred in a few frameworks [153, 163], a necessary pre-requisite for proposing any framework for gamification design given the heterogeneity of the approaches. Another point of interest is the relationship between these frameworks and the technology. Several frameworks include the use of technology to conceive gamification [16, 22, 161, 189, 194].

However, due to the variety of research areas involved, little homogeneity can be observed in the reviewed frameworks. Accordingly, three major approaches in the analyzed design processes are proposed as follows:

- **User-Centered**: the user and their goals are the central focus of the design and development (UCD processes from the Human-Computer Interaction).
- **Game-Centered**: game designs and game artifacts are the central focus of the design and development process.
- **Technology-Centered**: technological artifacts and modelling are the central focus of the design and development process. They are focused on the definition of architectures and systems as the basis of any gamification design and deployment.

Accordingly, Figure 2.5 shows the percentage of papers addressing each design approach proposed in the previous paragraph. More than a half of the frameworks reviewed are User-Centered (this does not imply a restriction on the use of game-design principles and/or technology, but reveals that the user is the "heart" of the design process). Several frameworks for gamification design have been discussed in the literature, being listed and described in previous tables. The publications are classified into three different design principles (User-Centered, Game-Centered, and Technology-Centered) related to the main perspectives

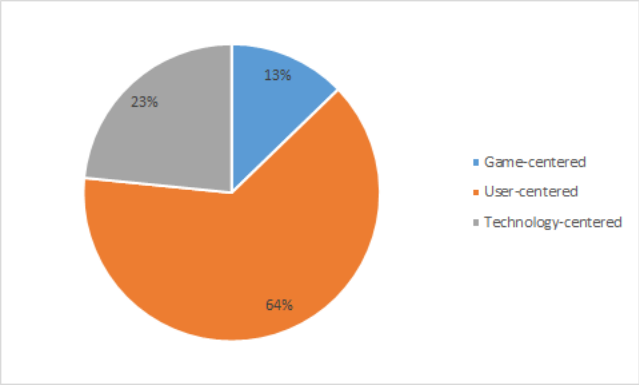

Figure 2.5 Approaches from initial frameworks

applied to the design process. As previously noted, gamification is a topic of interest which is being addressed from diverse research areas.

Thus, to know what items are taken into account in the gamification design process, a comparative study has been carried out. For the analysis of the data, an additional exclusion criterion has been applied to the reviewed initial frameworks discussed previously. This has allowed to obtain a list of "comparable" frameworks (there is a gap between the more theoretical and conceptual frameworks, thus precluding a comparison between them), hereafter referred to as "reviewed final frameworks". To be included, reviewed final frameworks should fit to:

- Conceptual approaches, consisting of concepts that are placed within a logical and sequential design, a less formal structure, based on specific concepts and propositions, and derived from empirical observation and intuition.
- Academic sources, recognized in an academic publication.
- Complete design approaches, not describing a partial or specific design process.

Once this filtering criterion has been applied, a total of 35 out of 47 reviewed final frameworks have been considered for the following discussion (see background in 2.6). From this list of reviewed final frameworks, 24 relevant design principles (hereafter referred to as items), commonly found in frameworks of this kind, have been grouped into six categories, one qualitative (concerning design principles, covering three of the items) and five quantitative (knowledge, logic, psychology, measurement and interaction, covering the remaining 21 items). The possible values are:

- **Explicit**: the item is present in the approach.
- **Implicit**: the item is not explicitly present in the approach. It has been inferred by the authors, referring to other sources or clarified by means of directly contacting the authors.
- **Not referred**: the item is not present in the approach.

Thus, this categorization is defined to facilitate the analysis process: Principles (Domain, Development and Background), Knowledge (Objectives, Feasibility, Risk, Investment, Stakeholders), Flow (Engagement cycle, End-game, On-boarding, Rules), Psychology (Fun, Motivation, Social Behaviours, Profile, Taxonomy), Measurement (Analytic, Metrics, Ethics) and Interaction (Narrative, Experience, Technology). A detailed description of each category is presented as follows:

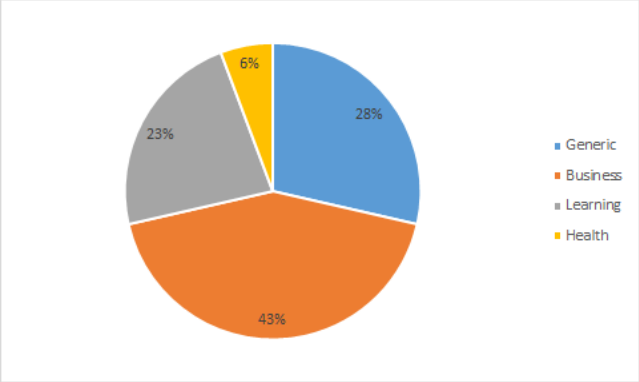

Figure 2.6 Categories' final frameworks

Principles

Basic principles are described through three items which are defined as follows:

- **Domain (DO)**: application areas can be grouped into generic, business, learning and health. Business frameworks present a high-level of interest for the community (15 frameworks), but generic ones are also widespread (10 frameworks). Learning-specific design frameworks are slightly less common (8 frameworks) and, finally, health environments have the lowest presence in the literature (2 frameworks).
- **Development (DE)**: most of them reveal iterative designs processes. In contrast, eight of them do not explicitly refer to this issue [49, 83, 88, 63, 92, 134, 175, 159].

- **Background (BA)**: two main works stand out as an inspiration for the gamification frameworks: the MDA framework [71] inspires [41, 83, 88, 135, 156, 161], meanwhile the 6D framework [191] is the basis for the works [13, 79, 88, 65, 193, 159].

Knowledge

The requirements for the design purpose are identified through the following five items:

- **Objectives (OB)**: almost all of the frameworks explicitly reveal the importance of defining clear objectives at the beginning of the process. Accordingly, behavioural objectives/goals are widely considered as the core of any gamification design process. Unclear or fuzzy objectives are common reasons for failure in gamification design.
- **Feasibility (FE)**: only ten of the frameworks explicitly refer to this issue. Special emphasis is considered in several frameworks which consider technological [67], economic [49] and ethical [189] feasibility.
- **Risk (RI)**: weaknesses and risks are considered by many frameworks [16, 41, 49, 127, 153, 161, 175, 65].
- **Investment (IN)**: only three frameworks explicitly refer to the necessity of a return of investment [49, 65, 158].
- **Stakeholders (ST)**: the need to interact with stakeholders is explicitly considered as relevant by a half of the frameworks approximately. It should be noted here that none of the learning specific frameworks takes stakeholders into account.

A summary of the knowledge-related items is graphically shown in Figure 2.7:

Flow

The state of optimal experience characterized for being fully focused and engaged in an activity is described through the following items:

- **Engagement cycle (EN)**: the notion of "gamification loop" is proposed to support the gamification design process [106]. This item has been considered explicitly by more than a half of the frameworks studied.
- **End-game (EG)**: several frameworks take this issue into account [16, 25, 79, 127, 156, 191].

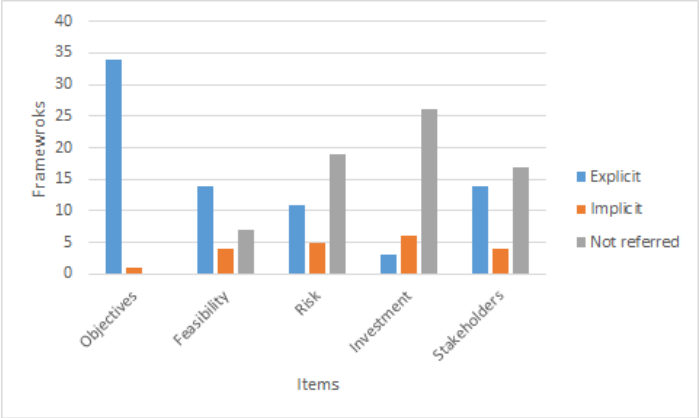

Figure 2.7 Knowledge items: final frameworks

- **On-boarding (ON)**: this issue is more widespread than the endgame process. In addition to previous frameworks which support endgame, the on-boarding process is supported by about a half of the frameworks.
- **Rules (RU)**: Most of the frameworks explicitly take them into account.

A summary of the flow-related items is graphically shown in Figure 2.8:

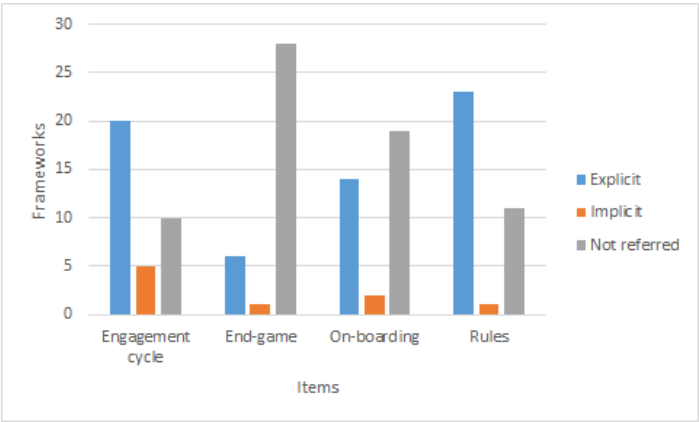

Figure 2.8 Flow item: final frameworks

Psychology

The psychology that holds gamification is not a basic topic, and diverse theories related to human behaviour have their impact in design. Therefore, six items are considered in this category:

- **Fun (FU)**: it is a relevant issue for most of the frameworks that should be explicitly or implicitly considered during the design process; only two works do not consider this aspect [87, 194].
- **Motivation (MO)**: different motivational factors and models have been proposed in the literature and it is the core of the design process in all the frameworks. Therefore, SDT [162], which supports the intrinsic human motivational needs, is the predominant source.
- **Social (SO)**: most of the frameworks studied consider social interaction either explicitly or implicitly in the design process; three exceptions [63, 158, 130].
- **Behaviours (BE)**: all of the frameworks studied address, explicitly or implicitly, the prior description of expected behaviours in the design process.
- **Profile (PR)**: identifying the players has also been studied in the literature [185]. Most of the frameworks (except seven of them) consider a good knowledge of their users and motivations as relevant.
- **Taxonomy (TA)**: some of the frameworks explicitly consider Bartle's taxonomy [8]:[25, 79, 119, 135, 191, 65]. To a lesser extent, the HEXAD User Type Framework [112], is also referred [22, 88, 112, 115, 193, 4].

A summary of the psychology-related items is graphically shown in Figure 2.9:

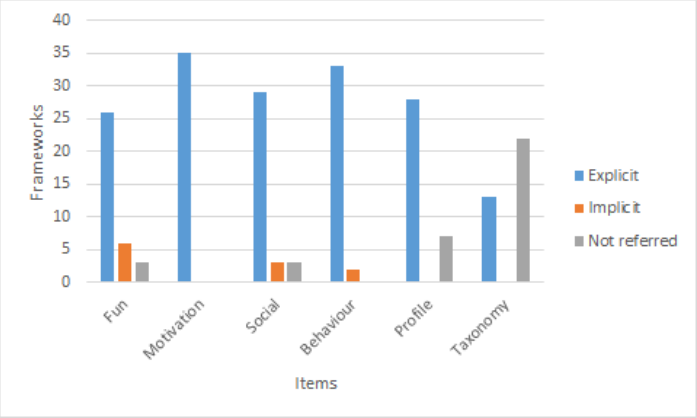

Figure 2.9 Psychological item: final frameworks

Measurement

The utility to monitor the experience ensuring the moral principles of the process is reflected in the following items:

- **Analytic (AN)**: various authors emphasize the benefits of measurement in gamification [27]. Most of the frameworks take the analysis of the experience into account, except in the case of two frameworks [49, 92].
- **Metrics (ME)**: are the standards used for measurement processes commonly associated with efficiency, performance, progress or quality. A first set of measures has been proposed by Zichermann and Cunningham [198]. More than half of the frameworks explicitly refer to this issue, but not all of the them define the use of metrics.
- **Ethics (ET)**: regarding the appropriate use of analytic, the ethical discussion within the gamification community is still in its infancy [173]. Special relevance can be assigned to one specific framework [189] and several frameworks give great importance to this issue [41, 95, 110, 127, 153, 128]. However, ethical issues are not extensively considered by most of the frameworks reviewed.

A summary of the measurement-related items is graphically shown in Figure 2.10:

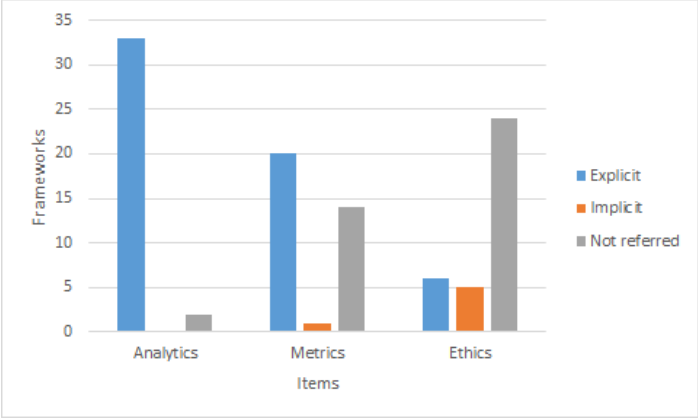

Figure 2.10 Measurement items: final frameworks

Interaction

The items regarding how the experience is conducted are described as follows:

- **Narrative (NA)**: more than half of the frameworks explicitly consider to develop a narrative as necessary with the aim of encompassing the design proposed.

- **Experience (EX)**: further research is needed to investigate the impact that gamification as a global User Experience. This way, some frameworks do not refer explicitly to gamification as a User Experience [49, 153, 65, 193, 112, 4, 158], although most of them are User-Centered.
- **Technology (TE)**: there is a controversy between the gamification conceptualization and the involvement of technology. More than a half of the frameworks require the support of technology for deploying a gamified experience.

A summary of the interaction-related items is graphically shown in Figure 2.10:

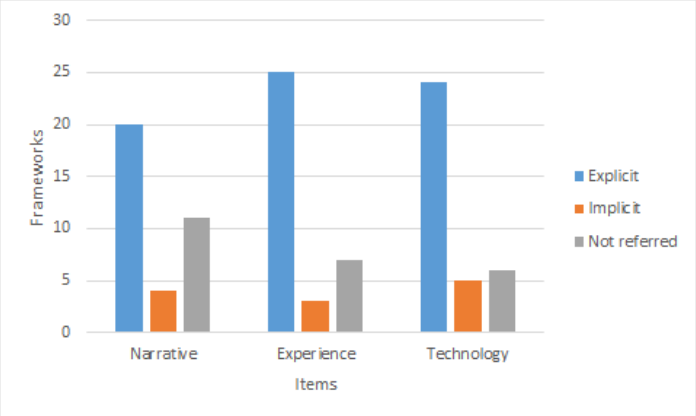

Figure 2.11 Interaction items: final frameworks

2.4.1 Concluding remarks

Most of the analyzed design principles and elements are present to some extent in the reviewed final frameworks, and can be seen in the game-design literature [164, 167] as relevant issues. Therefore, common game design items are widely applied in the process of gamification design, as shown in Figures 2.7, 2.8, 2.9, 2.10, and 2.11, revealing the highly regarded elements and those which are barely treated. Thus, frameworks present a low relevance of knowledge issues (risk, investment, stakeholders) except the definition of business objectives. Flow state presents great relevance for engagement cycle, and rules, in less manner for the on-boarding process, being irrelevant for the end-game process. A greater importance of psychology has been perceived (fun, motivation, behaviour, etc.) in contrast to low consideration of taxonomies to model users. The analysis and definition of metrics also have a great relevance within the measurement category. However, there is a low consideration of ethic principles. The development of a meaningful narrative and the adequacy of the use of technology to support the design process are highly considered. To

summarize all these findings, Figure 2.12 provides an overall comparison of items (both implicit and explicit) previously analyzed in relation to each framework. Additionally, all the items are presented in detail in the Appendix A.

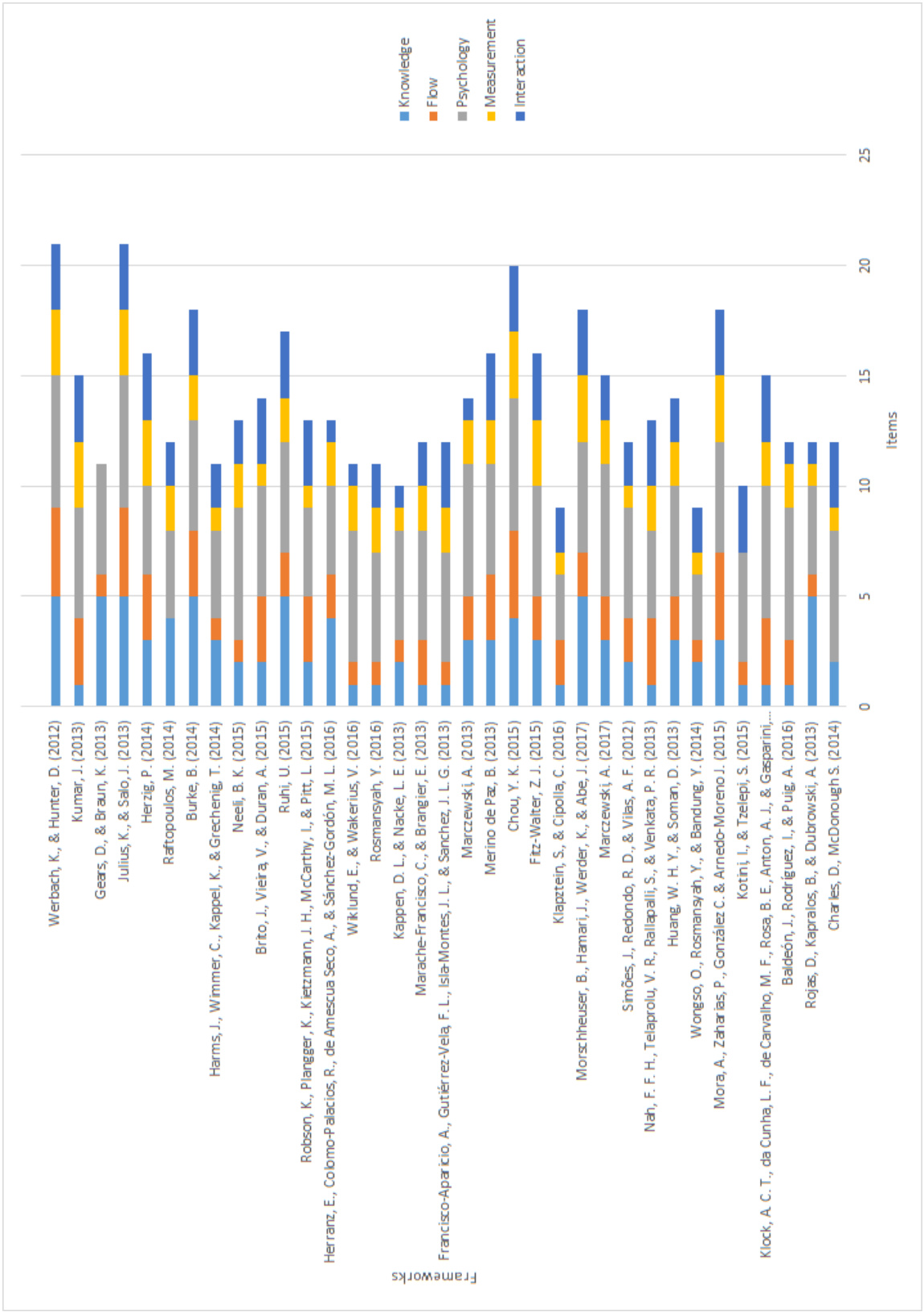

Figure 2.12 Summary of reviewed final frameworks

Chapter 3

Gamification design toolbox: analysis and development

3.1 Overview

Recent research has shown that gamification may be more engaging when it is personalized to each user [141]. Researchers have demonstrated the usefulness of personalized gamification experiences [17]. A personalized gamification design opens the door to a new ecosystems that provide an intimate user experience and increases the potential to motivate people. Therefore, personalizing gamification to each user is highly desirable. This way, personalized interactive systems seem to be more effective than "one-size-fits-all" approaches [17, 184], requiring a dynamic adaptation to the user's behaviours in response to any situation. These approaches usually offer system-tailored contents and services to users that caters to different users' characteristics [142].

Thus, in order to create true behaviour change, the entire gamification design should be focused on meeting the motivations of each individual user; in consequence, early long-term studies have been undertaken to investigate this topic further (e.g., [59, 7]). Accordingly, some basic elements must be taken into account before designing a personalized gamification experience: defining the user profiles, the content and functionality, as well as the interface elements [57]. Researchers have been conducting initial studies regarding a diverse set of dimensions for personalization, such as personality [77], gender [139], persuadability [142, 140, 141], and user types and design elements [184, 50, 39]. However, the way to make gamification interactions highly personalized, and the factors to do this, are still largely unexplored [17].

Nevertheless, considering the preliminary findings, the scope they offer for informing gamification design has not yet been explored in depth. There is an open research niche

regarding relationships between users, their specific preferences when interacting with gamification environments (and the specific game design elements to be used), beyond the application of a player taxonomy. In this context, elements of game design are the building blocks most commonly employed in the gamification design [33]. These design elements include badges, points, leaderboards, challenges, or avatars. Nowadays, the relationship between these elements and user types has not been sufficiently explored in the literature. In order to fill this gap, the objective is to gather the information that will help deepen the experience of personalized gamification design by applying diverse game design elements; outcomes would allow to obtain a gamification design toolbox to be part of the proposed gamification design framework. This way, mere user interactions to understanding user *preferences* are studied. This means not only the interest in understanding the generic behavioural patterns of users when in an application, but particularly in understanding how users are differential motivated by each design element. Outcomes will benefit gamification practitioners by assisting them in developing more complete designs.

Thus, from a psychological perspective, Myers [131] present the Myers-Briggs Type Indicator (MBTI) based on eight scales (Extraversion vs. Introversion, Sensing vs. Intuition, Thinking vs. Feeling, and Judging vs. Perceiving), in which individuals are matched with four of them. It was considered a useful personality scale years ago, conceived to help people identify some of their most important personal preferences. On the other hand, the Five Factor Model (FFM) of personality, commonly known as the “Big Five" [54], posits that the perception of personality is formed by five broad factors or dimensions: factor O (openness or openness to new experiences), factor C (Conscientiousness or liability), factor E (Extraversion or extroversion), factor A (agreeableness or kindness) and factor N (Neuroticism, or emotional instability). The recent literature agrees that the FFM model is a more accurate representation of an individual’s personality than the MBTI model; therefore, it is a preferred representation for understanding potential personalization factors [28].

From a games user research viewpoint and in terms of player modelling for personalization, researchers and designers have traditionally worked in models or taxonomies that keep the design process away from the complexity and individuality of each user. Accordingly, Hamari and Tuunanen [61] suggest that player typologies (the way in which players play or how they can be segmented according to their behaviour) have not been exhaustively studied yet. They review the existing player type models and synthesized the commonalities between them into five key dimensions pertaining to player motivations: Achievement, Exploration, Sociability, Domination, and Immersion. These dimensions largely fit with the oldest and most-used taxonomy in the gamification design literature, Bartle’s Player Types [8] (Player, Socializers, Killers, and Achievers), an observation that is corroborated on a review on design

frameworks [124]. Notice that this taxonomy has been created specifically for Multi User Dungeons (MUD) and it should not be generalized to gamification scope.

At the same time, Yee [196] proposes a set of elements that complement Bartle's model, on the basis that player types could be highly correlated with each other. Therefore it would be difficult to use Bartle's model on a practical basis. He updates the model using the following dimensions: achievement (advancement, mechanics, and competition), social (socializing, relationship, teamwork), and immersion (discovery, role-playing, customization, and escapism). More recently, BrainHex [132] has been developed as a player satisfaction model, which allows a comparison between other models (such as MBTI) and diverse playing style preferences. This model presents seven player "archetypes": Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socializer, and Achiever.

Nevertheless, it is noteworthy that these models have been developed for, and are fitted to, game design, with a clear purpose of entertainment. On the contrary, the main purpose of gamification design is not pure entertainment in leisure time, but motivating people in non-leisure environments. One approach that fits this is the Gamification Hexad User Types framework [114, 184] which maps user preferences towards different motivations in non-game contexts. This framework shows great potential for personalizing gamification applications since it has been conceived specifically for this goal [184]. In this model, six user types are described, as follows (see Fig. 3.1) [114]:

- **Socialisers (S)**: they are motivated by relatedness. They want to interact with others and create social connections.
- **Free Spirits (FS)**: they are motivated by autonomy and self-expression. They want to create and explore.
- **Achievers (A)**: they are motivated by mastery. They are looking for learning new things and improving themselves. They want challenges to overcome.
- **Philanthropists (Ph)**: they are motivated by purpose and meaning. This group is altruistic, enjoying when giving to other people and enriching the lives of others in some way with no expectations of reward.
- **Players (Pl)**: they are motivated by rewards. They will do what is needed of them to collect rewards from a system.
- **Disruptors (Di)**: they are motivated by change. They want to disrupt the system, either directly or through other users to force positive or negative change.

Figure 3.1 The Gamification User Types Hexad model

This framework has also been empirically validated by Tondello et al. [184], presenting a standard scale to score users' preferences. However, findings about prevailing user type or motivator may not be enough to facilitate designing personalized gamification experiences according to users' preferences. Therefore, they suggest a table of game design elements for each user type by means of a correlation analysis. Their findings demonstrated the usefulness of the Hexad User Types model as a measure of preferred design elements. In this case, they used an online questionnaire with two purposes: first, to find correlations between the participants and the Big Five personality traits [54], and secondly, to find correlations between game elements and each of the Hexad User Types.

Consequently, the aim to develop the gamification design toolbox has been to explore the different types of interaction with gamification digital applications. It is based on the Hexad User Types framework [114, 184], from a more general (considering generic user types) to a more granular viewpoint (considering hybrid user types), to be finally a part of a design toolbox in the framework developed. The hybrid viewpoint accounts for the fact that participants' highest scores usually occur in more than one user type. It is considered how different user type combinations affect users' preferences, instead of attempting to reduce each participant to a single (generic) user type. In addition, it is also explored users' preferences for different game design elements.

3.2 Study design and methods

Previous findings in the literature are presented as a starting point, and then the design of the study is described as well as the methods used.

3.2.1 Related works

In addition to the work presented by Tondello et al. [184], there are a few studies that should be mentioned, regarding the literature on personalized gamification design from the perspective of player types and game design elements. This way, Ferro et al. [39] study the relationship between player types and personality traits in gamification systems, aiming to identify potential relationships with game design elements. The overarching purpose is to provide an adequate and dynamic toolbox for designing gamification systems, specifically targeting users' intrinsic motivation (based on their knowledge and experience). However, their theoretical model is not empirically validated. Likewise, Xu [195] proposes a list of game mechanics that link to different player types (based on Bartle's model [8]).

Another study, conducted by Gil et al. [50], suggests that certain game design elements can motivate some users, but may be irrelevant or even off-putting for others. In their work, they empirically validate the effectiveness of diverse game design elements and their adequacy for player types. They use a personality-based questionnaire to infer the participants' player types and deploy diverse implementations of game design mechanics to discover subjects' motivations. Participants ($N = 32$) are all students from higher education. After completing the survey, participants has been asked to freely choose the assignments to solve by performing actions based on game design elements. It is remarkable that the authors consider only the main user type (the one with the highest score). When a participant has two tied highest scores within the typology, they are deemed to represent two independent users, not being considered as a single person.

Jia et al. [77] conduct a study on the relationships between an individual's personality traits and preferences for various motivational affordances used in gamification design (Points, Badges, Levels, Feedback, Progress, Challenge, Rewards, etc.). They consider that most gamification applications use various combinations of motivational affordances, but they are not designed for a specific use. The study is focused on personality traits using a derivative version of the Big Five model [54]. They conduct an online survey with 248 participants. Initially, participants have been asked to complete an assessment test of the Big Five factors of personality. Next, they have been asked about their perceptions about ten motivational affordances (game design elements) by means of demonstrative videos. Through a correlation study, they link motivational affordances with different game design elements.

Beyond the limitations and size of the samples used of the cited studies, it seems there are no relevant exploratory studies in the literature about the motivational effect of different ways of implementing the game design element considering the diversity of the population, beyond a generic viewpoint of user types. In consequence, this study has been run under the following principles. First, the findings should be obtained through empirical evidence,

as a result of a process of analysis, neither based on assumptions nor the prior experience. Secondly, it has been considered to reach the widest sample necessary for this kind of study (exploratory) to provide relevant conclusions. Thirdly, it has been considered to go further than previous works which commonly consider generic user types (i.e., labelling each participant solely based on the type in which they obtained the highest score), as a simplified way to segment users based on only one preference. Instead, it has been analyzed the participants' scores from a hybrid viewpoint, considering different degrees of preferences (i.e., considering combinations of each participant's scores for each user type instead of only the highest score).

To conclude, whereas previous studies are based on generic proposals of game design elements, it has been assessed the variation of the motivational effect to the different ways that each game design element can be implemented. Through this process, it aimed to provide a better understanding on how game design elements, and different ways of implementing these, can motivate to a lesser or greater degree different user types.

3.2.2 Game Design Elements

Traditionally, components and principles of gamification design are taken from game design within leisure environments as described in Chapter 2. However, although the process of designing a gamification system is not the same as designing a game (one has a pure entertainment viewpoint while the other enhances user engagement in non-game contexts), the core game design elements have some common characteristics. These elements are described and studied by diverse authors in game [167, 198] and non-game contexts [114, 32]. The purpose is to asses not only the participants' overall preference for each game design element, but also if this preference varies when different ways of implementing the elements are developed in gamification systems.

Probing further into the different instantiations (for personalization) of game design elements in gamification systems, a review has been conducted considering one suggested game design element for each user type from the study by Tondello et al. [184]. A widely set of game design elements has been selected which presented a significant correlations with the Hexad User Types (except for Philanthropists), for a better understanding of the study participants' motivations. Thus, the following game design elements have been selected for this study: leaderboards (Players), teams (Socializers), challenges (Achievers), voting mechanism (Disruptors), gifting (Philanthropists), and exploration (Free Spirits).

Leaderboards

There are many minor design decisions involved in the implementation of leaderboards that may influence their impact, which have not been explored yet [97]. For example, Dominguez et al. [35] use "achievements" instead of points in leaderboards, classifying players by the number of achievements they earned. In contrast, Sun et al. [180] hide the score from participants, who were only able to view the points interval with the next highest ranked player. Latulipe et al. [99] propose a leaderboard that shows changes from previous weeks as well as total badges earned. These approaches can be enjoyable not only to Players, but also to Achievers. In addition, leaderboards can be subdivided in various ways as proposed Zichermann and Linden [199]: locally, socially, and globally. Seaborn et al. [171] suggest a "pro-social" leaderboard set-up, where all pro-social interactions are recognized in the competitive environment. Thus, social perspectives may also be relevant to the Socializer user type.

Furthermore, *Karma* points [199] are freely given to others based on the perceived quality of their contributions, which may be a very interesting approach for Philanthropists too. A Free Spirit user type could be interested in a weekly leaderboard, ensuring that the leaderboard data is fresher and more dynamic for players, as proposed by Zichermann [199]. By refreshing leaderboards after a week, newcomers are not at a disadvantage compared to individuals who have been participating for longer [180]. Manipulating success perception in leaderboards [11] may be an enjoyable issue for Disruptors, even providing anonymity, e.g., through non-populated leaderboards where only the player's score is listed [18].

Thus, given the multiple ways that leaderboards can be presented and the increasing number of non-game applications that rely on them, a better understanding of the psychological implications of being placed in a leaderboard position is needed [180]. Regarding the related works presented, results from [77] show that people who are more extroverted tend to like competitive activities. In addition, Ferro et al. [39] propose leaderboards for Killers, considering Bartle's taxonomy [8], due to their need for dominance.

Teams

Regarding teams, a gamification experience designed by Stott and Neustaedter [178] describes how users belong to the same group throughout the whole study (static membership). However, auto-assignment users to a team, as employed by Latulipe et al. [99] might not be enjoyable for Free Spirits. Joining a team for solving challenging assignments [50] may be a meaningful way to motivate Achievers. In addition, cooperative experiences through

a teamwork are proposed by Vegt et al. [188], a "modus operandi" that could motivate Philanthropists.

In contrast, competitions between teams as described by Akpolat and Slany [2] could be enjoyable for Players and Achievers too, similarly to competitive experiences in teamwork situations [188]. Moreover, imposing regulations on groups [50] might not be well-perceived by Disruptors: attenuating a game's anarchy can be a demotivating factor for this user type. Regarding related works, Gil et al. [50] reveal that one of the most frequently used types of mechanics for Socializers are teams, and Ferro et al.[39] conclude that Socializers (from Bartle's) are inclined to be social and involved themselves in tasks that rely on social engagement (Humanists).

Challenges

Regarding challenges, the central aim has been to ensure there is always a challenge to be overcome [199]. However, providing users a sense of autonomy by allowing them to choose which challenges to pursue [5] may be enjoyable to Free Spirits, in contrast to challenges that must be completed in a limited amount of time, as described Zichermann and Linden [199]. The addition of unlockable content in the form of extra challenges [21] could also be attractive to Free Spirits. Additionally, designing challenges to be tackled as independently as possible [37] seem to be attractive to them too.

Moreover, Socializers could choose not to work alone in solving assignments as described by Gil et al. [50]. Providing increasing challenges that motivate increased mastery without frustrating a player to the point of quitting [187] could be a valuable design for Players, who are encouraged by levels and progression. Similarly, challenges being set up not only by the system but also by other players could be enjoyable for Disruptors. From related works, Achievers seem to be motivated by challenges [50] as well as an adequate element for people who seek to achieve and build upon their knowledge through demonstrating their dexterity and intelligence [39].

Voting mechanisms

Regarding voting mechanisms, Hardas and Purvis [62] propose four types: one-to-one, one-to-many, many-to-one, and many-to-many, from the most restrictive approach to the most permissive. Robson et al. [156] describe both positive and negative votes while spectators can vote again and again; this approach may be interesting for Players. An hybrid voting system is described too by Tian et al. [181], where voting is awarded. This may be something enjoyable to Achievers. Another approach [93] describes resources used as currency, which is earned and used to allow players to vote for ideas.

Tian et al. [181] also propose a collaborative voting mechanism (group voting), which may be an interesting approach to Socializers, being more relevant to them than traditional single voting, and the addition of voter histories [62]. A plurality voting rule can give good results where each voter casts single votes to preferred choices, an interesting prospect for Philanthropists who enjoy helping others. This way, Li et al.[102] propose a voting system consisting of thumbs up and thumbs down voting.

Gifting

Gifting is proposed in the form of easily transferable virtual items called *Karma* points [199], which could be a good motivating strategy for Philanthropists and Players, who aim to help others with items gained as rewards. Similarly, gifting is proposed by Gil et al. [50] as giving the player's own points to others as well as giving one of their own badges to another player.

Thus, gifts could be personalized regarding each recipient's taste or sent as a"one-size-fits-all" gift; a promising way to motivate Free Spirits, e.g. gifting with a message from the sender [96]. Socializers may also be motivated when gifting too; Yuizono et al. [197] propose a system where score is obtained by a group and all participants received a gift. In addition, Lampel and Bhalla [96] suggest that gift givers know not only the degree to which others value their gifts, but also how they measure up against other gift givers.

Moreover, gift reminders and recommendations, such as is described by Zichermann and Linden [199], could be enjoyable to Socializers. Some anonymity or mystery (i.e., keeping the sender of the gift secret), could be a way to motivate Disruptors too. Regarding related works, gifting and sharing may promote purpose, by providing additional meaning or value to the actions conducted by Philanthropist [50].

Exploration

Finally, regarding exploration, Nicholson [137] proposes the use of a light reward-based layer as the tutorial for exploration, which could be a relevant design to Players. In addition, Ostberg and Wagner [143] suggest that tasks issued by the exploratory tutorial should increase in difficulty, but should never ask too much for the user.

Additionally, Mele et al. [118] describe the first level as a exploration tutorial, which is intended to engage and activate the user (status) with the application. In this level, the user should be introduced to the application's environment and logic via a virtual tour, an approach that could be interesting for Achievers. Thus, Santos et al. [165] design a system in which users must visit and explore the main areas of the platform to earn the "Explorer" badge. To accomplish the second challenge and win the "Socializer" badge, the users must visit, follow and mention at least one user and make at least one comment; an element that

could be motivating to Socializers. In related works, Gil et al. [50] reveal the exploration as one of the most frequently used mechanics for Free Spirits. Inquisitive users like to explore and investigate new things and are represented by Explorers [39].

3.2.3 Survey Design

The survey has been designed through eight phases, with the involvement of various actors, as described below:

1. **Review**: an initial review has been conducted, focusing on gamification studies that address the connection between user types and game design elements, as well as case studies that describe how different design elements have been applied within gamification experiences (see next subsections 3.2.1 and 3.2.2, respectively).

2. **Design**: a preliminary draft of different ways of implementing each of the selected game design elements (subsequently referred to as "statements") has been developed, based on findings from the previous phase. Initially, it consists of a total of 87 statements.

3. **Expert validation**: a filtering process from the initial statements has been conducted by means of feedback from experts in human-computer interaction and games user research. The result has been a list of the six top-rated statements for each game design element (see Table 3.1), improving the validity of the proposal, and keeping the sense and purpose of the study. Experts have been eligible to join a focus group to rate the statements if they met the minimum requirements: being a Ph.D. or a Ph.D. candidate in one of the participant institutions with a demonstrable expertise in the field and knowledge of the Hexad model. The recruitment process has been carried out through personalized invitations sent by e-mail. A total of eight experts voluntarily have joined the focus group (4 Ph.D. and 4 Ph.D. candidates).

4. **Ethical approval**: the developed survey has received clearance from the ethics committees of the three institutions involved in this work (Ethics Committee of the Open University of Catalonia, Office of Research Ethics of University of Waterloo, and Ethics Committee on Research and Animal Welfare of University of La Laguna; see Appendix B).

5. **Translation**: two independent native speakers separately have translated all the statements and descriptions in the survey from Spanish, the original language, to English,

Portuguese, and Catalan. Finally, each translated version has been compared and discussed by an independent third native speaker.

6. **Pilot test**: a pilot survey has been run with a sample of participants (excluding researchers and experts in the field). Its purpose is an early identification of syntax or translation errors, as well as statements that participants found ambiguous or easy to misunderstand.

7. **Activation**: the survey has been enabled for 60 days.

8. **Dissemination**: a media campaign has been conducted by means of mailing lists, social networks, specific forums, and related events.

3.2.4 Participants

Regarding dissemination, a great effort has been put into getting a wide and representative sample. To this end, participants have been mainly recruited through snowball sampling with the use of e-mails (both academic and non-academic environments), through social networks and gamer events (e.g., Barcelona World Games), and the Learning Management Systems (LMS) of the participating institutions. All templates, contents and messages used in dissemination have been previously approved by the three ethic committees. It has been attempted the recruitment without offering a direct remuneration (commonly used in studies held by crowdsourcing platforms, which require micro payments per answer). Instead, all participants have been invited to enter a draw for two 50 Euro virtual gift cards (or equivalent in another currency), providing a valid e-mail address for this purpose. Due to the wide sample required in any exploratory study, additional dissemination labours have been carried out during the life cycle of the survey.

Thus, the total number of participants who have answered the survey is 925. However, 240 of them have been discarded because they have only partially completed the survey: 95 have not report any information, 74 have just provided demographic information, and 71 have only answered questions regarding general preferences. Afterwards, 50 participants more have been discarded due to they completed the survey in less than 5 minutes, the minimum dedication time (at least an average of 5 seconds per question) a necessary time to understand the questions correctly and respond in a non-random way. Finally, 45 participants who specified that in a typical week they played games for less than 10 minutes or null have been excluded to prevent a possible lack of awareness on the survey statements. This procedure has discarded a total of 335 respondents (36.2%) from the initial sample, retaining a final sample of 590 participants. It has been considered this step to be vital in assuring the

reliability and validity of the study, despite the considerable reduction to the initial sample. Additionally, participants have been required to be at least 18 years old to participate. In a graphical way, the systematic filtering process conducted is shown in Figure 3.2.

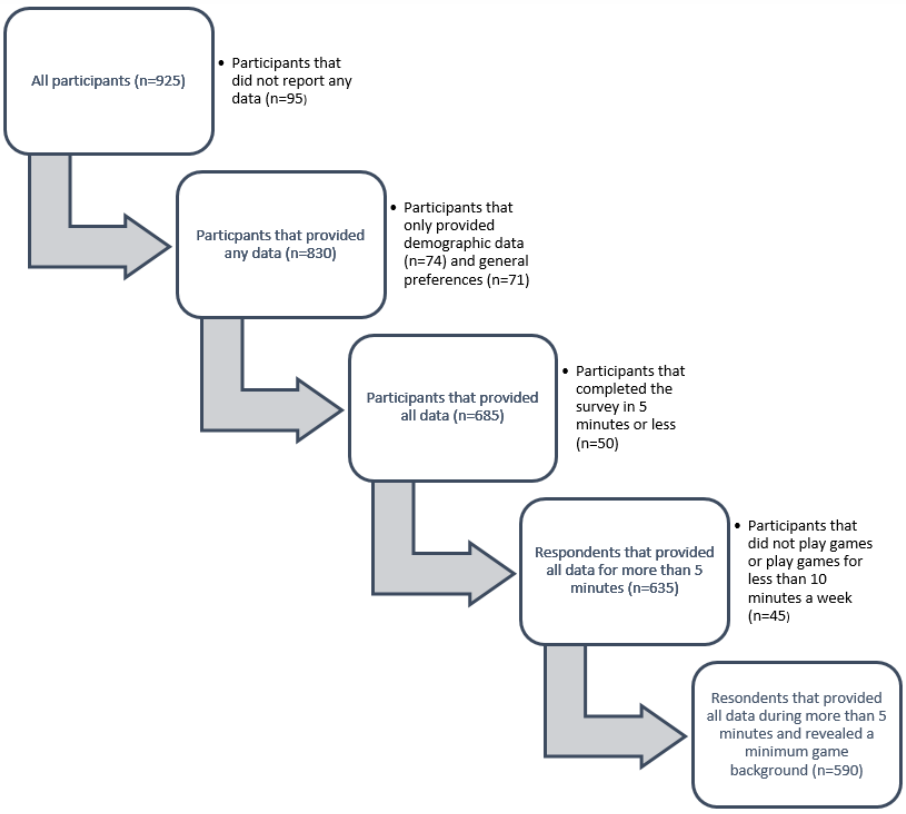

Figure 3.2 Sample's filtering process

3.2.5 Procedure

The study is based on an online survey, which has allowed us to collect data from a wide range of participants all over the world. As follows, the survey design and methods, and the recruitment process are described. The survey has been deployed in an online service (using the Lime Survey software). This has allowed to design and conduct a large-scale online survey translated into four languages, trying to ensure as much as possible the equivalence and validity of the statements used. The purpose when translating the survey has been to reach the maximum number of native speakers (adding up the four languages, there are close to one billion potential respondents in the world). In this study, participants have been asked to complete a 15-minute survey made up of questions focused on their preferences while using gamification systems within digital applications, which consisted of 5 sections with a total of 67 questions grouped as follows.

- Four questions about demographics (age, gender, country, and native language), with the purpose of describing the sample and analyzing its validity and representativeness.
- Two questions about gaming habits, aimed at assuring respondents have a minimal background in the field of the present study. By means of these questions, it has been aimed to ensure that respondents really understand the content of the proposed statements, trying to avoid random answers, which could be given due to a lack of awareness.
- Twenty four questions (7-point Likert scale) about interactions with gamification digital applications from the Gamification User Types Hexad Scale [184]. It has been a useful way to assess how user motivations are represented by the different user types. The purpose of this block of questions is to attempt a user segmentation based on their preferences when interacting with a gamification experience.
- Six questions (open questions) regarding examples of games which implement the game design elements they are asked about. By means of this, it has been aimed to measure the respondents knowledge about the elements on which the sentences are based, towards the validity of answers.
- Thirty questions (7-point Likert scale) regarding experience and enjoyment of different ways of implementing the selected game design elements described in Section 3.2.2 through statements (see Table 3.1). The purpose of these questions was to measure their relevance to diverse configurations of user types.
- One question (contact e-mail) inviting respondents to join the survey draw of two rewards.

By default, the survey could be completed anonymously and has allowed the participants to skip any of the proposed questions. Prior to the decision to participate, participants have been informed about the estimated time required to complete it. At any time during the process, participants have had the possibility to check their progress within the survey and abandon it if desired. The site has been programmed to only collect responses and not information that could potentially identify the respondents. In appreciation of the effort and time invested by respondents, they have had the option to participate in a draw, which only requires the submission of a valid e-mail address. To sum up, and considering the findings from the review, the following statements have been proposed and presented for the study in Table 3.1:

Table 3.1 Statements analyzed per game design element

	ID	Statement	Expected User Types
Leaderboards	S1	I like leaderboards that are regularly reset so newcomers will not be at a disadvantage	Player-Free Spirit
	S2	I like when leaderboards highlight each users' status	Player-Achiever
	S3	I like leaderboards that only display users from my peer group and friends	Player-Socializer
	S4	I like disrupting the leaderboard by lowering the cores of others	Player-Disruptor
	S5	I like leaderboards in which I can transfer points to others to help them climb up	Player-Philanthropist
Teams	S6	I like the freedom to join and leave a team whenever I wish	Socializer-Free Spirit
	S7	I like teams that have minimal requirements to join them	Socializer-Achiever
	S8	I like teams in which members depend on one another, one for all, all for one	Socializer-Philanthropist
	S9	I like to make comparisons between different teams (e.g., stats)	Socializer-Player
	S10	I like teams without pre-established rules	Socializer-Disruptor
Challenges	S11	I like challenges with multiple paths for success	Achiever-Free Spirit
	S12	I like challenges where I know I will be rewarded for overcoming them	Achiever-Player
	S13	I like to create challenges for other people	Achiever-Disruptor
	S14	I like challenges that must be completed in teams	Achiever-Socializer
	S15	I like helping others to overcome their challenges	Achiever-Philanthropist
Voting	S16	I like always voting for positive consequences for others	Disruptor-Philanthropist
	S17	I like it when my voting effort is rewarded	Disruptor-Player
	S18	I like it when it is required to have a certain status to vote	Disruptor-Achiever
	S19	I like to know how other people voted before I vote	Disruptor-Socializer
	S20	I like to have the freedom to choose a positive, blank, or negative vote	Disruptor-Free Spirit
Gifting	S21	I like anonymous gifting	Philanthropist-Disruptor
	S22	I like to customize my gifts	Philanthropist-Free Spirit
	S23	I like to know how much others value my gifts	Philanthropist-Socializer
	S24	I like it when gifting is not restricted to objects (e.g. - invitations or- access)	Philanthropist-Achiever
	S25	I like it when gifting is considered valuable	Philanthropist-Player
Exploration	S26	I like it when exploring provides additional advantages for me	Free Spirit-Player
	S27	I like it when exploration is required for the user progress	Free Spirit-Achiever
	S28	I like to be able to influence others ability to explore	Free Spirit-Disruptor
	S29	I like it when exploring facilitates social connections	Free Spirit-Socializer
	S30	I like when my feedback or advice can help other users explore	Free Spirit-Philanthropist

3.3 Analysis and Results

The analytical process described in the following subsections has been conducted using the R tool (version 3.2.2) [152], a free software environment for statistical computing.

3.3.1 Demographics

The distribution of the final sample of 590 participants, considering gender, age, selected survey language, and native language, is presented from Tables 3.2 to 3.5. In a general view, the sample has been composed of slightly more males (58.31%) than females. Participants' ages have ranged from 18 to 65 years old, where the mean has been 31.40, and the first and the third quartiles have been 23 and 38, respectively. Regarding language versions, Spanish and English languages have been the most widely chosen to complete the survey. Only 9.83% of participants have had to complete it in a language that is not their native language, which indicates that most (if not all) participants have not faced any trouble understanding the meaning of the questions. Although English natives are only 16.78% of the sample, the English version of the survey has been selected by 28.47% of the participants, most of them coming from countries whose official languages are not available in the survey. The cultural representation of the sample have been high, obtaining answers from participants of 47 different countries from six continents, with the following being the top six represented: Spain (316, 53.83%), Canada (74, 12.61%), Brazil (28, 4.77%), Mexico (28, 4.77%), USA (19, 3.24%), and Argentina (18, 3.07%). The complete list of countries of origin is shown in Appendix C.

Table 3.2 Sample's gender

	Total	**Perc. (%)**
Male	344	58.31
Female	238	40.34
Other	6	1.02
Missing value	2	0.34

Table 3.3 Sample's age

	Total	**Perc. (%)**
18–29	290	49.24
29–41	203	34.47
41–53	76	12.90
53–65	20	3.40
Missing value	1	0.17

This way, the comparative popularity of ways to access the survey have been: e-mail (63%), Facebook (19%), LinkedIn (5%), UOC's virtual learning environment (3%), and Twitter (3%), among others (7%). 78.98% of the participants have registered their email address in order to participate in the draw. Regarding respondent background, most respondents play games for an amount of time on one day a week (17.46%), or three days (16.10%), or up to seven days a week (29.32%). It is noteworthy that, on average, those playing only one or

Table 3.4 Sample's selected survey language

	Total	Perc. (%)
Spanish	333	56.44
English	168	28.47
Catalan	59	10.00
Portuguese	30	5.08

Table 3.5 Sample's native language

	Total	Perc. (%)
Spanish	351	59.49
English	99	16.78
Catalan	46	7.80
Portuguese	36	6.10
Other	58	9.83

two days (maybe at weekends) have been the oldest, while those that play every day have been the youngest. The fact that their high frequency on playing games makes the data more valid, which provides greater validity to the data obtained in this study. Moreover, a total of 89.32% of respondents have provided at least one application example of each game design element asked, which is not a mandatory section within the survey.

3.3.2 User demographics and preferences

As previously mentioned, user preferences have been assessed using the Gamification User Types Hexad Scale [184], a validated survey about interactions with gamified applications. Based on the answers, scores have been obtained for each user type per participant. Next, each respondent has been represented as a *label*, based on the user type in which they have the highest score. Whenever there has been a tie (i.e., the user presents the same score in the highest values), the number of participants assigned to each type has been incremented in 1.0 divided by the number of types involved (e.g., 1.0 if only one type has had the maximum score, 0.5 if two types have had the maximum score, 0.33 if there have been three, etc.). Figure 3.3 shows the comparative frequency of each user type in the sample (up) and the sample of Tondello et al. [184] (down). Thus, Philanthropists (27%) and Achievers (25%) are the predominant groups, followed by Free Spirits (22%). Then it comes Players (17%) and Socializers (8%), and there are only a few Disruptors (1%) in the sample.

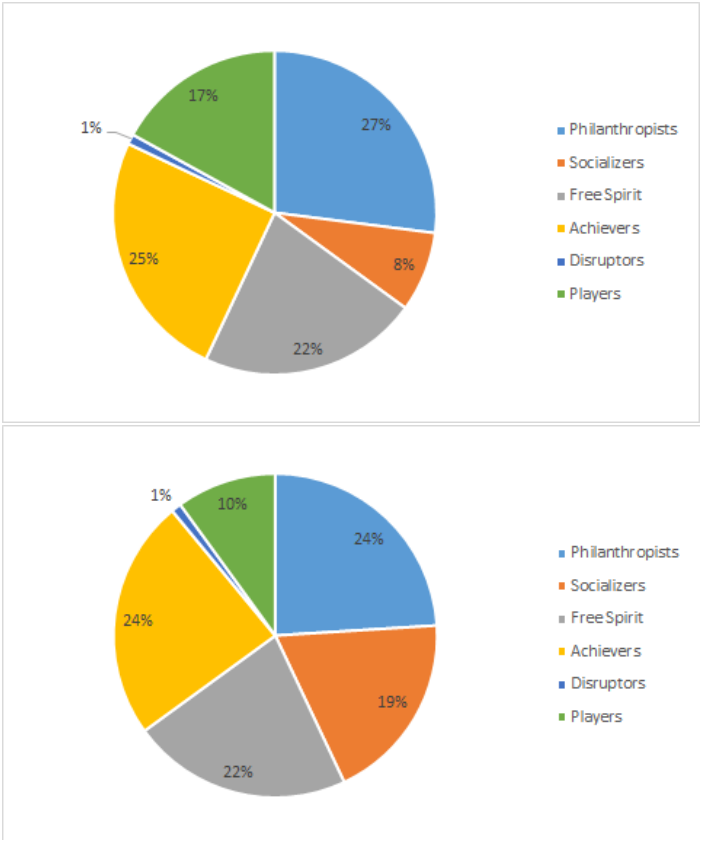

Figure 3.3 Distribution of the Hexad User Types (sample vs Tondello et al.)

The results of the aforementioned paper are quite similar. In this case, there have been many ties: 23.05% of the participants have had an equal high score in two groups, 4.41% in three, 2.03% in four, 1.02% in five and less than 0.01% in six. This means that 30.52% respondents (almost one in three) have not stood out as being a specific user type, a fact which gives special relevance to the hybrid approach to user types deployed in this work.

Regarding demographics, Figures 3.4, 3.5, and 3.6 show the distribution of user types by gender, age, and country, respectively. There seems to be a higher percentage of Philanthropists among females, whereas there seems to be more Socializers, Free Spirits and Players among males. However, Pearson's chi-squared test for independence has not revealed a significant association between primary user types and gender: $\chi^2(5) = 8.45, p = 0.133$.

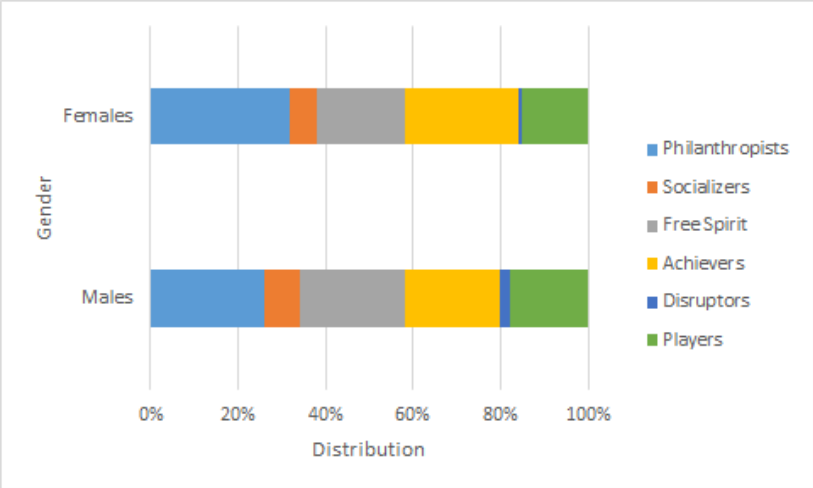

Figure 3.4 Distributions of sample's user types per gender
$N = 589$

Regarding age, it seems that the older the participant, the less their likelihood of being Achievers or Players, and the higher their chances of being Socializers, Philanthropists or Free Spirits. The tendency is clear but that results from the interval of 53-65 years old should not be considered due to the reduced sample size ($N = 20$). Additionally, the chi-squared test have not revealed a significant association between the primary user type and age: $\chi^2(15) = 17.30, p = 0.301$.

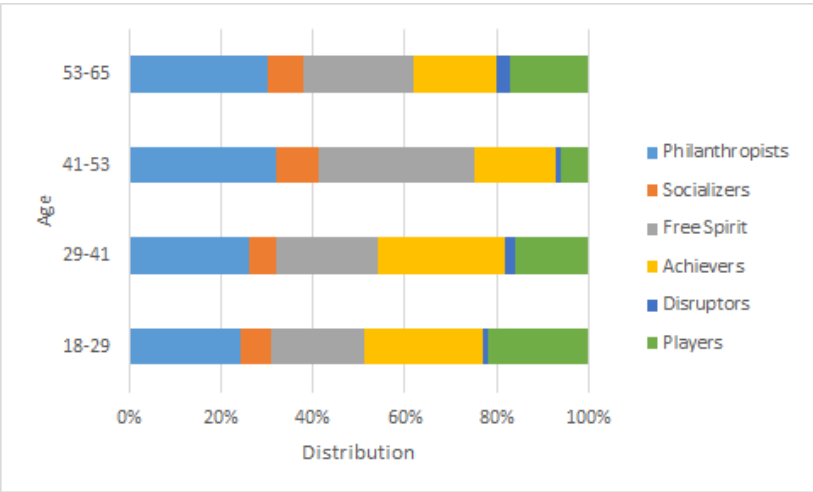

Figure 3.5 Distributions of sample's user types per age
$N = 589$ ($missingvalues = 1$)

Interestingly, user types per country are more differential. Accordingly, Canada and Brazil seem to present more Philanthropists; while the former has more Players, the latter

has more Achievers. Brazil also stands out for the highest percentage of Disruptors. On the other hand, both Spain and Mexico have higher proportions of Achievers. By applying Pearson's chi-squared test, it can be concluded that the factors of country of origin (or possibly the culture of that country's population) and primary user types are not independent: $\chi^2(15) = 28.17, p = 0.021$.

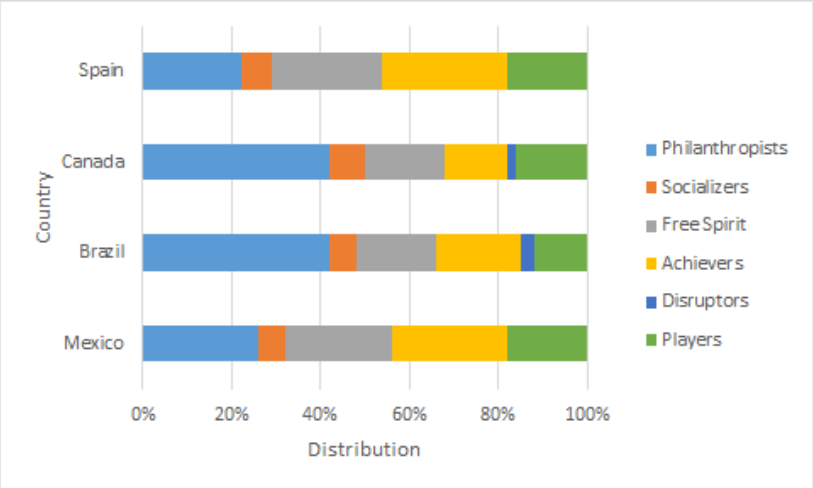

Figure 3.6 Distributions of sample's user types per country
$N = 446$

Considering a hybrid viewpoint, Table 3.6 shows the percentage of participants for each combination. In addition to computing the ties, the difference between the two highest scores (which may range from 0 to 28) has been also analyzed. As already noted, they are the same for 30.51% of the participants. The difference is equal to 1 point for 61.86%, equal to or below 2 for 80.68%, and equal to or below 3 for 90.00% of them. The mean of this difference is 1.45. These results show that the participant's user type should not be correctly identified by a highest score alone, since these differentials are very low for most participants. Thus, Table 3.7 gathers the correlations between pairs of scores. As is usual for ordinal variables, Kendall rank correlation coefficients (or Kendall's τ) has been computed. Since the absolute values of τ tend to be lower than the corresponding Pearson's r and Spearman's ρ, interpretation of effect sizes has to be adjusted. Based on Gilpin [51], the following equivalences are considered: small effect, $\tau = 0.20$ ($\approx r = 0.30$); medium effect, $\tau = 0.34$ ($\approx r = 0.50$); and large effect, $\tau = 0.50$ ($\approx r = 0.70$). Accordingly, the correlations between the scores of these pairs of user types seem to be relevant. While Philanthropists and Socializers present a medium effect, Free Spirits and Achievers, Philanthropists and Free Spirits, and Philanthropists and Achievers present a small effect.

Table 3.6 Combination of user types with highest scores

User types with the highest scores					Perc. (%)
Achievers	Free Spirits				15.25
Free Spirits	Philantropists				11.69
Achievers	Philantropists				11.02
Philantropists	Socializers				8.14
Achievers	Players				7.80
Achievers	Free Spirits	Philantropists			7.29
Free Spirits	Players				6.10
Philantropists	Players				3.73
Achievers	Socializers				2.54
Achievers	Philantropists	Socializers			2.54
Achievers	Free Spirits	Players			2.37
Free Spirits	Philantropists	Socializers			2.37
Achievers	Free Spirits	Philantropists	Socializers		2.37
Free Spirits	Socializers				2.03
Players	Socializers				2.03
Achievers	Philantropists	Players			1.19
Free Spirits	Philantropists	Players			1.19
Achievers	Free Spirits	Philantropists	Players	Socializers	1.19
Philantropists	Players	Socializers			1.02
Achievers	Free Spirits	Socializers			0.85
Achievers	Free Spirits	Philantropists	Players		0.85
Disruptors	Free Spirits				0.68
Disruptors	Philantropists				0.68
Achievers	Free Spirits	Players	Socializers		0.68
Free Spirits	Philantropists	Players	Socializers		0.68
Achievers	Socializers	Players			0.51
Achievers	Disruptors	Free Spirits	Philantropists		0.51
Disruptors	Socializers				0.34
Disruptors	Players				0.34
Disruptors	Philantropists	Socializers			0.34
Free Spirits	Players	Socializers			0.34
Achievers	Philantropists	Players	Socializers		0.34
Achievers	Disruptors				0.17
Achievers	Disruptors	Players			0.17
Achievers	Disruptors	Free Spirits			0.17
Achievers	Disruptors	Philantropists			0.17
Disruptors	Players	Socializers			0.17
Achievers	Disruptors	Free Spirits	Philantropists	Socializers	0.17

Table 3.7 Kendall rank correlation coefficients between scores of user types

	Philanthropists	**Socializers**	**Free Spirits**	**Achievers**	**Disruptors**	**Players**
Philanthropists	1**	**0.39****	**0.27****	**0.21****	0.07*	-0.06*
Socializers		1**	0.16**	0.14**	0.02	0.05
Free Spirits			1**	**0.29****	0.19**	0.02
Achievers				1**	0.15**	0.11**
Disruptors					1**	0.11**
Players						1**

Note. Relevant effects ($\tau >= 0.20$) are marked in bold. * $p < 0.05$ ** $p < 0.01$

Thus, figures 3.7 to 3.9 show the distributions of the five most frequent combinations of user types for the same criteria previously used. Regarding gender (Figure 3.7), while there have been relatively more Achievers-Free Spirits among females, the proportion of Free Spirit-Philanthropists is lower. The differences is not statistically significant: $\chi^2(4) = 0.03, p = 0.999$. According to Figure 3.8, the proportion of Achievers-Free Spirits is lower among older users while those of Free Spirit-Philanthropists and Achievers-Philanthropists is higher. Moreover, the proportion of Achievers-Players is higher among the young. Notice again the interval of 53-65 years old where the trend does not persist. It should not be considered due to the reduced sample size ($N = 20$).

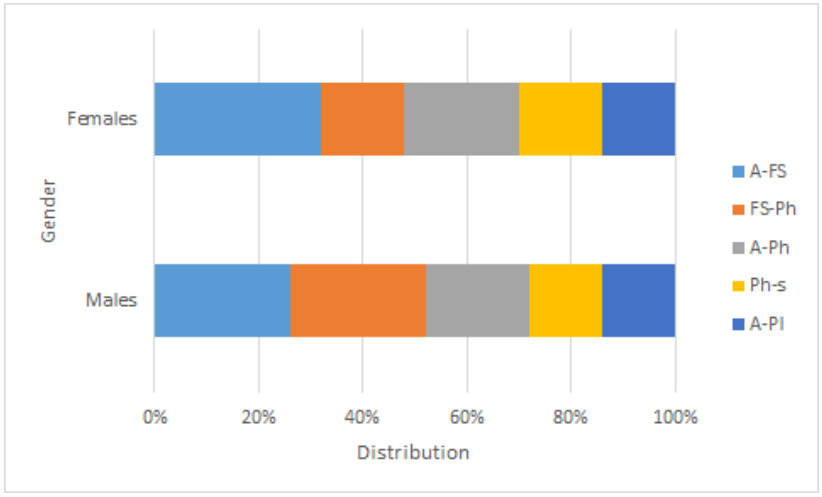

Figure 3.7 Distributions of top sample's hybrid user types per gender.
$N = 317$

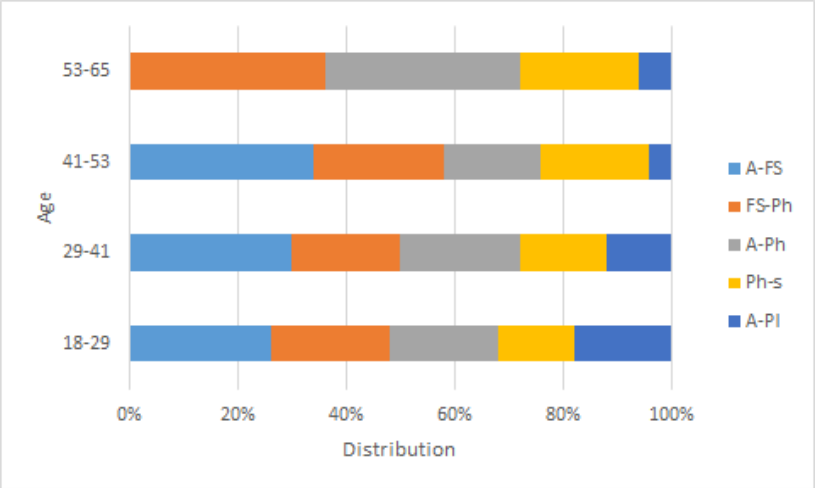

Figure 3.8 Distributions of top sample's hybrid user types per age.
$N = 318$

Finally, Figure 3.9 shows that there is a high variability among countries. Of these, the most salient differences are that Canada and Spain have a lower proportion of Achievers-Free Spirits, while Spain has a lower proportion of Free Spirits-Philanthropists and Achievers-Players, and a bigger proportion of Achievers-Philanthropists. Nevertheless, the differences are not statistically significant: $\chi^2(12) = 1.743, p = 1$.

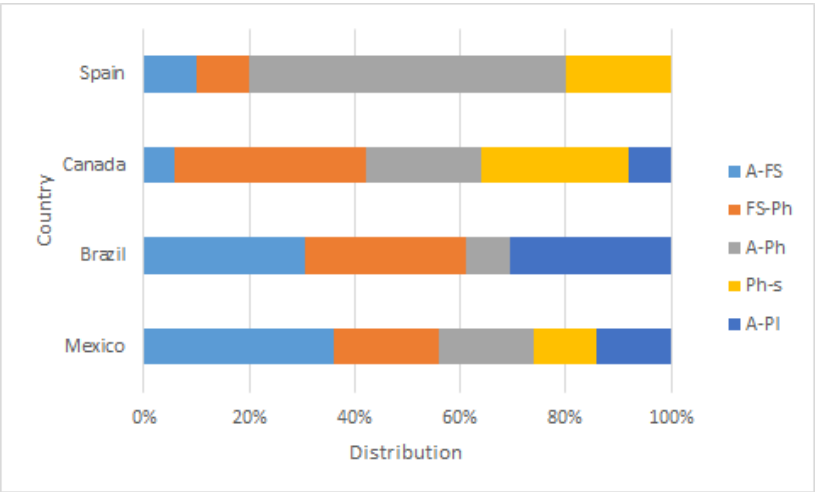

Figure 3.9 Distributions of top sample's hybrid user types per country.
$N = 248$

3.3.3 Interaction with game design elements

After describing the features user types and demographics of the sample, the assessment of game design elements by participants and how the different users types interact with these elements have been analyzed. Firstly, participants' experience with each game design element are analyzed. While leaderboards (76.95%), teams (70.34%), challenges (61.86%), and exploration (57.97%) have been the most frequently encountered, gifting (42.88%) and voting (23.73%) have been experienced by significantly fewer respondents. Table 3.8 shows the correlation scores between user types and the statements related to each game design element. In 15 of the cases, a relevant effect (in bold) has been observed and described:

- **Leaderboards**: two statements, S2 (I like when leaderboards highlight each user' status) and S4 (I like disrupting the leaderboard by lowering the scores of others) are weakly correlated with Players.
- **Teams**: one statement, S8 (I like teams in which members depend on one another, one for all, all for one) presents a weak correlation with Philanthropists and Socializers.
- **Challenges**: four statements are correlated with the user types: S12 (I like challenges where I know I will be rewarded for overcoming them) reveals a moderate correlation with Players, S13 (I like to create challenges for other people) a weak correlation with Philanthropists, S14 (I like challenges that must be completed in teams) a weak correlation with Socializers, and S15 (I like helping others to overcome their challenges) a moderate correlation with Philanthropists and a weak correlation with Socializers, Free Spirits and Achievers.
- **Voting**: two statements are correlated with the user types, S17 (I like it when my voting effort is rewarded) presents a moderate correlation with Players while S20 (I like to have the freedom to choose a positive, blank, or negative vote) has a weak correlation with Achievers. It is noteworthy that statements from 16 to 20, all related to Disruptors, show low coefficients for that user type.
- **Gifting**: one statement, S23 (I like to know how much others value my gifts) presents a weak correlation with Players.
- **Exploration**: two statements, S29 (I like it when exploring facilitates social connections) presents a weak correlation with Socializers and S30 (I like when my feedback or advice can help other users explore) with Philanthropists.

Table 3.8 Kendall rank correlation coefficients between user types' scores and statements regarding design elements

	Stat.	Philanthropists	Socializers	Free Spirits	Achievers	Disruptors	Players
Leaderboards	S1	0.11	0.11	0.06'	0.12	0.03	0.05'
	S2	0.06	0.12	0.07	0.10'	0.11	**0.27**'
	S3	0.11	0.06'	0.07	0.03	-0.02	0.05'
	S4	-0.10	-0.02	0.01	-0.03	0.08'	**0.20**'
	S5	0.18'	0.17	0.14	0.10	0.09	-0.03'
Teams	S6	0.04	-0.02'	0.12'	0.09	0.05	0.10
	S7	0.05	0.08'	0.05	0.00'	0.07	0.11
	S8	**0.22**'	**0.22**'	0.12	0.12	0.03	0.02
	S9	0.06	0.07'	0.12	0.12	0.11	0.17'
	S10	0.03	0.03'	0.05	0.02	0.09'	0.03
Challenges	S11	0.11	0.02	0.15'	0.17'	0.09	0.14
	S12	0.06	0.08	0.11	0.08'	0.04	**0.34**'
	S13	**0.21**	0.18	0.18	0.13'	0.14'	0.12
	S14	0.16	**0.29**'	0.13	0.15'	0.02	0.08
	S15	**0.39**'	**0.26**	**0.24**	**0.21**'	0.05	-0.02
Voting	S16	0.16'	0.08	0.07	0.11	-0.04'	-0.01
	S17	0.04	0.08	0.08	0.05	0.06'	**0.32**'
	S18	0.02	0.05	0.09	0.01'	0.05'	0.08
	S19	0.00	0.04'	0.03	0.00	0.03'	0.13
	S20	0.12	0.10	0.15'	**0.20**	0.00'	0.13
Gifting	S21	0.10'	0.07	0.09	0.09	0.02'	-0.02
	S22	0.11'	0.11	0.12'	0.08	-0.01	0.06
	S23	0.09'	0.11'	0.05	0.04	-0.03	**0.21**
	S24	0.14'	0.14	0.15	0.10'	-0.05	0.10
	S25	0.19'	0.16	0.08	0.07	-0.01	0.14'
Exploration	S26	0.11	0.05	0.14'	0.10	0.07	0.19'
	S27	0.09	0.08	0.16'	0.15'	0.07	0.10
	S28	0.14	0.16	0.13'	0.13	0.09'	0.09
	S29	0.16	**0.28**'	0.12'	0.07	0.02	0.14
	S30	**0.25**'	0.16	0.16'	0.14	0.06	0.05

Note. Relevant effects ($\tau >= 0.20$) are marked in bold.
' identifies correlations expected to have the highest coefficients according to the theory.

Table 3.9 Kendall rank correlation coefficients between pairs of user types' scores and statements on game design elements

		Ph-S	**Ph-FS**	**Ph-A**	**Ph-D**	**Ph-Pl**	**S-FS**	**S-A**	**S-D**	**S-Pl**	**FS-A**	**FS-D**	**FS-Pl**	**A-D**	**A-Pl**	**D-Pl**
Leaderboards	S1	0.12	0.10	0.14	0.09	0.09	0.12	0.15	0.08	0.08	0.10	0.06	0.07'	0.07	0.09	0.03
	S2	0.11	0.08	0.08	0.11	**0.26**	0.12	0.13	0.14	**0.26**	0.10	0.11	**0.27**	0.12	**0.27'**	**0.26**
	S3	0.10	0.10	0.09	0.04	0.11	0.08	0.07	0.02	0.07'	0.06	0.01	0.08	0.00	0.06	0.02
	S4	-0.07	-0.06	-0.08	0.00	0.11	0.00	-0.03	0.05	0.13	-0.01	0.06	0.18	0.04	0.14	0.18'
	S5	0.19	0.20	0.18	0.16	0.06'	**0.20**	0.17	0.15	0.07	0.14	0.14	0.04	0.12	0.01	0.04
Teams	S6	0.01	0.07	0.07	0.05	0.09	0.03'	0.02	0.02	0.05	0.10	0.07	0.12	0.07	0.11	0.09
	S7	0.07	0.06	0.03	0.08	0.13	0.08	0.05'	0.11	0.13	0.02	0.07	0.11	0.04	0.08	0.12
	S8	**0.25'**	**0.21**	**0.21**	0.14	0.14	**0.22**	**0.23**	0.14	0.13	0.14	0.08	0.07	0.09	0.08	0.03
	S9	0.08	0.11	0.10	0.11	0.18	0.11	0.12	0.12	0.18'	0.14	0.14	0.19	0.14	0.19	0.17
	S10	0.03	0.03	0.03	0.10	0.05	0.04	0.03	0.09'	0.04	0.05	0.11	0.07	0.08	0.03	0.07
Challenges	S11	0.07	0.14	0.16	0.11	0.16	0.08	0.10	0.08	0.10	0.18'	0.12	0.17	0.15	0.18	0.15
	S12	0.08	0.10	0.07	0.06	**0.32**	0.11	0.09	0.07	**0.28**	0.10	0.06	**0.32**	0.05	**0.29'**	**0.25**
	S13	**0.22**	**0.24**	**0.20**	**0.20**	**0.21**	**0.24**	**0.20**	**0.22**	**0.20**	0.17	0.18	0.19	0.18'	0.17	0.18
	S14	**0.27**	0.18	0.19	0.09	0.14	**0.29**	**0.29'**	0.19	**0.22**	0.16	0.07	0.12	0.09	0.12	0.07
	S15	**0.35**	**0.38**	**0.37'**	**0.23**	0.18	**0.31**	**0.30**	0.18	0.13	**0.25**	0.13	0.08	0.13	0.08	0.02
Voting	S16	0.13	0.14	0.14	0.04'	0.06	0.09	0.10	0.00	0.03	0.09	-0.01	0.02	0.02	0.04	-0.03
	S17	0.07	0.06	0.05	0.06	**0.29**	0.10	0.08	0.09	**0.27**	0.06	0.07	**0.31**	0.07	**0.28**	**0.25'**
	S18	0.05	0.06	0.01	0.04	0.09	0.08	0.03	0.06	0.09	0.06	0.07	0.12	0.04'	0.08	0.09
	S19	0.02	0.01	0.00	0.04	0.12	0.04	0.02	0.05'	0.12	0.01	0.04	0.12	0.02	0.11	0.10
	S20	0.11	0.15	0.18	0.06	0.16	0.13	0.17	0.05	0.14	**0.20**	0.07'	0.17	0.10	0.19	0.08
Gifting	S21	0.09	0.11	0.10	0.07'	0.04	0.09	0.09	0.06	0.02	0.08	0.05	0.00	0.04	0.02	0.00
	S22	0.12	0.13'	0.11	0.04	0.12	0.13	0.10	0.05	0.10	0.10	0.04	0.09	0.02	0.08	0.04
	S23	0.11'	0.08	0.08	0.02	**0.23**	0.10	0.09	0.05	**0.21**	0.05	-0.01	0.19	-0.01	0.18	0.12
	S24	0.17	0.16	0.15'	0.03	0.16	0.17	0.15	0.05	0.15	0.13	0.02	0.14	0.01	0.12	0.04
	S25	0.18	0.15	0.15	0.07	**0.22'**	0.14	0.14	0.09	0.18	0.08	0.02	0.15	0.02	0.13	0.09
Exploration	S26	0.07	0.13	0.10	0.10	**0.22**	0.09	0.08	0.07	0.15	0.12	0.10	0.20'	0.10	0.20	0.17
	S27	0.09	0.14	0.15	0.08	0.12	0.12	0.13	0.08	0.10	0.17'	0.10	0.13	0.13	0.16	0.11
	S28	0.17	0.15	0.15	0.13	0.14	0.18	0.17	0.16	0.14	0.13	0.11'	0.13	0.13	0.14	0.12
	S29	**0.26**	0.16	0.13	0.11	**0.20**	**0.27'**	**0.23**	**0.20**	**0.25**	0.10	0.07	0.17	0.06	0.14	0.12
	S30	**0.22**	**0.24'**	**0.23**	0.18	0.18	**0.20**	0.18	0.13	0.13	0.17	0.10	0.11	0.11	0.10	0.08

Note. Relevant effects ($\tau >= 0.20$) are marked in bold.

' identifies correlations expected to have the highest coefficients according to the theory.

The following abbreviations are used: Ph (Philanthropists), S (Socializers), FS (Free Spirits), A (Achievers), D (Disruptors), and Pl (Players).

Finally, considering correlations between the statements and the highest score for hybrid user types, Table 3.9 presents data about these relationships. The scores for this analysis have been computed as the sum of the scores associated to the referred user types. Therefore, this table provides us more specific information relevant to personalizing game design elements based on users' two highest scored user types instead of the approach commonly used in the literature, where just one is ascribed. Note that by summing scores, a correlation for a pair of user types "A-B" is equal to the correlation for "B-A". The main results are the following considering the effects as relevant when significant and $\tau >= 0.20$:

- **Leaderboards**: moderate correlations appear in statements S2 (I like when leaderboards highlight each users' status) and weakly correlations to S5 (I like leaderboards in which I can transfer points to others to help them climb up). In the first case, all pairs include the Player type, while the second presents a relationship to the pair Socializer-Free Spirit.

- **Teams**: moderate correlations occur in statement S8 (I like teams in which members depend on one another, one for all, all for one), involving the following pairs: Philanthropists-Socializers, Philanthropists-Free Spirits, Philanthropists-Achievers, Socializers-Free Spirits and Socializers-Achievers.

- **Challenges**: this is the game design element with the highest number of moderate correlation effects. Starting with statement S12 (I like challenges where I know I will be rewarded for overcoming them), most pairs with this effect include Players. Statement S13 (I like to create challenges for other people), is popular with Philanthropists and Socializers. Statement S14 (I like challenges that must be completed in teams) is largely of interest to Players. Finally, statement S15 (I like helping others to overcome their challenges) is moderately correlated with Philanthropists, as well as with specific pairs such as Socializers and Achievers.

- **Voting**: moderate correlations occur in statement S17 (I like it when my voting effort is rewarded) and weak in S20 (I like to have the freedom to choose a positive, blank, or negative vote). The former is correlated to pairs that include Players, while the latter is correlated to Free Spirits-Achievers.

- **Gifting**: Philanthropists-Players and Socializers-Players are moderately correlated with S23 (I like to know how much others value my gifts) but only Philanthropists-Players is weakly with S25 (I like it when gifting is considered valuable).

- **Exploration**: weak and moderate correlations have been found with S26 (I like it when exploring provides additional advantages for me), S29 (I like it when exploring

facilitates social connections) and S30 (I like when my feedback or advice can help other users explore). S26 is correlated to Philanthropists-Players, with S29 mainly correlated to groups that include Socializers. S30 is correlated to specific pairs including Philanthropists and Socializers.

3.4 Discussion

In this section, first, the sample is evaluated, next the main findings from the exploratory study are discussed.

3.4.1 Sample representativeness

First, the representativeness of the sample has been checked, which is necessary to make some attempt at extrapolating the conclusions and making them relevant to the whole population (i.e., the worldwide adult population that plays games for at least 10 minutes per week). The size of the study cohort ($N = 590$) is large and not limited to students compared to other published studies in this field (e.g., [184, 77, 50]); however it cannot be considered to be representative globally, due to the limited amount of 47 countries and cultures represented.

3.4.2 User types demographics

Previously, it should be highlighted that the statements related to Philanthropists, Free Spirits, and Achievers have received the highest ratings. Those related to Socializers and Players have received slightly lower ratings, meanwhile, the statements liked by Disruptors are the lower. As expected, these results are close to those obtained by Tondello et al. [184], with minor differences, maybe due to the sample sizes. In their work, Philanthropists (24%) and Achievers (24%) are the predominant types, followed by Free Spirits (22%). The main differences between these results and the current study are in the numbers of Socializers (19%) and Players (10%). Disruptors represents only a small proportion of their sample too (1%).

Analyzing the association between user types and gender, Philanthropists and Achiever females are more common than these user types among the cohort's males (31% and 28% versus 24% and 23%, respectively); and Players and Free Spirits are more common among males (18% and 23% versus 13% and 20%). There is less of a differential between the results and those of Tondello among Socializers and Disruptors (7% and 1% versus 9% and 1%). These results seem to fit with the findings of Hartmann and Klimmt [64]; they observe that men are more likely than women to play highly competitive games, and that they do not

enjoy helping others so much, but are motivated rather by earning rewards, competing, and feeling autonomous. Nevertheless, it is important to note that the chi-squared test has not revealed this gender difference regarding the Hexad user types to be statistically significant.

Regarding age, Philanthropists, Socializers, and Free Spirits are more prevalent among people aged 41-53 (32%, 11% and 31%, respectively), Achievers among people aged 29-41 (28%), Disruptors among peopled aged 53-65 (2%), and Players among younger people aged 18-29 (21%). As stated above, the youngest respondents seem to be more interested in competition and earning rewards. These results seem to fit with a study conducted by Quantic Foundry [151] with gamers, which run a survey of over 140000 users, showing the decrease of interest in competition over the years. The Quantic Foundry study also finds that older respondents preferred in greater proportion to disrupt the system. These results also suggest that age can influence the distribution of the user types in a wide sample; however, the chi-squared test showed that this difference is not statistically significant in the sample.

Examining cultural differences observed through participants' nationalities, Spaniards and Mexicans have a similar distribution of user types (being two countries with a historical cultural relationship and the same national language, Spanish), with a predominance of Achievers (29% and 27%, about average) and to a lesser extent, Disruptors (less than 0.1%). On the other hand, Canadian respondents have a higher proportion of Philanthropists (42%, well above the average of 27%), and a lower proportion of Achievers (13%, below the average of 25%). Brazilians also demonstrate a predominance of Philanthropists (42%); in addition, their country also have the highest proportion of Disruptors (4%, higher than the average of 1%) and a lower proportion of Players (12%, below the average of 17%). These results suggest that cultural differences can significantly influence the distribution of user types in a wide sample and are supported by the chi-squared test, which rejectes the possibility of the user type distribution being independent from the participants' nationalities (culture). However, these findings should be treated with caution due to the sample distribution and size and are not large enough to fully explore this point.

Despite these seemingly relevant differences in the user types' distribution, it is important to note that the scores related to each user type are generally very similar, and 30.51% of the participants have their maximum score equal for two or more groups. Additionally, the difference between the two highest scores is normatively equal to or below 2%. This means that classifying a participant in only one user type is an extreme simplification of their preferences. Therefore, the distribution of combinations of user types with the highest scores has been analyzed. The two most frequent pairs are Achievers-Free Spirits and Philanthropists-Free Spirits, showing that characteristics related to Free Spirits are present in

a larger number of participants than one would assume if only the highest scoring user type is noted.

Nevertheless, focusing on the correlation between pairs of user type scores, the most relevant correlations occur for the pairs Philanthropists-Socializers, Philanthropists-Achievers, Philanthropists-Free Spirits and Achievers-Free Spirits. These are significant combinations, with the Philanthropist type included in all three, and Free Spirits and Achievers found in two of them. Both Disruptors and Players present lower correlation coefficients with the other user types.

In summary, results have revealed that some differences in the demographics of user types based on gender are not statistically significant, although these differences rere prominent in relation to participants' nationalities (culture). However, these findings should be taken with some caution given the characteristics of the sample (more frequency of men, young and Spanish).

3.4.3 Preferences for different game design elements

Regarding participants' previous experience with the game design elements in the study, it seems most respondents are familiar with leaderboards and teams. Challenges and exploration are also familiar to them, whereas voting and gifting are less well-known by participants. Despite the participants' more limited experience with some of the game design elements, these elements still have significant correlations with one or more user types. Therefore, it seemed that less experience with a particular game design element do not affect the results regarding how the user types explain participants' preferences.

Accordingly, a weak correlation has been found between Philanthropists, teams and exploration, a moderate correlation between them and a positive attitude towards challenges, and no correlation has been found with gifting. It is not quite surprising that being Philanthropists as relevant in terms of the frequency of participants in the sample, the expected element related to them (gifting) is relatively less valued (or, at least, it is not identified) by participants. Regarding Socializers, a weak correlations with teams has been found, as expected; however, a weak correlation has been also found with challenges and exploration. Free Spirits presents a weak correlation with challenges, as expected too. Moreover, Achievers presents moderate correlations with challenges and a weaker correlation with voting. The Disruptors user type is not correlated with the suggested game design elements voting or challenges, which differs from the results reported by Tondello et al. [184]. Finally, Players presents the highest number of correlations: weak correlations are observed with leaderboards, challenges, voting, and gifting. It is also noteworthy that challenges are presented in correlations with all user

types except Disruptors; in contrast, gifting and leaderboards are correlated with only one user type, Players.

Thus, these results support the assumption that participants' preferences for different game design elements are affected by their user types. In general terms, current findings suggest that challenges constitute an element expected or desired for almost any user type; leaderboards are preferred by Players; teams should be considered specially for Philanthropists and Socializers; voting mechanisms are enjoyed by Players and Achievers; Gifting should be used to motivate Players; and Exploration is better rated by Socializers and Philanthropists. This means that individuals who score higher in each of these user types are more likely to be motivated and engaged by the game design elements that showed higher correlations. This is valuable information for game designers who want to tailor gamification systems to specific user types: after finding out a user's type scores, individual gamification elements can be prioritized (highlighted) or not (hidden) in a gamified system to increase the likeliness or affording optimal engagement.

Moreover, these calculations are based on questions formed by a set of examples of different ways of implementing the same core game design element. The observed differences show that the way in which a game design element is framed may alter participants' ratings regarding how much they enjoy that particular element, an issue that is not studied by Tondello et al. [184]. This finding suggests avenues for research into the differences in participants' enjoyment of the same element depending on how it is presented, the topic explored in the next subsection.

3.4.4 Effects of different ways of implementing each game design element

As follows, the different ways of implementing the studied game design elements are described:

Leaderboards

One of the statements related to leaderboards: S2 (I like when leaderboards highlight each users' status) presents a moderate correlation with the user types with the presence of Players. It has been an initial suspicion about this element to be enjoyable specially by Players and Achievers, due to the combination of reward and achievement, and the findings support the expectations. Results evince the suitability of leaderboards for all Players, with little influence felt from other user types. Additionally, a small correlation has been observed between S5 (I like leaderboards in which I can transfer points to others to help them climb

up) and the Socializers-Free Spirits pair. This is an unexpected combination, since it does not seem to be related to autonomy, but the freedom of transferring points within a bounded group (within a leaderboard context) maybe justifies this condition.

Teams

Regarding teams, one of the statements: S8 (I like teams in which members depend on one another, one for all, all for one) presents a moderate correlation with the pair composed of Socializers-Philanthropists. This corresponds to the expectation when describing this statement, due to the combination of socialization and mutual help. Nevertheless, the results show that only one sub-type, Socializers (influenced by philanthropy) presents a correlation with this statement, but not other sub-types (i.e., they could prefer a team without direct dependence or support between members). This leads to suspect that a simplification of user types to the predominant one may not be the adequate approach for designing gamification applications. Further, it suggests that considering all user type scores for an individual might be a better approach for personalization. This element also presents weak correlations with influences from either Socializers or Philanthropists.

Challenges

Regarding challenges, all combinations of users types with the influence of Players present a moderate correlation with S12 (I like challenges where I know I will be rewarded for overcoming them). This element has been initially expected to be enjoyable for Achievers and Players, due to the combination of challenges and rewards, but the inclusion of a rewarding system within a challenge seems to be enjoyable to Players of any type. At the same time, S13 (I like to create challenges for other people) has a weak or moderate correlation with all combinations of user types with Philanthropists. Perhaps the possibility of challenging others is perceived as an altruistic action for the benefit of others. Additionally, all pairs with Socializers present a weak correlation with these statements. Moreover, S14 (I like challenges that must be completed in teams) is moderately correlated with all combinations of Socializers (except with Disruptors), although the strongest correlation occurred with the Socializer-Achiever combination. This fits the previous expectations, due to the combination of challenges and teams. Once more, this leads to suspect that how designers implement the same game design element influences Socializers in a variable degree depending on the influence of other user types.

Finally, S15 (I like helping others to overcome their challenges), initially conceived for Achievers and Philanthropists, presents one of the strongest correlation scores, where the prevalence of Philanthropists is notable and explainable by the combination of the action

of aiding others with the purpose of overcoming a challenge. However, other pairs with Achievers are not significantly correlated with this element. For this reason, it seems again that a simplification of user types to the predominant one (generic viewpoint) may not be the most suitable approach for designing gamification applications.

Voting mechanisms

Regarding voting mechanisms, S17 (I like it when my voting effort is rewarded) is expected enjoyable for Disruptors and Players, due to the combination of voting with rewards. The results reveal a moderate correlation with the pair Disruptors-Players as expected, but also other moderate correlations with other pairs based on Players. Additionally, S20 (I like to have the freedom to choose a positive, blank, or negative vote) presents a weak correlation with the pair Free Spirit-Achiever. This suggests that the statements related to voting mechanisms may not have been perceived as an opportunity to change the system, either directly or through other users to force positive or negative change. It might be possible that the selection of a voting mechanism as a theoretically relevant game element for Disruptors is not the most appropriate. However, it must also point out that Disruptors represent only 1% of the sample; thus, no solid conclusions can be drawn regarding Disruptors from this sample.

Gifting

Regarding gifting, S23 (I like to know how much others value my gifts) is theoretically conceived for Philanthropists and Socializers, due to the social interaction between the gift giver and the receiver; however, it presents a weak correlation with one other user type too: Players. It seems that the concept of "value" is perceived from the perspective of a rewarding system, which would make this implementation enjoyable by Players. Perhaps the selection of gifting as a theoretically relevant game element for Philanthropists is not the most appropriate. Notice that the game design elements initially selected for study are those have significant correlations with the Hexad User Types from Tondello et al. [184] except gifting for Philanthropists.

Exploration

Lastly, regarding Exploration, S29 (I like it when exploring facilitates social connections) the strongest correlation score (moderate) with the pair of user types Free Spirit-Socializer is found, as expected due to the combination of social exploration activities. Weaker correlations are also revealed with other combinations featuring Socializers. Additionally, S30 (I like

when my feedback or advice can help other users explore) has a weak or moderate correlation with three combinations featuring Philanthropists (Philanthropist-Socializer, Philanthropist-Achiever and Philanthropist-Free Spirit), the last one being the strongest, which fits with the expectations when proposing this statement, due to the combination of exploration and helping others. Once more, these findings reflect that any Socializer will not be motivated in the same way with social connections as well as Philanthropists.

3.5 Concluding remarks

To sum up, outcomes are valuable insights to personalized gamification design. In particular, it has been shown how demographic variables such as age, gender, and culture can influence preferences to a greater or lesser extent. Furthermore, it has been demonstrated that user preferences based on user types, as well as the different ways that the same game element can be implemented, might strongly affect a user's enjoyment of that element. Therefore, the simplification of user types towards a "unique label" related to the most predominant user type (generic viewpoint) might not be good enough for effective personalized gamification design. These results show that the participants' user types do not seem to be correctly identified by the highest score alone, since differences are very low for most participants. Instead, considering user types from a hybrid perspective (Table 3.9) might be a better approach; however the relation between cost and benefit should also be taken into account. While a complete personalization might be expensive and difficult to design correctly, aggregating the statements considering diverse elements might enhance user engagement.

Finally, Table 3.10 summarizes the outcomes of this study, being a valuable design toolbox for a gamification design framework. It presents the matches or differences between the user types that are expected to be more motivated by the game elements represented by each statement and the hybrid user types, that showed the highest correlations with each statement. For example, if the designers research the composition of their audience (maybe as part of an initial "Persona" research) and find out that Player-Achiever is a combination of user types that is common, this means that they will more likely engage this audience by using leaderboards that reset regularly (S1) and/or highlight each user's status (S2). In contrast, if the combination of Player-Philanthropist is more common, it would probably be better to design a leaderboard that only displays the user's group of friends. Similarly, considering the exploration element, if the target user base has a higher number of Free Spirit-Achievers, it might be interesting to design some sort of exploration that is required for progress; on the other hand, if Free Spirit-Socializers are more common, using exploratory tasks that facilitate social interaction would be a better idea.

Table 3.10 Comparison of the expectations versus the relevant correlations between user types' and statements

	ID	Statement	Expected User Types	Most relevant User Type
Leaderboards	S1	I like leaderboards that are regularly reset so newcomers will not be at a disadvantage	Player-Free Spirit	**Player-Free Spirit**, **Player**-Achiever
	S2	I like when leaderboards highlight each users' status	Player-Achiever	**Player-Achiever**, **Player**-Free Spirit
	S3	I like leaderboards that only display users from my peer group and friends	Player-Socializer	**Player**-Philanthropist
	S4	I like disrupting the leaderboard by lowering the cores of others	Player-Disruptor	**Player**-Free Spirit
	S5	I like leaderboards in which I can transfer points to others to help them climb up	Player-Philanthropist	Free Spirit-Socializer
Teams	S6	I like the freedom to join and leave a team whenever I wish	Socializer-Free Spirit	**Free-Spirit**-Player
	S7	I like teams that have minimal requirements to join them	Socializer-Achiever	Socializer-Player, Player-Philanthropist
	S8	I like teams in which members depend on one another, one for all, all for one)	Socializer-Philanthropist	**Socializer-Philanthropist**
	S9	I like to make comparisons between different teams (e.g., stats)	Socializer-Player	**Player**-Philanthropist, **Player**-Achiever
	S10	I like teams without pre-established rules	Socializer-Disruptor	Free Spirit-**Disruptor**
Challenges	S11	I like challenges with multiple paths for success	Achiever-Free Spirit	**Achiever-Free Spirit**, **Achiever**-Player
	S12	I like challenges where I know I will be rewarded for overcoming them	Achiever-Player	**Player**-Free Spirit, **Player**-Philanthropist
	S13	I like to create challenges for other people	Achiever-Disruptor	Socializer-Free Spirit, Free Spirit-Philanthropist
	S14	I like challenges that must be completed in teams	Achiever-Socializer	**Achiever-Socializer**, Free Spirit-**Socializer**
	S15	I like helping others to overcome their challenges	Achiever-Philanthropist	Free Spirit-**Philanthropist**
Voting	S16	I like always voting for positive consequences for others	Disruptor-Philanthropist	Free Spirit-**Philanthropist**
	S17	I like it when my voting effort is rewarded	Disruptor-Player	Free Spirit-**Player**
	S18	I like it when it is required to have a certain status to vote	Disruptor-Achiever	Free Spirit-Player
	S19	I like to know how other people voted before I vote	Disruptor-Socializer	Player-**Socializer**, Player-Philanthropist
	S20	I like to have the freedom to choose a positive, blank, or negative vote	Disruptor-Free Spirit	**Free Spirit**-Achiever
Gifting	S21	I like anonymous gifting	Philanthropist-Disruptor	**Philanthropist**-Free Spirit
	S22	I like to customize my gifts	Philanthropist-Free Spirit	**Philanthropist-Free Spirit**, Socializer-**Free Spirit**
	S23	I like to know how much others value my gifts	Philanthropist-Socializer	**Philanthropist**-Player
	S24	I like it when gifting is not restricted to objects (e.g. - invitations or- access)	Philanthropist-Achiever	Socializer-**Philanthropist**, Socializer-Free Spirit
	S25	I like it when gifting is considered valuable	Philanthropist-Player	**Philanthropist-Player**
Exploration	S26	I like it when exploring provides additional advantages for me	Free Spirit-Player	Philanthropist-**Player**
	S27	I like it when exploration is required for the user progress	Free Spirit-Achiever	**Free Spirit-Achiever**
	S28	I like to be able to influence others ability to explore	Free Spirit-Disruptor	**Free Spirit**-Socializer
	S29	I like it when exploring facilitates social connections	Free Spirit-Socializer	**Free Spirit-Socializer**
	S30	I like when my feedback or advice can help other users explore	Free Spirit-Philanthropist	**Free Spirit-Philanthropist**

Chapter 4

FRAGGLE: a FRamework for AGile Gamification design of Learning Experiences

4.1 Overview

At this point in time, the need for a conceptual framework for designing gamification becomes clear. As seen in Chapter 2, a wide array of gamification frameworks exists in the literature, but it is noteworthy that most of them have been developed with a business scope in mind, to a lesser extent in learning. However, most of the references in the literature are highly focused on specific experiences [134] or simple sets of guidelines [92, 82]. Thus, gamification of learning seems to be a promising approach to overcome these difficulties, although the achievement of that effect becomes hard without a design framework. Otherwise, unwanted effects during the application of gamification have been already reported in the literature [14]. Accordingly, different learning experiences in higher education contexts report failures due to the use of "ad-hoc" gamification designs [10, 48, 6]. Additionally, back-end reports from instructors show designing issues as cost, time, and difficulties on implementation due to the lack of affordable design processes [138, 190, 72]. Moreover, a gamification design toolbox has been empirically developed in Chapter 3.

Therefore, this Chapter presents an approach to a conceptual framework for designing gamification in educative contexts, built upon Agile methodologies [42]: a FRamework for AGile Gamification design of personalized Learning Experiences. Agile methodologies aim to improve the efficiency and quality of the final developments, having the ability to respond to changes and new definitions, providing the greatest possible satisfaction to the final user

and continuous feedback. Therefore, in contrast to traditional methodologies, Agile relies on incremental developments with very short iterations, giving greater value to the individual issues with high effectiveness in unclear and changeable environments, specially indicated for the personalized purpose. Agile development encompasses a broad set of principles and methodologies; the main inspiration for FRAGGLE are Lean UX [58] and Behaviour-Driven Development (BDD) [23].

On the one hand, Lean UX, (inspired by Lean Startup [155], design thinking, and the Agile development theories), is an approach for an extremely fast User-Centered Design (UCD) which aims to ensure achievements for specific targets under a model based on experimentation. By its application, it is intended to avoid the traditional slow design and production cycles commonly defined for other gamification proposals. The main approach takes the basis of the Lean Startup movement and launches a valued MVP, getting early validation from users about the design and improving on a real world by iterations. Human-Centered Interaction literature proves the usefulness of User-Centered techniques in the design process, in particular by iterative prototypes. Thus, the process is more than just a thoughtful design and will not end when the user's interactions start. Although users are not aware about their participation in the design process, they themselves are indirect designers of the experience. This way, Agile principles are a perfect fit for developments that require quick reaction times, and reducing associate costs and efforts, similar to the requirements when designing a gamified experiences.

On the other hand, BDD is proposed as a synthesis of practices derived from Test-Driven Development (TDD), coming from Extreme Programming methodology (XP). It is based on the specification of user behaviours and how the features should perform. The most important ones for users are developed first. Thus, through the collaboration and continuous feedback, this practice becomes more clear and efficient. The main reasons for BDD application are the proposal of User Stories as outcomes. The implementation process is then limited to only those parts which actually contribute to such outcomes, measured via the Acceptance Tests. Thus, BDD practices let us turn the objectives into readable and manageable specifications. Following these principles, the use of Agile methodologies beyond software development may be appropriate for an affordable design of the gamified experiences since its effectiveness has been proven over the years.

4.2 Design process

Since the knowledge taken from the analysis of the literature review in Chapter 2, the proposed approach is structured in four phases: declaration, creation, execution, and learning, as can be seen in Figure 4.1. At the declaration phase, the conceptualization for the design process is explained covering all design issues. The creation phase covers the gamified design. At the execution phase, tracking is carried out by means of user interaction. Finally, the learning phase includes the analysis and measurement tasks, including necessary management and prediction works for the improvement. At follows, the declaration and creation phases are developed, which are the most relevant to get started.

4.2.1 Declaration

The first phase of the framework aimed to cover the acquisition of the necessary information and the description of assumptions. During this phase, four key concepts must be sequentially declared: problem (as the target to be solved through gamification techniques), root cause (demotivation), the necessary actions for reaching the expected outcomes, and finally, the tests for determining if the behaviours lead to the motivation problem solving.

1. **Problems**. The first task consists of the identification of the difficulties to be solved by gamification. A problem must be previously detected, before starting any gamification design process. Some information, both quantitative or qualitative, is acquired from the learning scope and it is determined that some improvement is required. Then, gamification can be considered as one of the possible solution but never the other way around (by deciding to use it and then looking for a problem that needs solving).

   At the same time, metrics should be identified. They will support a later stage to figure out if the desired objectives have been achieved. Therefore, an objective must be specific, measurable, achievable, relevant, and time-bound.

   e.g. The passing rate by continuous assessment system in the quarterly subject.

   Additionally, once the motivation problems have been identified they should be sorted by a priority iteration in order to attend them through a MVP in a short time.

   e.g. 75% of students in Operating Systems (Computer Engineering grade) do not deliver the tasks through the virtual platform on time, so a continuous assessment process cannot be applied.

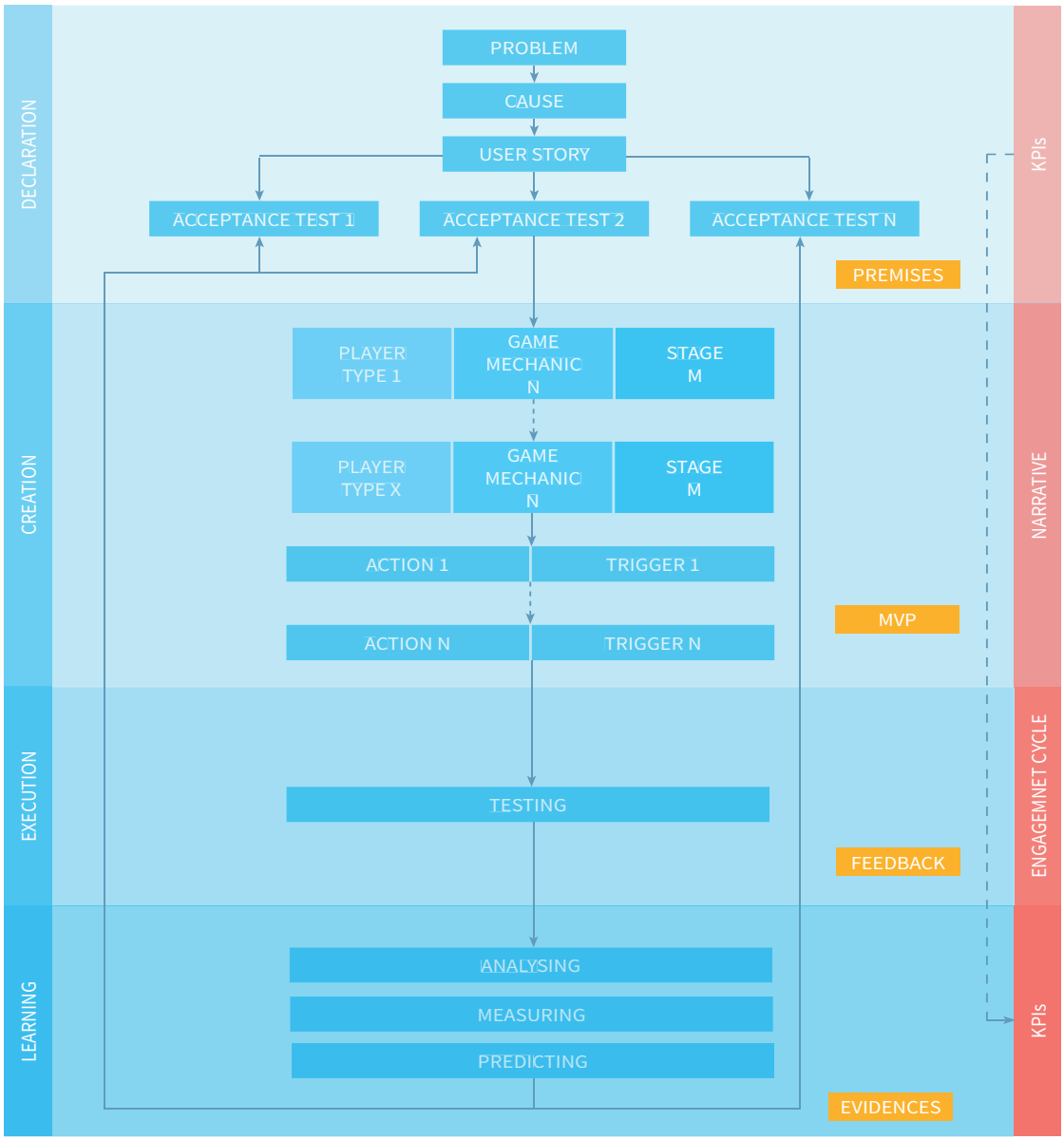

Figure 4.1 FRAGGLE's framework overview

2. **Causes**. This step intends to identify the reasons which caused the previously detected problems. This process can be carried out through the "Five Whys" technique [172], very suitable to Agile environments. This technique relies on recursively repeating the question "Why" five times from the targeted problem and each of the ensuing answers. This procedure can be developed not only subjectively but with information previously gathered from students. Note that the root cause (motivational) must be identified at some stage during this process, otherwise, gamification techniques would not suitable.

e.g. A motivational lack that causes the absence of work habits, a requirement to lead the continuous assessment.

3. **User Stories**. They are descriptions of the desired outcomes (objectives) by setting informal sentences written from the student perspective. Each User Story provides a valuable description of actions to learners towards the engagement. User Stories must be located at the intersection of the learners' and instructors' interests. The creation of such descriptions may be aided by the Role-Feature-Reason template. The basic structure consists of a quantified narrative definition as follows: as a student, I want to feel engaged in...(action), so that...(achievement), during...(time).

   e.g. As a student, I want to feel more engaged to make the regular deliveries, so that I will delivery all of them on time during this semester.

   Therefore, the quality of User Stories should be assessed avoiding ambiguity, being achievable, timely and challenging. The appropriate metrics for the achievements related to the problem are defined. Ethical and legal implications must also be highly considered. Finally, if the feasibility of an User Story is not assured after being described, it must be discarded.

4. **Acceptance Tests**. This step produces a list of expected concrete behaviours which measure the achievement level of each appropriate User Story, through engagement. Each User Story may have a set of Acceptance Tests, which are generated with the aid of the following template: given...(context), when...(action), then...(consequence).

   e.g. Given the first deliverable of the course, then at least 90% of students have made a submission containing the expected work on time.

   Thus, the expected "behaviours" must be aligned with the User Story it belongs to. Although a User Story may have associated different Acceptance Tests, it is not strictly necessary a full coverage, but recommended. The quality of the Acceptance Tests should be ensured avoiding ambiguity and they should be measurable, achievable, timely, and challenging through the definition of the appropriate metrics and Key Performance Indicators (KPI). The actions and the achievements will let to know if the tests have successful passed. Commonly metrics are related to items such as frequency, duration, virality, and rating. An Acceptance Test is considered successful when the values taken from KPIs in data analysis (last phase) exceeded the defined threshold along the time.

4.2.2 Creation

The Acceptance Tests are the starting point of the iterations which are carried out within the Lean process. To pass them, a suitable customization is a relevant issue for their achievement. According to Seaborn [170], gamification in action is defined by the application of a limited number of game elements. Therefore, it becomes essential the knowledge of the most suitable game elements for particular user types and preferences to enable a personalized experience.

At the Creation stage, for each of the Acceptance Tests, the appropriate design components are incorporated under a comprehensive narrative layer, called "metaphor" (any account of connected events as a sequence into the engagement cycle). In this phase, the description of the different players, game mechanics, stages, actions and triggers is developed. The result of the Creation stage will be at least a MVP.

1. **Players**. They are the different users (in learning context, students) who will join voluntarily into a gamified experience. Regarding their attributes, in order to cluster them, several player motivation taxonomies have been developed in the literature [185]. According to SDT [162]. there are three main elements of human intrinsic motivation: relatedness, autonomy and competence. Of course, extrinsic motivation should be present especially in the initial phases, but not highly recommendable to ensure the engagement in a long time.

   Before the interaction with real users, different profiles must be pre-defined. For this reason, it is necessary to describe several *user prototypes*, as the models which would interact within the gamified learning experience. It is an hypothetical segmentation for personalized experiences and provides some of the more useful insights to better understand the different user types who are going to interact with the environment. One approach that fits this issue, is the Gamification Hexad User Types framework [114]. Previous findings demonstrated the usefulness of the Hexad User Types model as a measure of preferred design elements. Note that the interests and motivational issues of players may change along the gamified experience, influenced by the interaction with other players within the learning experience. This issue is considered in the last phase through the design of the appropriate analytic procedure.

   e.g. Student Free Spirit-Achiever, discovering and challenging could be appropriate actions to this profile.

2. **Game mechanics**. They are the key elements in the design. According to the game designer Jesse Schell, "Game mechanics are the core of what a game truly is. They are the interactions and relationships that remain when all of the aesthetics, technology,

and story are stripped away" [167]. Thus, the appropriate selection of game mechanics for each player is a relevant issue for the the engagement purpose. Accordingly, the outcome from the exploratory study presented in the Chapter 3 has allowed the development of the following design tool (see Table 4.1):

3. **Stages**. Any game mechanic is not suitable for every situation. Depending on the time into the engagement flow, different players would not show the same interest and sensitivity from the game elements and motivation. In this cycle, some mechanics are *better* developed at concrete stages, throughout the experience. Therefore, Chou [26] identifies the player's journey in a gamification involvement. In order to decompose the experience, it can be broken into four stages: discovery, on-boarding, mid-game, and end-game.

   e.g. For the student with profile Free Spirit-Achiever, discovering the environment is an appropriate game mechanic to be applied in the on-boarding.

4. **Actions**. At this point, the desired performances, led by the previous design performances, should be well taken into account. Actions are the "verbs" of the gamification. These are the performances that move forward (dynamics). Therefore, different Use Cases [75] must be developed for each proposal including a player, through a game mechanic into a stage, as described before. A Use Case is a list of actions, typically defining interactions between a role, known in Unified Modelling Language (UML) as an "actor" in a system, to achieve a goal. The main purposes for its use are: giving a clear and consistent description of the user performance (desired actions), and determining what the system will run (trigger). The definition of the expected behaviours aims to prevent the situations that players can experience and lead to the disengagement (although it should be considered and dealt with the appropriate trigger). Note that Actions should be complemented with the expected non-desired performances. Therefore, all defined actions will belong or not to the "rules" of experience.

   e.g. For the student with profile Free Spirit-Achiever, by using exploring in the on-boarding stage, the valuable actions are: a) downloading the necessary material to complete the activity, b) checking the statement of the task, and c) uploading the work on time. The unwanted action is: d) no accessing to the relevant topic.

Table 4.1 Gamification design toolbox

Game design element	Feature	User Types
Leaderboards	Leaderboards that are regularly reset so newcomers will not be at a disadvantage	Player-Free Spirit, Player-Achiever
	Leaderboards that highlight each users' status	Player-Achiever, Player-Free Spirit
	Leaderboards that only display users from a peer group or friends	Player-Philanthropist
	leaderboards that enable lowering the cores of others	Player-Free Spirit
	Leaderboards that allow the transfer of points to others to help them climb up	Free Spirit-Socializer
Teams	Teams with the freedom to join and leave	Free-Spirit-Player
	Teams that have minimal requirements to join them	Socializer-Player, Player-Philanthropist
	Teams in which members depend on one another, one for all, all for one	Socializer-Philanthropist
	Teams than enable the comparisons between others (e.g., stats)	Player-Philanthropist, Player-Achiever
	Teams without pre-established rules	Free Spirit-Disruptor
Challenges	Challenges with multiple paths for success	Achiever-Free Spirit, Achiever-Player
	Challenges to be rewarded for overcoming them	Player-Free Spirit, Player-Philanthropist
	Challenges created to other people	Socializer-Free Spirit, Free Spirit-Philanthropist
	Challenges that must be completed in teams	Achiever-Socializer, Free Spirit-Socializer
	Challenges to be overcame with the help of others	Free Spirit-Philanthropist
Voting	Voting for positive consequences to others	Free Spirit-Philanthropist
	Voting effort is rewarded	Free Spirit-Player
	Voting is allowed by means of a certain status	Free Spirit-Player
	Voting knowing other people voted before	Player-Socializer, Player-Philanthropist
	Voting for positive, blank, or negative	Free Spirit-Achiever
Gifting	Gifting anonymously	Philanthropist-Free Spirit
	Gifting in a customized way	Philanthropist-Free Spirit, Socializer-Free Spirit
	Gifting knowing how much others value it	Philanthropist-Player
	Gifting not restricted to objects (e.g. - invitations or- access)	Socializer-Philanthropist, Socializer-Free Spirit
	Gifting is considered valuable	Philanthropist-Player
Exploration	Exploration provides additional advantages for me	Philanthropist-Player
	Exploration is required for the user progress	Free Spirit-Achiever
	Exploration can be by others	Free Spirit-Socializer
	Exploration facilitates social connections	Free Spirit-Socializer
	Exploration can be influenced by others feedback or advice	Free Spirit-Philanthropist

5. **Triggers**. Motivational factors are quite sensitive to interaction issues like feedback. Thus, any action should mean an associated response in order to keep an engagement state during the engagement cycle. Triggers give the necessary feedback to learners when some event happens (actions) in the associated stage. Therefore, they aims to produce emotional responses (aesthetics). Thus, they should be developed as a personalized feedback according to the specific actions described above.

   e.g. For the action "exploration is available in the on-boarding phase", the student may choose between a set of diverse exploratory tasks to easily know how it works, being rewarded.

   All these components should be aligned to the metaphor. This contextualizes the rules in the learning experience, giving sense to the whole experience so it may not be considered arbitrary by the learners. Furthermore, during the design process, it is essential that the five dimensions (one for each letter of SPARC) are taken into account as an extension of SDT for the specific learning scope. These dimensions are:

   - **Sense**: the activity must make sense to the students and be coherent with a learning process.
   - **Purpose**: the activity must have a clear purpose form the instructor's standpoint. This purpose should be aligned with some learning outcomes.
   - **Autonomy**: the activity should be optional and let students make choices.
   - **Relatedness**: each action should have some positive impact on the rest of students or the course itself.
   - **Competence**: the activity should ensure that students will be able to master the rules and the chosen tool. It is worth pointing out that, in SPARC, competence is not related to the ability to achieve learning outcomes, since that would be within the scope of the curriculum design.

4.2.3 Execution

A tool must be used to implement all the design. Once deployed, at least a valued MVP has been developed, during the Execution phase, where the engagement cycle takes place. It will consist of a concatenation of experiences which involve the learners in order to the achieve the proposed objectives. It is conceived by the logical relationship of the elements previously identified and described:

"Players" through motivational incentives do "actions" by adopting the appropriate "game mechanics" at a concrete "stage" activating a "trigger" which produce a feedback under a "narrative" layer leading to new motivations.

Additionally, it is necessary to track and "log" the user interactions in order to allow the acquisition of quantitative data and check the efficiency and effectiveness of the promoted actions. User's feedback becomes essential, although subsequent analytic tasks can determine much finer information about the process. It must be assumed that an optimal design will not be achieved in early iterations. Therefore, it is more important to make design dynamically instead of a planned way. As a result, a personalized *journey* is developed to attend to learners profile and motivators.

4.2.4 Learning

The main purpose of the Learning phase is the analysis and measurement of activities, in order to know the achievement of Acceptance Tests, according to the predefined metrics and corresponding KPIs. A medium or long-term experience requires regular checkpoints to know how the gamified experience has been developed and to ensure the it has being effective regarding the proposed objectives. Therefore, the structure of an existing design should be modified by new iteration to promote the expected learner behaviour in order to redirect possible deviations. Note that a short term-engagement does not imply that the behavioural objectives are going to be achieved, since it can be due to the novelty of the experience. Additionally, the detection of the commonly performances during the courses through the use of patterns must be exploited. Behavioural patterns aims to detect the unexpected behaviour. By its process, the appropriate "solutions" that respond to the specific needs of learners (corrective design) can be provided, even the execution of preventive design actions (e.g. changing the requirements to achieve a new level or setting up some boosters).

4.3 Concluding remarks

The gamification design framework presented in this chapter has been the result of an iterative process started by a brain storming process taking the outcomes of the literature review conducted until a discussion in panel with experts. This approach has been conceived as a flow of incremental designs based on iterations (inspired in the Lean UX since it is specially effective in unclear and dynamic environments like gamified experiences), giving greater value to individual behaviours, through the principles of the Behaviour-Driven Development methodology. Concretely, the design process has been formed by low levels of abstraction for a step-by-step understandable and measurable application, being suitable not only in learning contexts (see case studies in Chapters 5,6, and 7) but in health, as presented in Chapter 8.

Part II

Case studies

The second part comprises the application of the design framework and the evaluation of the impact in learning environments. Chapter 5 presents the design and analysis of an e-learning activity that relies on the application of such an approach as its motivational foundation with the goal of encouraging adult learners to solve non-graded formative activities. It also aims to increase their sense of kinship. The impact of some design items are studied in Chapter 6. With the purpose to investigate if the gamified learning experiences can better motivate and engage students if they are personalized, a new case study is presented in Chapter 7. To conclude this thesis, Chapter 8 presents a gamified crowd-sourcing-inspired tool for cognitive impairment prevention of older adults. It enables personalization both from clinical and engagement perspectives whose design is developed through the design framework and involves the application of the knowledge generated in an industry project.

Chapter 5

"One-size-fits-all" gamification design: a case study in Requirements Engineering

5.1 Overview

The design of a curriculum focuses on guaranteeing that students will acquire the required competences according to the learning objectives of the course. An important factor that the design process should take into account is ensuring that content delivery will be engaging [18]. Students who become engaged in their academic activities have a better chance to persevere in or even embrace activities which do not directly contribute to their final grades, moving from a purely extrinsic motivation (to pass the course) to an intrinsic one (a fruitful learning process). In worst case scenarios, it can even prevent students from dropping the course. Nevertheless, highly motivated students have better chances of success.

However, most of the studies present gamified cases of study on a younger audience [133, 186], usually at the 20-25 age bracket who usually commit full-time to their studies. Therefore, the use of this approach poses an interesting research challenge in some educational contexts with adult learners [89]. This scenario fits with the student profile at UOC, one of the first in the world that is completely online-based, with the main purpose of providing access to higher education to non-traditional students [160]. The average student is more than 30 years old (64%, and 27% for the 40+ age bracket), most work full-time and are financially independent (95%), married (73%) or have children (58%). In the literature about gamification for engagement, there is a lack of studies with adult learners in higher education. Accordingly, a case study of a course-long activity for a software engineering course at UOC, designed though the use of game design principles, is developed in this Chapter. This allowed to get a better understanding about the impact of applying a gamification design in the learning process by means of the use of the proposed framework.

Given this context, the aim of this section is to describe in detail the gamification design of the experience conducted. The study has been carried out with two groups of the Requirements Engineering (RE) course taught online at UOC. Students could optionally take this course during their second year of the Computer Engineering grade after passing a general Software Engineering course. The RE course covered the study of all the activities involved in the requirements engineering process (elicitation, documentation, management and verification & validation) using both Agile and traditional methodologies. It is structured in fifteen school weeks followed by an evaluation period. During the school weeks, students should study the learning resources, resolve three mandatory assignments and participate in discussions

5.2 Design principles

In order to guide the design process of the gamification design in the higher education course with adult learners, goals and basic principles of the experience's are described, as follows:

- **Problem to solve**: two main problems to solve have been identified. First, lack of student motivation to go beyond just solving evaluative activities (0% in last edition), and second, the low sense of comradeship between students – a common issue in the online studies. These issues have been already discussed in the literature [53].
- **Expected behaviours**: the purpose along the present gamification experience is unique and exclusively (EB1) to motivate online students in solving formative (not graded) activities and (EB2) to increase the sense of kinship between e-learners in the same group. In contrast to other existing experiences in the literature, the aim of the gamification experience is not to measure the improvement of the final grades at the end of the experiment.
- **Motivation types**: the participants of this experience fit into four categories identified in an internal study (not public) of the University about the profile of the students. These categories and their frequencies are: (MT1) Passive students (28.1%), who are not considered very organized or disciplined, and tend to be less active; (MT2) Disciplined-materialist students (20.6%), who like discipline and rules, are good workers but are not involved aside from study; (MT3) Persistent-idealist students (28.8%), who are active, organized, creative, empathetic, and involved in social causes and movements; and (MT4) Rebel young students (22.5%), who are the youngest group, tending towards indiscipline, commonly individualists and hedonists, but considered creative and imaginative.

Form a gamified perspective, it is difficult to create a "one-size-fits-all" solution that caters to any user profile. Different people enjoy different kinds of mechanics, and trying to reach everybody usually diminishes the chances of success. Therefore, the generic gamification design has been focused on types (MT2) and (MT3), the ones most demanding and eager to verbalize disagreement if a course does not meet up their quality standards. Of course, the design do not explicitly precluded types (MT1) and (MT4), just focused on a subset of students during the design process. From this starting point, *FRAGGLE* framework has been developed, as well as the *SPARC* design validation of intrinsic motivation presented in 4. Therefore, these dimensions have been applied as follows:

- **Sense**: the activity must make sense to the students and be coherent with a learning process.
- **Purpose**: the activity must have a clear purpose form the instructor's standpoint. This purpose should be aligned with some learning outcomes.
- **Autonomy**: the activity should be optional and let, even encourage, that students make choices.
- **Relatedness**: each action should have some positive impact on the rest of students or the course itself.
- **Competence**: the activity should ensure that students will be able to master the rules and the chosen tool. It is worth pointing out that, in *SPARC*, competence is not related with the ability to achieve learning outcomes, since that would be within the scope of the curriculum design (it is assumed to be correct).

Additionally, three elements are described: (1) the *rules*, which describe the basics of the activity mechanics; (2) the *metaphor*, which contextualizes the rules in the learning context, giving sense to the whole activity so it may not be considered arbitrary by the students; and (3) the *tool* used to implement the rules and the metaphor. Furthermore, during the design process, it is essential that the five dimensions (one for each letter of *SPARC*) are taken into account.

5.2.1 The rules

The rules presented are very simple and inspired in a reward-based crowd-funding model where several *stretch goals* related to a project are achieved by raising monetary contributions from large number of people. In this case, as far as the application of gamification elements

is concerned, *rewards* are presented instead of stretch goals and *quests* instead of money. In fact, gamification seems to work with majority of configurations and pairings with different crowd-sourcing types [128].

The basic element of the formative gamification experience is a list of formative tasks (quests) that students could solve during the course. Tasks could have several characteristics such as: *individual/teamwork* (indicates whether the task must be solved individually or in group), *challenge* (indicates the task is an invitation to a defiance) or *expire* (indicates the task has a deadline to be solved). Moreover, tasks belong to one of the following performance phases within the experience: *on boarding* (simple tasks as first touch and tutoring), *mid-game* (regular task development) and *endgame* (final task to goal achievements).

This set of tasks related to the course topics have been proposed during the first fourteen school weeks of the course (the task-activation time-line is about 5-10 weekly tasks approximately). A subset of them (excluding details) are shown in Table 5.1. Note that, to guarantee the success of the experience, all tasks satisfy two requirements. First, they are small pieces of work that do not require high dedication of the student. Second, they consist of formative activities that students should have originally worked out along the course, regardless of the gamification experience (e.g. there is no artificial increase in the student's workload, the new experience just provided a different course structure). Besides, to facilitate the on-boarding phase, the level of difficulty of the proposed tasks is incremental. The above requirements guarantee the *Sense* and *Competence* dimensions of the *SPARC* validation within *FRAGGLE*.

Every task has a individual score which can be obtained when the task is successfully solved. In this case of study, a total of 100 points by group have been released during the course and, as can be seen in Table 5.1, most of the tasks are worth 1 point. These points are accumulated into a global score, for the whole class as a group, which is updated along the course. All students in a class work as a single team. Several academic-rewards can be

Table 5.1 Formative tasks

Id	Task description	Points	IND	TEAM	CH	EXP	Phase
T1	Convince at least X students to participate in the activity	1		x	x		on boarding
T2	Resolve an exercise proposed in the learning resources	1		x			mid-game
T3	Resolve a doubt posted in the course forum from another student at most 2 days after posting	1	x			x	mid-game
T4	Commit to obtain the highest grade in an evaluative activity of the course	1	x		x	x	mid-game
T5	Resolve an exam model	1		x		x	mid-game
T6	Correct the resolution of an exam developed by another student	1	x			x	mid-game
T7	Answer a survey about the course	2	x				end-game

[1]

Table 5.2 Rewards

Id	Academic-reward	Achievement
R1	Have extra days to deliver the evaluative activity being carried out at the time of reaching the score	10
R2	Evaluate the current activity on 12 points instead of 10	25
R3	Have extra days to deliver the rest of the evaluative activities of the course	40
R4	Provide the students with examples of resolved exams	60
R5	Do not take into account the worst exercise during the evaluation of the exam	80

reached during the course when the point-score achieves a specific score, similar to achieving a stretch goal in a crowd-funding project. In this case, a total of five possible rewards (see Table 5.2) are described. Note that when a reward is achieved, all students could benefit from it even if they have not participated in the activity. This collaborative approach try to address the expected behaviour regarding the kinship and guarantees the *Relatedness* dimension of the *SPARC* design validation.

Because the activity is presented as voluntary, students can decide their grade of participation every moment and choose the tasks they want to solve during the course. This approach addresses the expected behaviour regarding the students motivation and justifies the *Autonomy* dimension of the *SPARC* validation. To sum up, the key game design elements proposed in the collaborative gamification experience are Tasks (quests), Marks (Points) and Academic-Collaborative-Rewards.

5.2.2 The metaphor

The metaphor justifies the use of the rules from student perception, thus the activity does not seem arbitrary. In this regard, the whole activity is presented as an Agile project, a metaphor which perfectly fits into the content of the RE course where the activity has been carried out, justifying again the Sense dimension of the *SPARC* validation. This metaphor also aligns the objectives of the activity with the learning outcomes, and thus guarantees the *Purpose* dimension of the framework.

The game design principles described in the above section perfectly fit into the principles of the Agile software development methodologies such as Scrum. One of the key artifacts of this paradigm is the product backlog, which comprises a list of requirements that a development team maintains for a product. These requirements can be organized using a task board, also called Scrum task board. Usually, a task board is structured in several rows (each one representing one user requirement) and several columns (each one representing the development state - to do, in process, to verify or done - of the tasks involved to achieve each requirement).

Figure 5.1 Task board overview

To fit this metaphor, the concepts of the learning environment are adapted to the Agile context. Therefore, the list of tasks is a task board which contains formative tasks instead of requirements. Following the task board structure, the list of tasks is organized into four sub-lists (see Figure 5.1): *To-Do*, tasks that must be solved, *Doing*, tasks that are being solved by the students, *To Review*, solved tasks that need to be reviewed by the teacher, and *Achieved*, tasks successfully solved.

The participants of the activity have had two types of roles which interact with the list in different way, students and teachers. Students (which conformed the Agile development team and Networking team respectively) can only move tasks from the *To-Do* sub-list to the *Doing* one (when they assign themselves the task) or *To Review* (when they finish the task). Teachers (which take the role of the scrum master) are the only ones who can put new tasks to the *To-Do* sub-list (when they create a new task). Moreover, teachers are also the only ones who can move tasks to the *Doing* sub-list (in case the task should be revised by the student/s) or the *Achieved* sub-list (in case the task has been successfully solved).

5.2.3 The tool

In order to implement the activity, a supporting tool has been required. Among the available free of charge tools for managing tasks, the selected tool has been Trello, a web-based project management application based on the Agile paradigm. This choice is based on the connection with the contents of the RE course where the activity has been carried out. Besides, this tool provides a highly interactive experience and, in fact, it had been previously used in a gamified experience within a course of Computer Engineering degree with great results [56].

Trello supports the most important elements of Agile, as described before. As 4th column of Table 5.3 summarizes, the Agile task board (list of tasks) has been implemented using a

Table 5.3 Design term equivalences

Course	Rules	Metaphor	Tool
Formative activity	Game	Agile project	Project
Formative task	Quest	Requirement	Card
Task characteristics	Not applicable	Meta-type	Label
Student / Teacher	Player	Developer / Scrum master	Member
Classroom	Team	Development team	Board members
List	Game board	Product Backlog	Board
Sub-list	Not applicable	Task board column	List
Mark	Point	Not applicable	Not applicable
Total grade	Point-score	Not applicable	Not applicable
Academic-reward	Reward	Milestone	Not applicable

Trello board, where each task is represented by a card. Cards keep all the needed information to know about tasks: a brief description of the task and the associated mark, a set of labels (IND, TEAM, CH, EXP) to describe the its characteristics, the members involved in the card, and a log of its activity, among others. As an Agile task board, the Trello board has been structured in several lists where members could easily drag and drop cards in order to indicate its state, facilitating the autonomy of the students/teachers managing the board.

5.3 Analysis and results

The gamified experience described has been evaluated from two different perspectives at the end of the course. From the first perspective, the design process of the experience itself has been assessed, by analyzing whether the final experience have been actually coherent with the *SPARC* framework. From the second perspective, the student attitude and performance during the course has been analyzed in order to measure whether the behaviour outcomes are achieved. The main works have been conducted by means of the software Minitab (version 17.1.0), a statistics package developed by Minitab Inc.

5.3.1 Methodology and tools

As highlighted above, the objective of this experience, and therefore its evaluation, have not pursued the improvement of student marks from previous courses, which is a common approach in similar studies [138, 98]. Therefore, there is no need to make a conventional assessment procedure about the acquired knowledge or grades. The chosen methodology for the evaluation has been inspired on the first level of the Kirkpatrick “Four Level Model” [86] of course evaluation, specifically taking “reaction” level as the centre of interest. Kirkpatrick’s model is used for evaluating training activities from different perspectives, a very suitable tool to be applied to e-learning environments, mainly due to its simplicity and immediate

applicability. At "reaction" level, the evaluation measures how participants respond to the applied process. It allows the measurement about the degree of student's satisfaction on regards to the formative experience performed and assessed. In this case, it is the satisfaction about the proposed gamification design and attitudes towards the experience. Consequently, both quantitative and qualitative analysis have been carried out, as described below. During any assessment process of a case study in a online learning environment, the selection of the appropriate tools is relevant. The instruments which have supported the evaluation process are described as follows:

- **Task manager**: the selected tool for the experience designed has allowed us to obtain a lot of information on its use by students, namely time-lines, participants and task accomplishment rate.
- **Forum**: it is the virtual space where students follow the course by interacting with the teachers and classmates. Through this environment, it is possible to monitor which strategies have been carried out by students.
- **Questionnaires**: two different questionnaires have been developed and validated for the research purpose (see Appendix D). On the one hand, a demographic questionnaire has been initially released to elicit some information about age, gender, availability, familiar status, and preferences, in order to know if they fit the UOC student profile described in the 5.1. On the other hand, the design and experience questionnaire has been released and aimed to assess the attitude and performance during the gamified course, as well as their opinion about the proposed gamification design experience. This questionnaire consists of 17 questions: 15 close-ended (multiple-choice) and 2 open-ended. These questions have been built and validated by three independent teachers, two of them supervisors of the RE and an external one. The questionnaire has been enabled at the end of the course and on-line available for a month.

5.3.2 Population

The study has been conducted from September 2015 to February 2016 in two groups of the RE course. As previously described, this is an optional subject in the itinerary of Software Engineering within the Computer Engineering degree. A total of 94 students have been enrolled in the course, presenting the following demographic data: age $range = 22 - 53$ years old, with $M = 34.07$, $ME = 34$ and $SD = 6.88$. On regard to student gender, 91 out of 94 are male and 3 out of 94 are female. Given the voluntary nature of the activity, the population of this study (i.e the people who chose to participate) has been finally comprised

Table 5.4 Evaluation questionnaire

Question	Scope	Acceptance
Do you think the tasks have been proposed make sense in the context of this subject?	Sense	93.75%
Do you think it has been achieved the goal of encouraging the process of student learning?	Purpose	68.75%
Do you think it has been achieved the goal of encouraging student participation in activities?	Purpose	75%
Have you freely chosen tasks you wanted to develop?	Autonomy	93.75%
Do you think it has been achieved the goal of promoting teamwork?	Relatedness	56.25%
Do you think that the activity has created fellowship feeling with other students?	Relatedness	53.13%
Do you think it has been achieved the goal of learning about project management tools?	Competence	90.63%

for a total of 60 students (63.82% of the total students enrolled in the RE course). It seems to fit to UOC student profile previously described.

5.3.3 Design assessment

The first objective of the evaluation process has been to determine whether the five dimensions from the *SPARC* validation (Sense, Purpose, Autonomy, Relatedness and Competence) has been adequately proposed. This allows us to assess whether the gamification experience design has been coherent and adequate to the learning context by means the use of the FRAGGLE framework. In the first study, students have been asked at the end of the course about the experience designed through a questionnaire with seven close-ended questions (Yes/No/Don't Know-Not answer) as a way to analyze and compare the perception of the students about the designed experience (see Table 5.4). A total of 32 participant students (53.33%) have completed the questionnaire.

5.3.4 Performance and attitude assessment

The objective of this evaluation has been to determine if the experience is really motivating for the adult learners. In this section, different data recollected during the activity are shown.

Student performance

First of all, how students performed (collaborated) as a group has been analyzed during the activity (see Figure 5.2). In this regard, the joint process of most of the students has been

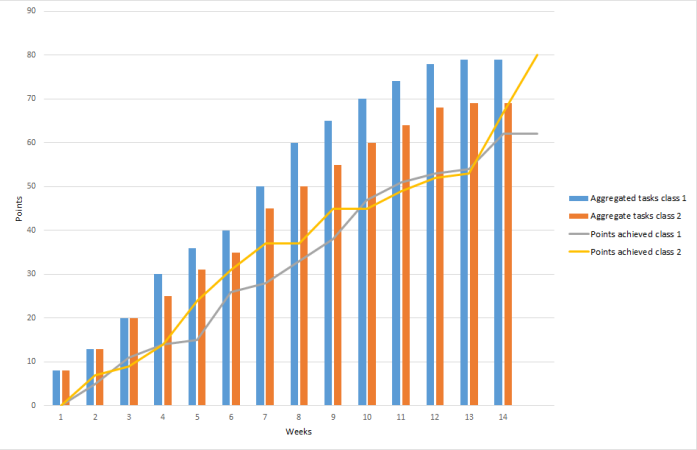

Figure 5.2 Aggregate proposed/solved tasks

concentrated into the first three weeks in both groups, with a drop out rate of 0% during the course. The task-activation time-line within the experience has been about 5-10 weekly tasks approximately. One group has achieved a total of 62/100 (62%) points while the other has got up to 80/100 (80%) (see Table 5.2). Regarding to the former, the increase rate has been regular but suddenly has stopped when the penultimate reward has been achieved. In contrast, the latter has showed a steep increase during last two weeks until the last achievement has been earned. The previous analysis has been complemented with another assessing how each student performs individually. As follows, Figure 5.3 shows the student ranges of participation. This data should be considered taking into account that the expected average performance has been between 2-3 tasks per student.

Results show some imbalance in the development of tasks between the participant students (60). There has been a moderate group of students who did not participate in any task (26.67% of passive participants). Ordered by frequency, the second one displayed corresponds to students which have participated only in one task, a minimum effort performance, less than designed tasks average (18.34%, lower active participants). Students which have participated in two or more tasks have been 54.99% of the participants (higher active participants). This data provides evidence that more than half of the participants who voluntarily have selected the gamified version of the subject (participants) have been actively involved.

Additionally, another identified indicator aligned with student performance is the number and kind of post and replies conducted in the forums. This evaluation has been carried out from both a qualitative and quantitative standpoint. The number of messages directly related to the gamification features have reached up to 177 out of 677 posts (25.70%), being an increment of 35% over total posts in previous edition of the RE. A total of 41% of these 177

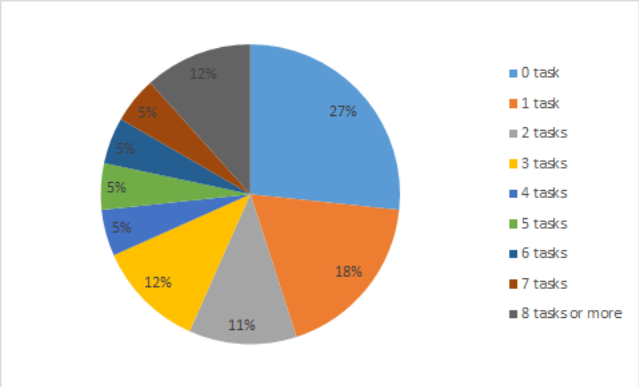

Figure 5.3 Developed tasks per student

posts have been directed related with the procedure for tasks achievement (organization and resource optimization in the activity).

Participation questionnaire

Student behaviour has been also assessed at the end course questionnaire by including three additional questions. A total of 16 of the participant students have completed the open-ended part of the questionnaire (26.66%). The two open-ended questions revealed certain information about student participation. They have been also directly asked whether they have been motivated by the experience only by the rewards or not. The results have showed that half of them recognized they have been highly/very highly motivated by rewards.

Correlational study

In order to find out the strength of any apparent link between all the variables studied and provide an additional sense of the previous revelations, the Pearson's coefficient for lineal correlation has been applied to all used variables (age, gender, participation and tasks). Prior to the interpretation of results, it is important to differentiate null participants (students who have not been involved in the experience), passive participants (students who decided a voluntary participation but not have achieved in almost one task achievement), and active participants (students who participate leading the achievement of one task, called lower active, and more than one task, called higher active).

Through the application of the procedure, results have revealed a certain correlation that should be highlighted. The study reveals only a positive medium-moderate correlation between the age of active participants (lower and higher active) and the number of achieved tasks ($r = 0.4$, with $p - value < 0.01$). No more correlations have been found (all the values are not displayed in a table due to space limitations). Moreover, moderate correlation results

should be treated with caution, since even not being a high correlation, it can provide some indications about the characteristics of high motivated adult learners.

5.4 Discussion

As previously stated, it is essential that a gamification experience be coherently designed in contrast to those designed in an “ad-hoc" manner. In that regard, the current experience has followed this premise, being designed by means of the *FRAGGLE* framework and validated with each dimension of the *SPARC*. From the students perspective, the results of the design assessment questionnaire have revealed that positive answers (Yes) are the most predominant ones in all of the topics, with rates between 53.13%-93.75% of acceptance in the five intrinsic motivational scopes.

The *Sense* and *Autonomy* dimensions have been the most positively evaluated (93.75%), as well as *Competence* (90.63%), which are key issues when integrating any kind of experiences in education. Nevertheless, this rate could (and should) be improved, especially those related to *Purpose* (note this dimension is closer to the instructor). *Relatedness* may be a dimension which needs to be taken into special consideration, since, even though the result has been strictly considered positive (more than 50%), it is low, given that it takes part of the behavioural objectives. The team-working mechanic need further improvements since it can be concluded, in that regard, that one of the expected behaviours (to increase the sense of kinship) has been not completely fulfilled.

Thus, it seems the design process has been coherent and the final result is mostly aligned with the *SPARC* validation items. If it is considered, as a starting point, the fact that the majority of the course students voluntarily chose to participate in the activity (63.82%), it looks like that a coherent gamified learning experience can be a promising approach to also motivate adult students in higher education contexts. Even though the percentage of participants is just above 50%, this value is well within the expected bench-marking process (see Section 5.2). In fact, it is above the expected value from engaging the proposed types (MT2) and (MT3) UOC students.

Regarding the high acceptance rate in the *Sense* dimension (93.75%), it can be conceived that a gamified learning experience will not necessarily be outright rejected by adult students. On contrary, they can embrace it as something completely natural, an integral part of the learning process itself. Looking in more detail at all the data recollected during the performance and attitude assessment, some interesting facts that provided some additional insights are found.

First, it has been theoretically considered that the extrinsic motivation of the participant students would be much higher than intrinsic motivation. However, in the ratio between extrinsic and intrinsic motivation revealed by students in the experience, about half of the students have been intrinsically motivated. It is a very different situation from the previously non-gamified edition (0% of formative tasks developed). This gives meaning to the whole design process, by ensuring that the student has clearly seen the connection between the training process and the acquisition of new knowledge or skills. Intrinsic motivation creates a sustained engagement that ensures adult learners actually reach the learning objectives of the subject, beyond those temporary motivation that is generated by curiosity or the novelty of a new experience.

Regarding the expected behaviours (see Section 5.2), individual and collective performances of the adult learners must also be considered. Collectively, both groups have performed the tasks regularly (0% drop outs) each week during the course. The only difference appears two weeks before the ending when one group has seemed to consider that reaching the 60 point mark (reward C4) is the only feasible outcome, perceiving the distance up to 80 points (reward C5) too far away. Therefore, they have performed a last effort in that way and they are satisfied with getting the penultimate reward. However, the other group have decided to get all rewards and perform with a very high rate of tasks achievement during the same period (previously they have worked at a more moderate rhythm of accomplishment).

At the end, it has been interesting to know, by means of the correlation study, the slight relationship taht exists between the age of the task resolution rate of active participation of students.

5.5 Concluding remarks

Individually, the dataset has revealed that more than a half of them have participated in two or more tasks in the average designed scenario in order to get all rewards. In fact, a total of 31.67% of participants have achieved more than two tasks. These students have been highly motivated in making their contribution to the group, even though they could have benefited from the rewards solving less tasks. Globally, it can be considered that the overall goal of motivating adult learners in solving non-graded formative activities has been reached (EB1).

Another issue to be considered is the participation increment within the forums. 25.70% of the total messages exchanged have been directly related to the gamified learning experience. For instance, about organization and resource optimization, or motivation and greetings. As an anecdote, some leaders have appeared in both groups, taking the role of motivators and organizers, so no additional contributions have been even required by the teachers. To some

extent, they have replaced the teacher in its coaching role. Consequently, regarding EB2, an increment on the sense of kinship between students has been notice, although to a lesser extent than expected.

Chapter 6

"One-size-fits-all" gamification design: a case study in Computer Network Design

6.1 Overview

the design and analysis of a gamified e-learning activity within a software engineering course has been presented in Chapter 5. It relies on the application of such an approach as its motivational foundation from a purely educational standpoint. The goal has been to encourage adult learners to solve non-graded formative activities and to increase their sense of kinship to the class group. The results have revealed a positive assessment of the experience designed and student engagement. However, a new study has been developed applying minor design changes to a different subject to know what issues affect student engagement the most. The gamified learning experience in an online course of Computer Network Design has been held at UOC. Thus, the CN course has been divided into two different virtual classes: Spanish and Catalan, although the experience has been only developed in the English environment.

As starting point, it should be noted there have been two types of activities that a student needs to address in the CN course. On the one hand, activities with the purpose of testing whether the student has acquired the appropriate knowledge and contribute to the final grade. On the other hand, activities that have been purely designed for the skills improvement without a real impact on the final grade. Regarding the second one, the course study guide lists a small group of activities that have been considered an integral part of the study schedule, such as practical exercises and self-assessment tests. Therefore, the kind of work proposed in the online gamified course involves refining their skills and the rewards are mostly related to providing additional degrees of flexibility or advantages in carrying out graded activities (see Tables 6.1 and 6.2). Thus, the aim has also been to somehow compensate the time devoted to the training activities, since they have not been graded.

Table 6.1 Milestones and bonuses in PIED-PIPER

Milestone	Bonus
0: Set up the lab	It opens the possibility to obtain an official Cisco certificate
A: Bandwidth upgrade	The on-line exams can be retried once
B: Remote work via VPN	A sample from last course will be published
C: Tech Crunch Disrupt setting	Students are granted with an extra week to complete a delivery
D: Cloud setup	Students are granted with an extra week to complete the Practice
E: Dark fibre upgrade	The sum of all exercises sums up to 11
F: Condor Cam CNwork	3 specific questions or exercises will be published

Table 6.2 Milestones and bonuses in ENCOM

Milestone	Bonus
0: Upgrade routers to IPV6	It opens the possibility to obtain an official Cisco certificate
A: Gbps Etherchannel backbone	The on-line exams can be retried once
B: Remote work via VPN	Activating the download of additional course materials
C1: Open a new branch in Hong Kong	The exercise 2 has a potential of up to 12 points
C2: Free-space Optical (FSO) laser link from HK branch	Graded exercise 2 actually counts 12 points
D: South Atlantic Express (SAex) link participation	You can redistribute question weighted grades as desired
E: Dark fibre across London	The submission date is moved one week
F: European Data Relay System node deployment	Students will be given the opportunity, once the grades are published, to resubmit it

6.2 Design principles

In order to guide the design process of the gamified learning experience in the higher education course with adult learners, goals and basic principles of the experience's have been described as follows:

- To motivate online students in solving training activities (not graded)
- To increase the feeling of kinship between e-learners in the same group

As a previous step to any description of the design guidelines, it should be highlighted that before running any gamification experience (in previous editions), the accomplishment rate of skill-related non-graded activities in both courses was 0%, and the sense of comradeship and communication between students (a common issue in online studies) was low (almost null). The latter has been noticed by the lack of interventions (post/replies between instructor-student) in the communication channels.

Consequently, design has relied on FRAGGLE, a framework that provides a guideline to develop a gamified experience which provides the SPARC validation to analyze the resulting design process. Based on these principles, the structure of the gamified experience is summarized and presented from three viewpoints: metaphor (which contextualizes the

rules to the learning process, giving sense to the whole activity), rules (which describe the basics of the activity), and tool (which is used to implement the rules and the metaphor). Furthermore, during the design process, it must be ensured that five dimensions (one for each letter of SPARC) are present in the proposed experience: Sense, Purpose, Autonomy, Relatedness and Competence.

6.2.1 Rules

The proposed rules are very simple, inspired in a reward-based crowd-funding model where several stretch goals related to a project are achieved by raising monetary contributions from a large number of people. In this case, instead of money, completing tickets have become company milestones. These milestones are independent from each other, so there is no linearity or dependency. When a ticket is completed and assessed successfully, is added to the class scoreboard. Each time a milestone is achieved, all students benefited from it, even if they do not directly participate in the activity. The designed flow is described in 6.1. Additionally, the difference in the number of students enrolled in each group has been taken into consideration to balance the number of tickets and proposed tasks to be solved.

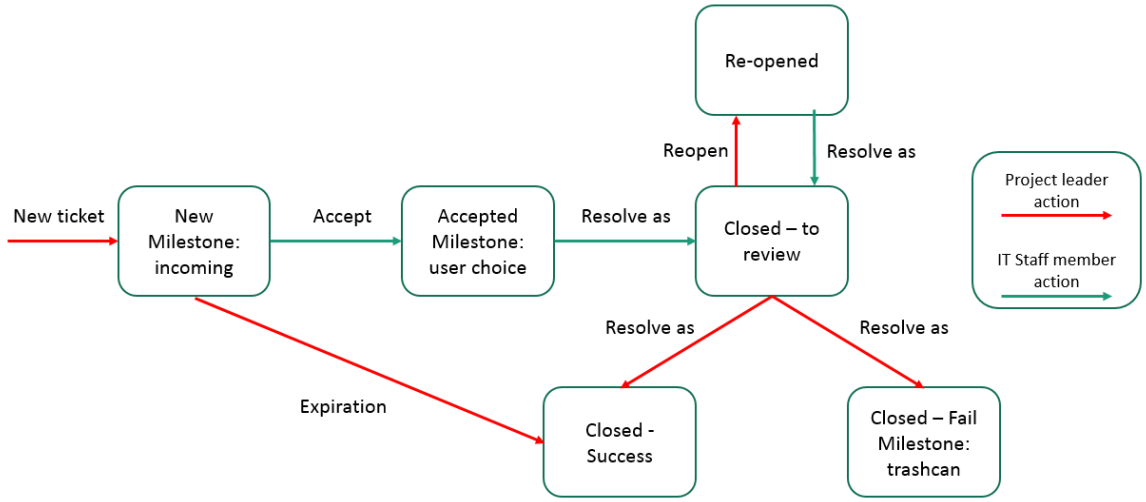

Figure 6.1 Activity workflow

6.2.2 Metaphor

The main purpose of the metaphor is to directly feed from reality. Therefore, given the CN course topic, the activity has been inspired in the expected day-to-day activity for two IT staff teams (support) at a network corporate (here named PIED-PIPER and ENCOM

which fits to both groups of the course). To manage the tasks assigned in their daily work shift, an issue tracking management, or “ticketing” system has been used. Regularly, project leaders (instructors) have generated tickets containing tasks that needed to be carried out (individually or in group). All tasks associated with a ticket are related to some formative (non-graded) activity. IT staff members (students) have assigned themselves the available tickets they thought capable of solving (partially or totally). Once accepted, it has been the team member’s responsibility to bring it to completion, either individually or with the help of other team members, depending on the typology of the associated tasks.

Thus, to incentive the ticket completion, the company also has announced a set of goals (or “milestones”). To reward the effort of the IT staff, the whole team obtained certain bonuses whenever a milestone has been achieved. Students can choose to which milestone the accomplished ticket belongs, each milestone requiring N tickets. The essence of this activity has been a collective effort within all course students, as a single team: the IT staff. In this sense, the activity has encompassed the entire course.

6.2.3 Tool

The selected tool has been TracWiki, an open source, Web-based project management and bug tracking system, commonly used in organizations such as ours in the metaphor. It supports ticket description and comments, version control log messages, milestone descriptions, report descriptions, etc. An overview of the tool is shown in Figure 6.2.

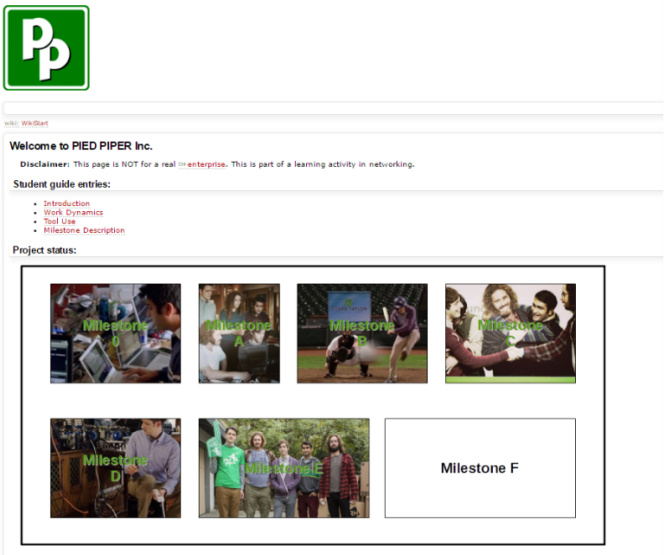

Figure 6.2 TracWiki tool

6.3 Analysis and results

An analysis process has been developed and the results are presented as follows. The study has been conducted from February 2016 to July 2016 in two groups of CN. They belong to two optional subjects at the Information Technology itinerary in e-learning mode of Computer Engineering degree. The main works have been conducted by means of the software Minitab (version 17.1.0), a statistics package developed by Minitab Inc. A total of 147 students have enrolled in both groups, described as follows: $agerange = 21 - 56$, $M = 36.29$, $Me = 37.00$, and $StDev = 8.13$. Moreover, the student's sample of this study (by means of the students' age) is normally distributed considering the Anderson-Darling Normality Test with a p-value of 0.09, a test commonly used to determine if the data satisfy the normality distribution.

In addition, the student sample has been considered representative regarding the UOC student profile, where 64% of them are more than 30 years old, and 27% of them belong to the 40+ age bracket, most work full-time and are financially independent (95%), married (73%) or have children (58%) - data taken from an internal study. This is not the common profile of students who commit full-time to university degrees or masters in our country (20-25 years old). Regarding gender, 135 out of 147 (91.84%) are male. Digging into the personal context, data reveals that 25.20% of students have finished previous university studies, 83.00% work full time, and 38.20% have family with children. This is not a common demographic context in higher education in comparison to most of the related studies available in the literature.

Therefore, the objective of the analysis process is to know the main issues that may lead to disengagement. To carry out this process, two different viewpoints have been considered: user interaction (through system logs), and feedback (through the use of questionnaires).

6.3.1 Student interaction

At the beginning of the course, students have been informed that participation in the online gamification version of the course is totally voluntary (the tool and bases were available). Each student has been able to check it and decide to join the activity or not. They have been free to choose the "traditional" structure of the course too. Therefore, given the voluntary nature of the experience, the sample of students from both groups has been comprised of 31 students out of 147 (21.09% of the total students who enrolled in the CN course) with a dropout rate of 0%. That is, none of the students who participated have moved to the traditional format when possible.

Thus, students successfully have delivered a total 303 tasks, 151 tasks being part of 55/90 tickets successfully resolved by group A (61.12%) while 152 tasks being part of 60/115 of available tickets successfully resolved (52.17%) by group B. In a more detailed analysis, most

of the unsolved tasks have required to be developed not individually and not all milestones have been reached. Thus, group A has reached 5 out of 7 milestones: 0, A, B, C, D, and partially F (see description in Table 6.1), and group B have reached 5 out of 8 milestones: 0, A, B, C1, E (see description in Table 6.2). The students have been free to assign the resolved tickets to the milestone that most interested them.

Moreover, the tickets have been enabled progressively as initially planned considering the final amount of participants, regardless the evolution of each group (the tickets are accumulated and do not expire). The solving rate of tickets has been regular throughout the course in both groups. At the beginning of the course the group A has been more active, while the performance of group B has been a little better in the last weeks. Despite that, dataset shows some imbalance in the ticket development among the participant students being described with a $taskrange = 1-70$, $M = 1.15$, $Me = 6.00$, and $StDev = 12.58$. This suggests that not all students have carried out their contributions to the same extent, although they have been equally rewarded.

Once analyzed how the students developed their tickets from a quantitative viewpoint, it has been considered the quality of these submissions. Regarding the flow described, when a ticket is submitted for the assessment, it can be accepted or refused (failed or reopened). Firstly, group A has reached an acceptance rate of 36.18% of deliveries and B, 39.74%. These rates are low, although thinking that they would leave the tickets submission because the first rejections, students have completed the vast majority of them in a second instance.

6.3.2 Student feedback

The objective of the following analytical process has been to know the perception and the most relevant triggers to adult learners. In this section, a summary of the responses collected from an online questionnaire has been run at the end of the course. Students have been asked for rating some items at a five-level Likert scale, from level 1 (very disagree) to level 5 (very agree). As follows, it is highlighted the most relevant findings. Firstly, participant students have been asked about their overall perception about the gamified experience and the course. Thus, Figure 6.3 shows some imbalance in their responses ($N = 31$): more than a half have perceived the proposed design as "agree" or "very agree", and more than three quarters have not perceived it as a poor experience.

Additionally, the students have been asked about their main motivations in solving non-formative tasks. Results have revealed a low motivation due to the social pressure of other members, and slightly better (moderate) regarding the social relationships and group rewards (see Table 6.3). Moreover, they have been required to answer concerning the design viewpoint of cooperation or competition, as the cores that guide the metaphor and rules. 89.80% of

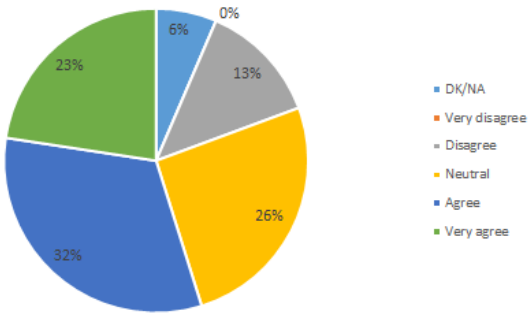

Figure 6.3 Students' perception

them reveal preferences towards the cooperative environments as opposed to the competition between students. The evaluation of common benefits, even if they have not participated, has been upper to level 3 (neutral) by 80% of them.

Table 6.3 Evaluation of students' motivation

Item ($N = 31$)	**Range**	**M**	**Me**	**StDev**
I developed tickets motivated by group	1.00-5.00	3.34	4.00	1.13
I developed tickets due to group pressure	1.00-4.00	2.15	2.00	0.86
I was exclusivity motivated by rewards	1.00-5.00	3.32	4.00	1.03

Considering the students enrolled in the course (even if they decide not to participate), it has been intended to know how the proposed competences have been perceived. Consequently, the evaluations are shown in Table 6.4. This feedback suggests that students are moderately interested in developing the language competence (shown by the use of English language) and interpersonal (solving group tickets and achieving group milestones). However, the creativity required to solve the proposed tasks has been the most highly valued competence.

Table 6.4 Evaluation of students' competences

Item ($N = 147$)	**Range**	**M**	**Me**	**StDev**
Creativity	1.00-5.00	4.21	4.00	0.80
Language	1.00-5.00	3.70	4.00	0.83
Interpersonal	1.00-5.00	3.51	3.00	0.88

Table 6.5 SPARC’s validation

Item ($N = 147$)	**Range**	**M**	**Me**	**StDev**
Sense	1.00-5.00	3.90	4.00	1.04
Purpose	1.00-5.00	3.89	4.00	0.97
Autonomy	1.00-5.00	3.31	3.00	1.29
Relatedness	1.00-5.00	3.93	4.00	1.08
Competence	1.00-5.00	4.16	4.00	1.03

Moreover, students have been asked about some statements regarding the five dimensions of the SPARC framework (Sense, Purpose, Autonomy, Relatedness and Competence). Some interesting insights can be observed, as summarized in Table 6.5. Despite all values presented are above 3 (neutral), only one of them (competence) is above the “agreement” level (4). Additionally, the feeling of autonomy has been perceived slightly above neutrality. Sense, Purpose and Relatedness are the higher scoring values, slightly below the threshold of “agreement”.

6.4 Discussion

Results have revealed an unexpected effect on student motivation since a low percentage of them (21.08%) have participated in the online gamified learning experience. Hence, it seems the students have not perceived the proposal as “attractive" and have decided to continue in the non-gamified version of the course. By means of the analysis of responses, the most repeated argument has been “the lack of time”, which has made us consider that the proposal has been initially perceived like a greater effort. Although many of the students have argued this, the rate is much lower than a similar sample in the previous study in RE (see Chapter 5. Additionally, it is remarkable that 21.64% of enrolled student have admitted that they have not even consider the published bases.

Regarding the expected outcomes, the motivation of participant students in solving training tasks (not graded), has been moderate, achieving rates of about the 61.12% and 52.17% of tickets successfully solved in both groups. Note that the starting point has been 0% in previous non-gamified editions and it has been designed a “one-size-fits-all” experience to motivate a section of the students. However, it is considered the motivational effect as moderate, slightly lower than the expectations, despite of the 60% of them have valued it as positive/very positive, reaching the 80% including the neutral feedback. The second expected outcome (to increase the sense of kinship between e-learners in the same group)

has been partially achieved too. The participation has been high regarding the mean number of delivered activities in a non-gamified edition (almost 0%). Regarding the RE study presented in the Chapter (5) a great difference has been perceived between the two gamified courses (63.82% and 26.72% of the total students in the courses RE and the current course respectively), as well as a total of achievements of 62.00% and 80.00% in two groups in RE, in contrast to 61.12% and 52.17%).

6.5 Concluding remarks

Several hypothesis have been defined, which might explain the motivation differences to the previous case of study from diverse points of view (despite of most of the design principles applied in both courses are the same) as follows:

- **Demographic**: the attributes from both samples have been similar and fit the so-called adult learners. RE course presents the following demographic data: $agerange = 22-53$, $M = 34.07$, $Me = 34$ and $StDev = 6.88$, where 91 out of 94 are male. This characteristics (adult learners) do not differ at all from those presented in this case study. Therefore we cannot consider demographics as relevant variable to explain the perceived engagement differences between both studies.

- **Course contents**: although the course and contents are not the same (they are different subjects), are presented as optional subjects in the online Computer Engineering degree. These studies stand out by learners that encourage professional skills as proposed in the non-formative tasks. Thus, it is not considered as relevant as to strongly influence participation and motivation.

- **Language**: while RE have allowed contents and communications in their native language (Spanish and Catalan), CN has been limited to the use of English language. This limitation has been applied to the whole course design with a clear purpose of improving the linguistic competences, since the vast majority of technical documentation is available in this language. However, by means of the analysis of the feedback from questionnaire, this item can be considered as relevant to explain a lower participation rate in the current course. The lack of initial skills to face an experience and achieve the mastery seems to be crucial.

- **Rules**: the rules proposed in CN have been slightly more complex than RE. Therefore, it becomes necessary a long on-boarding period to involve the students (avoiding a simultaneous introduction). Feedback received leads to consider that the on-boarding

process required a longer time to successfully introduce the more complex rules. Similar to the language issue, it is considered that the combination of a short on-boarding period and complex rules might be perceived as a barrier for the student participation and lead to promote the initial rejection of the gamified experience.

- **Metaphor**: the same metaphor has been applied in both studies, but adapted to each subject (software or Networks environments), as well as rules context, giving sense to the whole activity. Additionally, it has been considered that the principle of "one-for-all & all-for-one" is appropriate to easily understand the proposed cooperative environment. Data taken from the questionnaires seems to corroborate this thought. Therefore, lightweight differences in this way have not been considered as relevant.

- **Tool**: the selected tool to support the online gamification design is different: from Trello (RE) to TracWiki (CN). It has been suspected that a wiki system is not the most appropriate tool and ends being a relevant barrier for the student enrolment. Qualitative data support this thought. The need of a more easy of usage tool, even allowing a "drag & drop" interaction, seems to be relevant. Diverse tools like Trello can be the key to make it initially more attractive to participants to join.

Chapter 7

Personalized gamification design: a case-control study in Computer Network Design

7.1 Overview

Existing literature shows a great interest about gamification in higher education [186], being almost, if not all, "one-size fits all" approaches, the same way as presented in Chapters 5 and 6. Thus, gamification of learning in higher education seems to be a key to increase student motivation and commitment. However, the effect described in most case of studies available in the literature seems to be always limited because they are not designed considering the characteristics and motivations of each student. Diverse psychological viewpoints agree that people are not equal, therefore, they cannot be motivated effectively in the same way. Thus, personalization is conceived as an approach on gamification design to motivate students more effectively, however, it has been minimally explored and less applied [17].

Recently, the term "Gamification Persona" [149] has been coined as the way of gathering and keeping visible the objectives of the appropriate users, considering aspects of the personality and its motivations. Therefore, acquiring knowledge about the students with the purpose of building personalized experiences is a relevant goal for the development of a gamified learning experience. Consequently, early studies on personalized interactive systems seem to be more effective than "one-size-fits-all" approaches [17], entailing an adaptation of the gamification experience to the user's preferences. These approaches are usually system-tailored contents and services that fit different users' characteristics [142]. This way, gamification should be designed to meet the motivations of each individual student.

Accordingly, Ferro et al. [39] study the relationship between player types and personality traits in gamification systems, aiming to identify potential relationships with game design elements. The purpose is to obtain some findings for designing gamification systems, specially targeting users' intrinsic motivation, based on their knowledge and experience. Moreover, Tondello et al. present a novel general framework for personalized gameful applications using recommender systems (i.e., software tools and technologies to recommend suggestions to users that they might enjoy) [183]. Therefore, the presented case-control study aims to cover an open research niche regarding the relationship between students and their specific preferences when interacting with a gamified learning environments. Accordingly, outcomes from Chapter 3 that investigates the different interaction types with gamification digital applications based on user types and preferences for different game design elements has been considered as the base of the personalized design.

7.2 Design principles

The design process has been based on the FRAGGLE framework as well as the SPARC principles for design validation presented in Chapter 4. Therefore, the model structures the design process, and the key dimensions (rules, metaphor and tool) are presented as follows.

7.2.1 Rules

The rules are the basics of the activity, which interactions can be carried out by the players. They are described as follows.

On-boarding

Recruits complete the "station assignment test" (see Appendix E in order to join the adventure. They are asking how they would act in each different situation and their preferences when interacting in a gamified environment. It takes the base of the Hexad User Types scale [184]. The results of this test determine to which station they are assigned. Each station has a "motto" that lets recruits guess what they are about as well as the expected user types, as shown in Table 7.1.

Mid-game

There are two separate scoreboards for each station: Research and Development. The overseer periodically publishes challenges (exercises, such as practices or tests) assigned to one of them. The station scores points in Research or Development whenever a challenge is

Table 7.1 Station's rules

Station	**Parading**	**Expected User Types**
Alpha	Progress relies on competition	Player-Free Spirit, Players-Achiever
Beta	Small circles in harmony	Philanthropists-Socializer
Delta	Free spirits	Achiever-Free Spirit
Gamma	One for all, all for one	Philanthropists-Free Spirit, Philanthropists-Achiever

successfully completed by the recruits. Rewards are unlocked when some combination of scores is reached in both scoreboards. For instance, when they achieve 10 Research points and 15 Development points, they get bonus questions or extra days for a class deliverable. However, the specific rules about who get the rewards or how scoring is achieved, differs depending on the station, being presented in the Table 7.2. That is the personalized key factor. For instance, station Alpha is competitive (not everybody got the reward) and recruits work individually, whereas station Beta is mostly collaborative and they have to work in subgroups. At a later stage, a new scoreboard appears unexpectedly: Crisis. Here, additional challenges are sometimes proposed, each assigned to a narrative. For instance, a reactor meltdown, a hull breach, or some enemy that has to be defeated, such a polar bear or the black mist (both from the "Lost" mythology). In case the recruits are unable to solve the challenge before a deadline expires. Consequently, it is the "Game Over".

Table 7.2 Station's description

Station	**Rules**
Alpha	Some competitive milestones and exercises are individual
Beta	Work is divided in subgroups
Delta	Minimum scores and personal work recognition are established
Gamma	The whole work is cooperative

End-game

The gamification experience is considered finished at the end of the course. Recruits are considered to "win" if they survive their tour of duty (i.e. avert every "Crisis" challenge)

and uncover the mystery. There is no special reward for this, apart from the satisfaction of success. The outcome is purely designed from a narrative standpoint.

7.2.2 Metaphor

The metaphor allows to contextualize the activity in the learning context, giving sense to the whole activity, and introducing the narrative. In this regard, students are presented with the following introductory text, which summarizes such narrative:

We are in the year 2025. A consortium of high technology companies decides to act as benefactors of the Cisco Dharma Initiative (CDI), a project to stimulate research, innovation and development (R & D & I) in all types of areas. In its initial phase, the program has deployed four underwater stations where it is expected to develop leading projects in a high tech environment.

Students become recruits who are assigned to four different underwater stations, according to their preferences. An oversee monitors the recruits' actions during their tour of duty, which requires completing several challenges and solving dangerous situations that will unexpectedly arise (as well as uncovering some mysteries that will appear at a later stage). The metaphor mostly follows the mythology laid out by the TV series "Lost", but also take a bit from video games such as SOMA and the Fallout and System Shock series.

7.2.3 Tool

At the end, everything that has been defined in the previous dimensions should be somehow implemented and deployed in the learning environment. Therefore, it is important to take into account from the very beginning which tools exist, or must be created, that would be capable of this. Two tools have been mainly used during the experience. On the one hand, a micro-blogging widget embedded in the virtual classroom. The overseer has used this tool to frequently send messages about the underwater stations' status (e.g. new challenges, scores, goading or congratulating players about their actions, etc.). On the other hand, all challenges have been published and managed using Trello boards, one for each station (see Figure 7.1). A deck of cards has been used for each scoreboard type: Research, Development and Crisis.

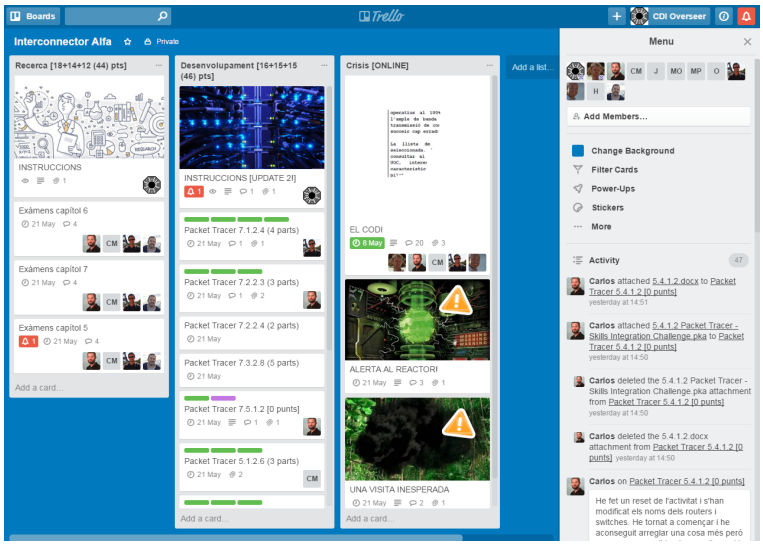

Figure 7.1 Trello's board overview

7.3 Analysis and results

The analytic process described in the following subsections has been conducted using the Minitab statistical tool (version 17.1.0) for Windows platform, a software environment for statistical computing.

7.3.1 Participants

The study has been held at UOC in two groups CN, Catalan (CAT) and Spanish (CAS), during the academic season 16/17. It is an optional subject of the Computer Engineering degree program. Students' submissions in the course have been done in their native language (Catalan or Spanish), although the contents of the subject have been presented in the same language: English. In total, 81 students have enrolled in both groups: 60 of them in CAT (74.07%) and 21 to CAS (25.92%). Regarding age, students in CAT present an average age of 36.15 years old ($SD = 7.55$), whereas students in CAS have an average age of 39.29 ($SD = 6.30$) (see descriptive analysis in Table 7.3. Thus, to know the normality of the presented samples, the Anderson-Darling normality test has been run. CAT and CAS present a p-value of 0.151 and 0.634, respectively. Both locations fail to reject the null hypothesis at $\alpha = 0.05$ significance level. Therefore, there is not enough evidence to conclude the data do not come from normally distributed populations.

Table 7.3 Demographic summary

Group	N	Mean	StDev	Min	Median	Max
CAT	60	36.15	7.55	20.00	35.00	56.00
CAS	21	39.29	6.55	28.00	39.00	54.00

To compare the variability of the two samples, confidence intervals have been used to compare the standard deviation ratio for the two samples. The confidence interval for normally distributed data contains 1. Therefore, the null hypothesis fails to reject that the ratio equals 1. The p-values for both tests are above $\alpha = 0.05$, so it fails to reject the null hypothesis that the ratio of the standard deviations is one. The results suggest that there is not difference in the standard deviations of the students' age of two groups and their normality distribution.

Regarding gender, 54 of them are male (90.00%) and 6 are female (10.00%) in CAT, meanwhile 20 of them are male (95.00%) and 1 is female (5.00%) in CAS. Pearson's Chi-Square test allows to test how likely is that distribution of males and females in each group. The null hypothesis would be that gender and the group are independent of one another. It has returned a value of 0.541; $df = 1$; $p = 0.462$. Thus, the null hypothesis cannot be rejected. Therefore, the assumption that there is no influence in the group to which the student belonged by gender is kept.

Regarding personal situation, 12 of students in CAT already have a university degree (20.00%), 42 work full-time (70.00%), and 17 have children (28.33%). Regarding CAS, 6 of them already have a university degree (28.57%), 17 of them work full-time (80.96%), and 6 have children (28.57%). The Chi-Square test returned a value of 0.260; $df = 2$; $p = 0.878$. Thus, the null hypothesis cannot be rejected. Therefore, it has been assumed that there is no influence in the group to which the students belong and their personal situation.

Data collection

Student engagement has been measured regarding the proposed objective (to motivate grade-level students to solve non-evaluative activities) through the collection of both quantitative and qualitative data. Quantitative data has been collected from the users' logs generated by Trello and qualitative data has come from an anonymous survey at the end of the course. Therefore, two viewpoints have been considered respectively by means of these kind of analysis: behavioral and emotional engagement [44]. On the one hand, behavioral engagement concerns the involvement in learning and academic tasks, and includes behaviors such as effort and persistence, among others [176]. The development of non-evaluative tasks (self-

assessment and practices) has been measured within student's behavioral engagement and individually by means of the number of active students (those who have participated in at least one non-evaluative activity) and the total of developed tasks by each group. On the other hand, emotional engagement refers to students' affective reactions in the classroom, including interest, boredom, happiness, sadness, and anxiety [176]. They reveal how motivation leaded not only to behavioral engagement, but also to emotional engagement.

Reliability

To measure the reliability of the measurement scale of items presented in the final survey, Cronbach's alpha has been used for the dataset of the 12 items presented in a five-level Likert scale. Cronbach's alpha assumes that the questions are only measuring one latent variable or dimension. In this case, emotional student engagement has been measured at the end of the gamified learning experience. The alpha coefficient for the 12 items in the CAT survey has been 0.915, while a value of 0.943 has been obtained in CAS. This suggests that the items have high internal consistency (note that a reliability coefficient of 0.70 or higher is considered "acceptable" in most social science research [52], although some authors suggest higher values of 0.90 to 0.95, and the obtained value is located within that interval).

Procedure

The CN course has comprised a total of twenty school weeks within the second quarter of the term and started on February 2017. The gamified learning experience has been encompassed in fourteen weeks. Students belong to the CAS or CAT group according to the native language recorded in their academic profile. Once the students have been assigned to each group, a survey is proposed to assign them to each sub-group (called Alfa, Beta, Delta, Gamma) in the CAT group (CAS do not have subgroups; it presented the same "one-size-fits-all" gamification experience to all students). A survey has been enabled for two weeks and published in the native language of students. The survey has been adapted to this context from the Gamification User Types Hexad Scale [184] in order to apply the metaphor from the current gamification learning experience but remaining the original statements of the scale (see Appendix E. Once all students in CAT have completed the survey, they are assigned to one of the sub-groups through the following algorithm (see Algorithm 1) where "S" (stations) refers to the different groups, meanwhile "G" (generic) to the specific user types described in the User Types Hexad Framework [112]. Moreover, "H" refers to the combination of user types (hybrid user types, a fine-grained combination of user types) with more presence in an exploratory study presented in Chapter 4, and (V1,V2) are the highest values of each user type from users' responses.

```
Data: S = [Delta, Gamma, Beta, Alfa]; G = [Free Spirit, Philanthropist, Socializer, Player,
      Achiever, Disruptor]; H = [(Free Spirit, Achiever),(Philanthropist, Free
      Spirit),(Philanthropist, Achiever),(Philanthropist, Socializer),(Player, Free
      Spirit),(Player, Achiever)];
foreach Student in CAT do Profile=Hexad User Type Test (Student);
foreach (V1,V2) in Profile do ;
if (V1,V2)|(V2,V1)==H[1] then
  | return (Student, G[1]);
if (V1,V2)|(V2,V1)==H[2] then
  | return (Student, G[2]);
if (V1,V2)|(V2,V1)==H[3] then
  | return (Student, G[2]);
if (V1,V2)|(V2,V1)==H[4] then
  | return (Student, G[3]);
if (V1,V2)|(V2,V1)==H[5] then
  | return (Student, G[4]);
if (V1,V2)|(V2,V1)==H[6] then
  | return (Student, G[4]);
if V1=="Free Spirit" then
  | return (Student, S[1]);
if V1=="Philanthropist" then
  | return (Student, S[2]);
if V1=="Socializer" then
  | return (Student, S[3]);
if V1=="Player" then
  | return (Student, S[4]);
if V1=="Achiever" then
  | return (Student, S[4]);
if V1=="Disruptor" then
  | if V2=="Free Spirit" then
  |   | return (Student, S[1]);
  | if V2=="Philanthropist" then
  |   | return (Student, S[2]);
  | if V2=="Socializer" then
  |   | return (Student, S[3]);
  | if V2=="Player" then
  |   | return (Student, S[4]);
  | if V2=="Achiever" then
  |   | return (Student, S[4]);
;
;
```

Algorithm 1: Assignment algorithm

Thus, the purpose of the assignment function has been to kink each student to the most adequate gamification experience. In this sense, it is intended to fit some of the hybrid profiles (participants that score high in more than one Hexad user type) with the groups closer to their highest user type scores by means of the result of the Hexad User Types Scale [184]. When it is not the case, it is only considered the participant's highest user type score to make the assignment. In the case of the primary user type is Disruptor (the less frequent user type by far), it has been considered the second highest user type. This assignment is a procedure of its own and based on the findings in Chapter 3, where different perspectives of measuring user

types have been investigated, from a coarse-grained (generic), to a fine-grained considering combination of them (hybrid user types) and how motivation is affected by the game design elements tailoring to particular user types. However, the process described in this work can be replicated by any researcher in further studies.

Accordingly, within the 48 hours after the completion of the survey, students have been individually informed to sign into the specific Trello dashboard (station). Finally, before the publication of marks (on the 20th week of the course), students from both groups (CAT and CAS) have been asked to run a voluntary post-survey in their native language. A total of 49 of students in CAT (81.66%) and 17 in CAS (80.95%) completed the post-survey (see Appendix F).

7.4 Results

The results obtained are presented in the following three viewpoints:

Impact of personalization

As starting point, the alignment with the data collection methods and data analyses are described:

- **Process**: a comparison of CAT/CAS as whole from two student engagement perspectives: behavioral and emotional.
- **Method**: descriptive analysis and U-Mann Whitney test.
- **Input**: Trello log / Survey.

First, the analysis of the student behavioral engagement through the development of non-evaluative activities (self-assessment and practices) has been developed measuring the number of developed tasks by each group and the number of active students (those who have participated in at least one non-evaluative activity), thanks to Trello's log. Actives students (who have developed at least one non-evaluative tasks) have been 39 in CAT (65.00% out of the 60 total), detailed by types of tasks as follows: 28 students (46.67%) have participated of the simulation tasks, while 34 students (56.67%) have participated of the self-assessment exams. Deeping into each CAT subgroup (personalized gamification experiences), the Alpha subgroup has presented a student participation of 54.55% of the simulation tasks and 81.82% of the self-assessment exams; Beta has revealed a participation of 47.05% and 41.17%; Delta, 35.29% and 41.17%; and finally, Gamma, 53.34% and 73.34%, respectively.

Table 7.4 Student task development

Group	N	Mean	StDev	Min	Median	Max
CAT	60	6.42	8.85	0.00	2.00	34.00
CAS	21	3.90	5.30	0.00	2.00	16.00

Regarding CAS, 11 students have been identified as active (51.00% out of the total 21), 8 of them have completed simulation tasks (38.09%), and 8 (38.09%) have completed self-assessment exams. In the following Table (7.4), the descriptive analysis of the two types of activities as a whole (number activities that each student participated) of both groups is summarized. Note that the ratio student/task has been the same regardless of the size of each group and subgroup in this study.

Next, the U-Mann-Whitney Test, which is commonly used to check the heterogeneity of two ordinal samples, has been run. The starting assumption has been that the observations of both groups are independent. Therefore, under the null hypothesis, the starting distribution of both groups has been the same, whereas the alternative hypothesis has reflected that the values of one of the samples tend to exceed those of the other (personalized vs one-size-fits-all). Results have revealed a 95.10% of confidence that the difference between the population medians is between -0.001 and 3.002. The null hypothesis have stated that the difference in the median of participated task in a group is 0. Because the p-value of 0.0913 is higher than confidence level of 0.05, it cannot be reject the null hypothesis, and it cannot be concluded that there is a statistical significance between the groups.

Thus, considering the two types of activities with active students, the following descriptive analysis has been run (7.5). U-Mann-Whitney test has not been significant at 0.7781 with a confidence level of 0.05; therefore, null hypothesis cannot be reject the, and therefore it cannot be concluded that there is a statistical significance between the groups.

Regarding emotional engagement of students, the emotion-related intrinsic principles described in SPARC validation has been also analyzed thanks the feedback from survey. Students have been asked in a five-level Likert scale about the level of emotional perception regarding the gamified learning experience which they have been involved on (from value 1

Table 7.5 Active student task development

Group	N	Mean	StDev	Min	Median	Max
CAT	39	9.87	9.31	1.00	7.00	34.00
CAS	11	7.45	5.20	2.00	7.00	16.00

Table 7.6 Emotional perception

Group	N	Sense	Purpose	Autonomy	Relatedness	Competence
CAT	49	3.82	4.10	3.82	3.28	4.00
CAS	17	3.76	3.82	3.74	2.94	3.88

“very irrelevant" to 5 “very relevant"). Thus, the following Table (7.6) shows a comparison between CAT/CAS for each SPARC item. Students have valued the perception of the experience as 3.84 and 3.47 respectively. Another element to be considered regarding the emotional engagement has been the interest in having similar experiences in other subjects in the future. Students have been asked about it and results reveal that 78.43% of students in CAT agree, a much higher value than 52.63% in CAS. Moreover, the U-Mann-Whitney Test has been run to analyze the statistical significance of the different value of each item between the groups, all being non-significant at 0.9142, 0.2664, 0.4200, 0.2491, and 0.8653 respectively, with a confidence level of 0.05. Based on these results, null hypothesis cannot be rejected and cannot be concluded that student emotional perception is different between the two groups.

Impact of condition assignment based on the student’s user type in comparison to random assignment

As starting point, the alignment with data collection methods and data analysis is described:

- **Process**: a comparison of Gamma1 (CAT) / Gamma2 (CAS) from two student engagement perspectives: behavioral and emotional.
- **Method**: descriptive analysis and U-Mann Whitney test.
- **Input**: Trello log / Survey.

As described before, the analysis have started considering the student behavioral engagement through the development of non-evaluative activities (self-assessment and practices). Therefore, subgroups Gamma1 (CAT) and Gamma2 (CAS) have been analyzed and compared, where the designed gamification learning experiences have been the same. Students have been assigned to subgroup Gamma1 based on the result of their initial user type test, meanwhile Gamma2 has been formed by all kinds of students independently of their preferences, since students in the CAT group have not performed the initial test. Thus, Gamma1 has been comprised by 15 students and Gamma2, 21 students. Active students have been 11 in Gamma1 (73.34% of the total), being detailed by types of tasks as follows:

Table 7.7 Student task development

Group	N	Mean	StDev	Min	Median	Max
Gamma1(CAT)	15	7.33	6.88	0.00	5.00	20.00
Gamma2(CAS)	21	3.90	5.30	0.00	2.00	16.00

8 students (53.34%) complete the simulation tasks, while 11 students (73.34%) complete self-assessment exams. Regarding Gamma2 in CAS, 11 students have been identified as active (52.38% of total), with 8 (38.09%) of them having completed simulation tasks and also 8 (38.09%) having completed self-assessment exams. As follows, a summary of the descriptive analysis of two types of activities as a whole (number activities participated by a student) of both subgroups is shown in Table 7.7.

Next, the U-Mann-Whitney test has been run. Under the null hypothesis, the starting distribution of both groups has been the same, whereas the alternative hypothesis reflects that the values of one of the samples tend to exceed those of the other (student assigned by test vs random assignment). The point estimated of the population median for the difference in the number of task completed by students in the two groups is 3.00. There is a 95.30% of confidence that the difference between the population medians is between 0.001-7.000. Because the p-value is 0.0913, which is more than the significance level of 0.05, it cannot be rejected the null hypothesis and cannot be concluded that student performance in the two subgroups is different.

Considering the two types of activities with active students, the following descriptive analysis (see Table 7.8) has been run. U-Mann-Whitney test is not significant at 0.1467 with a confidence level of 0.05; therefore, it cannot be rejected the null hypothesis, and cannot be concluded that there is a statistical significance between the groups.

Regarding emotional engagement of the students, the emotion-related intrinsic principles described in SPARC validation model have been compared. Thus, the following Table (7.9) shows a comparison between Gamma1/Gamma2 for each SPARC item. Students have valued the perception of the experience as 3.93 and 3.47 respectively. Another element to be considered regarding the emotional engagement is the interest to join similar experiences in

Table 7.8 Active student task development

Group	N	Mean	StDev	Min	Median	Max
Gamma1(CAT)	11	10.00	6.08	3.00	10.00	20.00
Gamma2(CAS)	11	7.45	5.20	2.00	7.00	16.00

Table 7.9 Emotional perception

Group	N	Sense	Purpose	Autonomy	Relatedness	Competence
Gamma1(CAT)	15	3.80	4.13	4.20	3.53	4.00
Gamma2(CAS)	17	3.76	3.82	3.74	2.94	3.88

other subjects in the future: results revealed that 86.67% of students in Gamma1 agree with this affirmative, a much higher value than 52.63% in Gamma2.

Moreover, U-Mann-Whitney test has been run to analyze the statistical significance of the difference on the responses to each item between the subgroups, with all being non-significant at 0.9053, 0.2530, 0.6733, 0.1286, and 0.9366 respectively with a confidence level of 0.05. Based on these results, it cannot be rejected the null hypothesis and cannot be concluded that student emotional perception in the two subgroups is statistically different.

Engagement impact factor in personalized experiences

As starting point, the alignment with data collection methods and data analyses are described:

- **Process**: a comparison of Alpha, Beta, Delta, Gamma (CAT) from two student engagement perspectives: behavioral and emotional.
- **Method**: descriptive analysis and the one-way ANOVA (analysis of variance).
- **Input**: Trello log / Survey.

Similar to the previous steps, the analysis of the student behavioral engagement through the development of non-evaluative activities (self-assessment and practices) have started this process. In this case, Alpha, Beta, Delta and Gamma (from CAT) subgroups have been analyzed and compared and the students have been assigned by means of the previous test. Thus, the total of 60 students enrolled in CAT have been distributed in the subgroups as showed in Figure 7.2.

It seems the results of the assignment process have distributed students uniformly in each subgroup, none of them being much uncompensated. Alpha has been composed of 11 students; Beta, 17; Delta, 17; and Gamma, 15. Students have revealed they generally agree (34.69%) or agree very much (32.65%) with the station they have been assigned after running the initial test and considering their preferences (Alpha - “Every progress is based on competition", Beta - “Little circles in harmony", Delta - “Free spirits", Gamma - “One for all and all for one"). Only four students (8.16%) have not agreed with their assignment at

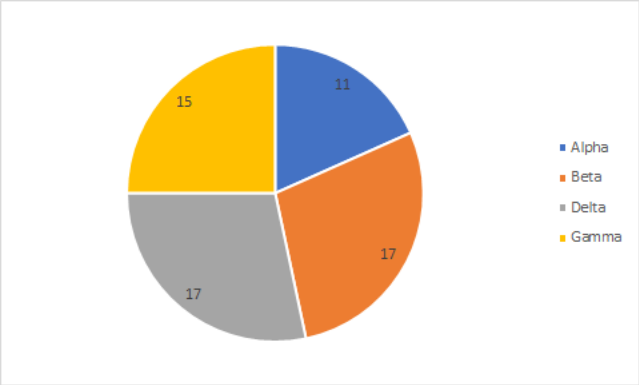

Figure 7.2 Student distribution (CAT)

the end of the experience, two of them in Alpha, one in Beta, and the other in Gamma. In contrast, all the students in Delta have agreed with the assignment.

Deepening into each subgroup, the descriptive analysis of the two types of activities has been summarized in Table 7.10. Alpha's log has revealed a total of 54.55% of students have participated of the simulation tasks, while 81.82% of the self-assessment exams; Beta, 47.06% and 41.18%; Delta, 35.29% and 41.18%; and finally, 53.34% and 73.34% in Gamma respectively.

As follows, the one-way ANOVA with four factors has been run. Regarding the outcomes, the null hypothesis has stated that the average hardness values of the four different groups are the same. Since the p-value (0.879) is more than the significance level of 0.05, the null hypothesis cannot be rejected and cannot be concluded that some of the groups have different means. The interval graph is show in the following graph (see Figure 7.3, where Beta and Delta have the lowest average in comparison to Alpha, the highest.

Table 7.10 Student task development (CAT)

Group	N	Mean	StDev	Min	Median	Max
Alpha	11	7.73	10.37	0.00	3.00	34.00
Beta	17	5.59	9.16	0.00	1.00	34.00
Delta	17	5.59	9.64	0.00	1.00	30.00
Gamma	15	7.33	6.88	0.00	5.00	20.00

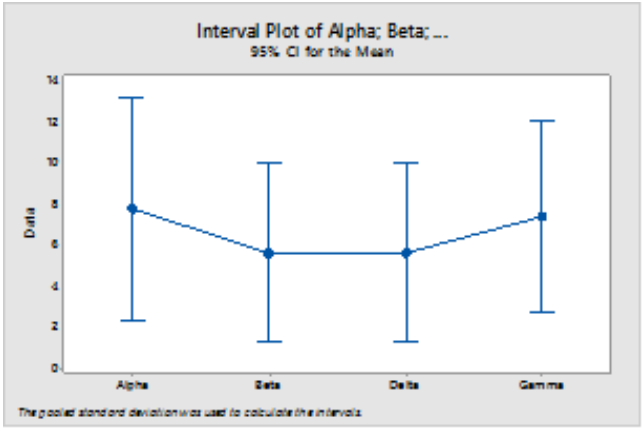

Figure 7.3 Students task development interval graph (CAT)

Furthermore, the distribution of active students has been 9 in Alpha (81.82% of total), 9 in Beta (52.94%), 10 in Delta (58.82%), and 11 in Gamma (64.70%). Therefore, considering the two types of activities only with active students, the following descriptive analysis (see Table 7.11) has been run:

Next, the one-way ANOVA with four factors has been again run. Considering these results, the null hypothesis has stated that the average hardness values of the four different groups are the same. Since the p-value (0.994) is more than the significance level of 0.05, it cannot be rejected the null hypothesis and cannot be concluded that some of the groups have different means. The interval graph is shown in Figure 7.4, where Beta and Delta are the highest in comparison to Alpha, the lowest.

Table 7.11 Active student task development (CAT)

Group	N	Mean	StDev	Min	Median	Max
Alpha	9	9.44	10.78	1.00	4.00	34.00
Beta	9	10.56	10.36	1.00	9.00	34.00
Delta	9	10.56	11.26	1.00	7.00	30.00
Gamma	11	10.00	6.08	3.00	10.00	20.00

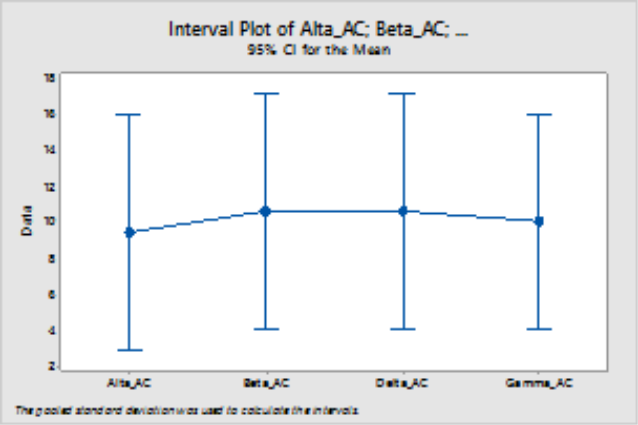

Figure 7.4 Active students task development interval graph (CAT)

Regarding emotional engagement of students, the emotion-related intrinsic principles described in SPARC validation model have been compared. Thus, the following Table 7.12 shows a comparison between the Alpha, Beta, Delta, and Gamma subgroups for each SPARC item. Additionally, students have valued the perception of the experience as 3.67, 3.92, 3.75 and 3.93 respectively in a five-level Likert scale (from value 1 "very irrelevant" to 5 "very relevant"). Another element to be considered regarding the emotional engagement is the interest to have similar experiences in other subjects in the future: results have revealed that 88.89% of students in Alpha have agreed with this affirmative, 61.54% in Beta, 91.67% in Delta, and 86.67% in Gamma. However, the one-way ANOVA have reveled that the f-values and p-values of each element in "S", "P", "A", "R" "C" are respectively 0.01 and 0.999, 0.23 and 0.877, 1.33 and 0.277, 1.98 and 0.131, and 0.87 and 0.462. Thus, it cannot be rejected the null hypothesis and it cannot be concluded that some of the groups have different means.

Table 7.12 Emotional perception (CAT)

Group	N	Sense	Purpose	Autonomy	Relatedness	Competence
Alpha	9	3.78	3.89	3.67	3.11	3.56
Beta	13	3.85	4.08	3.62	3.62	4.15
Delta	12	3.83	4.25	3.67	2.75	4.17
Gamma	15	3.80	4.13	4.20	3.53	4.00

7.5 Discussion

Regarding the impact of the online personalized gamification learning experience on students´ engagement versus generic from a behavioural engagement viewpoint, the outcomes have revealed that 65.00% of all the students who joined in a personalized gamification learning experiences have been active, meaning that they have participated of at least one non-formative task. Nevertheless, a total of 51.00% of the students from the non-personalized gamification course have been active. Thus, there has been a considerable difference of 14 percentage points between the active students in the personalized condition in comparison to the non-personalized condition. While the ratio student/task has been the same regardless of the size of each group and subgroup, students have participated of an average of 6.42 tasks per student (being 9.87 if considered only the active students) in the personalized condition; in contrast, the "one-size-fits-all" condition have revealed a total of 3.90 tasks per student (only considered active students, 7.45). The difference is higher than 1.5 times between conditions in case of all students.

From the emotional engagement viewpoint, students have valued the emotional perception of the experience as 3.84 and 3.47 respectively in a five-level Likert scale with values from 1 to 5. Moreover, the interest to join in a similar experience has been mentioned by 78.43% of the students who have experienced personalization, a much higher value than 52.63% in the "one-size-fits-all" condition. Deepening into the emotion-related principles of intrinsic motivation, all items have been highly valued in the personalized experience. In consequence, these findings have leaded to the conclusion that personalized gamification learning experience might have a greater impact on students' engagement than "one-size-fits-all" gamification learning experience. This way, a future work could be the application of other mechanisms of personalization and what would be the adequate ratio of design effort and impact of personalization on the students' experiences.

Regarding the impact on students' engagement when assigned to different tailored gamification learning experience based on their user type compared versus a random assignation, the outcomes have revealed that 73.34% of all the students who have joined the gamification learning experience by means of their user type have been active (that is, they have participated of at least one task from a behavioral engagement viewpoint). Nevertheless, a total of 51.00% of the students randomly assigned to the gamification course have been active. Thus, there is a considerable difference of 22 percentage points between the active students in the subgroups assigned through the participants' user types in comparison to the subgroups with random assignment. Since the ratio student/task is the same regardless of the size of each group and subgroup in this study, students have completed an average of 7.33 tasks (being

10.00 if only considered the active ones) in the user type-assigned subgroups; in contrast, the randomly assigned subgroups have showed a total of 3.90 tasks per student (only considering active students, 7.45). The difference is higher than 1.8 times between the two conditions.

From the emotional engagement viewpoint, students have valued the emotional perception of the experience as a average of 3.93 and 3.47 respectively in a five-level Likert scale with values from 1 to 5. Furthermore, the interest to join in a similar experience has been mentioned by 86.67% of the students who have been assigned to groups based on their user type, a much higher value than 52.63% in the groups formed by diverse user types. In consequence, these findings have leaded to conclude that a gamified learning experience would have a greater impact on students' engagement when personalized based on their user types, compared to students assigned randomly to groups.

Regarding the differences on student engagement between the personalized gamification learning experiences, the outcomes from the study have revealed a little difference in the averages of tasks completed among the four experiences from a behavioral viewpoint. Thus, the Alpha and Gamma subgroups have showed a participation rate of 7.73 tasks per student, meanwhile subgroups Beta and Delta, 5.59. The difference is smaller when considering only the active students (Alpha: 9.44, Beta: 10.56, Delta: 10.56, and Gamma: 10.00). Moreover, the number of students assigned to each experience is balanced; there has not been a station (personalized gamification learning experience) with fewer students, which could have influenced the student engagement (e.g. feeling of loneliness).

From the emotional engagement viewpoint, students have valued the emotional perception of each experience as 3.67, 3.92, 3.75 and 3.93 respectively in a five-level Likert scale with values from 1 to 5. Regarding the interest to join in a similar experience, 88.89% of students in the Alpha subgroup have agreed with the affirmative, 61.54% in Beta, 91.67% in Delta, and 86.67% in Gamma. Only the Beta subgroup have presented a lower rate than the other. Regarding emotional-related items, the differences are low and above neutral (3), except for Relatedness in Delta. This can be explained because this group has been designed more likely for Free Spirits; however, student interaction has not been promoted by the gamification design elements employed in the course. In consequence, these findings have leaded to conclude that the different personalized gamification learning experiences by user types engage students roughly by the same factor from the behavioral viewpoint, but this cannot be assumed from the emotional point of view.

7.6 Concluding remarks

Upon the completion of this study, the descriptive statistics have suggested that personalization of gamification design for student engagement in the learning process seems to work better than generic approaches, since the metrics related to behavioral and emotional engagement have been higher for the personalized condition on average. However, the standard deviation for all metrics has been very high in relation to the means, in general. This issue, as well as the difference in sample sizes, have prevented reporting any significant results, even with the resulting differences in means. Moreover, the high standard deviations have also showed that the difference in the means could reflect a scenario in which some students have been very active students (more than the expected student/performance ratio) as opposed to many students who have not acted as expected. In addition, a limitation should be considered at the present case study; the student profile at the UOC online studies is different to face-to-face studies (age of learners), so it should be taken with caution as it may vary for younger students in higher education.

Chapter 8

Applying gamification design framework in health: a case of industry

8.1 Overview

Gamification encompasses diverse kinds of non-game contexts such as education and training, human resources, marketing, sales, health and well-being, etc. Until now, the gamification design framework has been validated in three case studies in learning environments (Chapters 5, 6, 7). Now it is intended to evaluate an application in health and well-being. Thus, most of the academic works related with gamification of health and well-being are focused on enhancing and motivating health behaviour related to exercise, nutrition, medication adherence, weight control, etc., where the chronic disease management and physical activity are the most studied health topics [166]. Traditionally, one of the most popular gamified approaches to a healthy lifestyle has been physical improvement. Nowadays, innovative devices allow people to measure things like how many steps they take, how much they sleep and how much they exercise, which is then used as a motivational tool to get healthier and improve their performance. Additionally, recent researches have contributed to this approach with the design of new strategies to create meaningful and playful fitness applications for older adults [84, 104] revealing an abundant integration of gamification techniques in physical training tools.

However, an increasing relevance by the academic community in the gamification of cognitive training domain has been detected through the publications during last years and diverse projects have been funded in Europe. For instance, the DOREMI project [1] aims to design of a gamified cognitive training solution for older people by using a User-Centered

[1] http://www.doremi-fp7.eu/

design process, PERSSILAA [2] attempts to develop and validate a new service model to screen for and prevent frailty of older adults, supporting cognitive functioning by the use of gamification, meanwhile, and NEXT-LEVEL project [3], focuses to generate design principles for the gamification of mental health interventions, where cognitive training and behavioural therapy is a topic of interest.

The main cause of this interest is the dementia, currently becoming a great concern in industrialized countries [150]. It is presented as a syndrome, usually of a chronic or progressive nature, in which a deterioration of cognitive functions beyond expected from normal aging appears. It is characterized by the deterioration of memory, thinking, behaviour and the ability to perform everyday activities. The World Health Organization (WHO) estimates about 47.5 million people are affected worldwide, and 7.7 million new cases appear every year. Early episodes of dementia, also known as Mild Cognitive Impairment (MCI), involve many of the related problems described before, especially with memory, language, and other cognitive functions. In addition, often accompanied or preceded, by the impairment of emotional control, social behaviour and motivation. However, new approaches, from a better understanding of the risk factors for cognitive impairment, reveals a remoteness from drug therapies [94], developing dynamic interventions which can preserve cognitive function and also help to maintain quality of life and independence well into old age.

Taking into account this scenario, the prevention of dementia, and generally, the cognitive care should be a lifelong pursuit. Preventive health behaviours include the behaviours that are undertaken by individuals for the purpose of preventing illness, detecting early illness symptoms, and maintaining general well-being [174]. Therefore, on the one hand, research results support the effectiveness and durability of the cognitive training interventions in improving targeted cognitive abilities [81]. On the other hand, outcomes also suggest that cognitive programs are less effective for individuals who already present cognitive impairments. That becomes a strong reason to start working on cognitive health maintenance in early and mid-life, before these problems arise [38]. Consequently, the interest in cognitive training software, as well as the interaction for prevention of cognitive abilities in older adults has grown during latest years; cumulative evidence reveals cognitive interventions are effective [76].

[2] https://www.perssilaa.eu/

[3] ttp://studiolab.ide.tudelft.nl/studiolab/persuasivegamedesign/

8.2 Cognitive training

The analysis of diverse cognitive training tools reveals a common issue: they are based on a set of sequential and monotonous exercises. Unfortunately, this characteristic seems to slowly reduce user engagement, leading to a poorer performance, and defeat at the end. Continuous motivation in training programs are usually driven by tangible and quick outcomes, as a result of adequate performances, but cognitive improvements usually appear gradually in this scope. Therefore, it is expected a gradually loss of interest and enthusiasm. In this way, gamification, seems to be appropriate to address these difficulties. It fits on recent researches which suggests that motivation and engagement are closely related to improvements following cognitive training [85].

A systematic review of the existing literature of gamified cognitive training reveals the interest aroused about how to increase the adherence and effectiveness to these interventions through gamification. However, diverse studies have revealed the heterogeneity of them and the inadequate samples sizes used by them in order to get solid conclusions about how gamification increases the engagement in the interventions [107]. Gamification can be powerful motivator, but it can also be overwhelming for older people if designed poorly. Consequently, the most problematic area of gamification actually lies in the difficulty in designing a gamified experience, particularly in health contexts [147]. The application of a gamification design framework as a path to success is implied as necessary, as well as considering personalization [55] through the knowledge of static and dynamic user attributes, analyzing activity tracking, comprehending user behaviour and assessing behavioural determinants.

Thus, engaging every participant through gamification is not a silver-bullet for all motivations problems of every older adult. This way, Tondello et al. [182] inform about the necessary development of design guidelines and tools for gameful health and well-being applications, being personalized to each individual user. Most of these applications commonly use combinations of motivational affordances and are not designed for a specific user, where every user is treated at the same way and is exposed to the same game elements. Personalization offers system-tailored contents and services to its users, tailoring content and functionality to a particular user's need based on a user's characteristics [142].

8.3 Commercial solutions

As a previous part of the design process, a review of the gamified cognitive commercial tools has been conducted in order to know which game design elements are being integrated. Firstly, it is noteworthy that most of them, when applied for older adults, are designed

to complete many trials in a monotonous way, where a reward-driven focus only seems to work for a short time. Gamification has been added with the purpose of improving desired behaviours and outcomes regarding healthy habits, but some evidence on how the effect of engagement for a long time is are missed. Thus, six of the most relevant applications for cognitive training which incorporate a gameful design has been selected for a benchmarking purpose: Lumosity[4], Unobrain[5], FitBrains[6], MensaBrainTraining[7], Cognifit[8], and BrainyApp[9]. Accordingly, nine of not recommended design items (from the research outcomes about gamification design and older adults) has been selected for the analysis (see Table 8.1):

- Providing a competitive environments (1): competition-based gamification might be more effective for young rather than old participants [128].
- Making direct comparisons (2): older adults did not like the visualizations of their own efforts or competition with other participants [73].
- No peer reinforcement (3): strong desire to share activities with other users, give and receive feedback from peers perceived in older adults [84].
- Silver-bullet design (4): personalization provides the users a sense of control over the users' health [117].
- Missing personalized reinforcements (5): provides encouragement tailored to older adults need-satisfaction characteristics [84].
- Anticipated rewards knowledge not provided (6): its knowledge has a good effects on the exercise outcomes and also psychological feelings of users [24].
- Displaying distracting elements (7): adding 'distracting' game elements may have a negative impact on users' performance by inducing unneeded stress [85].
- Missing the metaphor (8): metaphors, dramatic arcs and game dynamics as vehicles for increased engagement and long-term sustained change [147].
- Using virtual badges (9): virtual badges appear to be a positively impact on youth but not on older adults [103].

[4]https://www.lumosity.com/
[5]http://www.unobrain.com/
[6]http://www.fitbrains.com/
[7]http://www.mensabraintraining.com/
[8]https://www.cognifit.com/
[9]https://brainyapp.com/

Table 8.1 Gamification on cognitive training tools

Milestone	Bonus
Lumosity	(1), (2), (3), (7), (8)
Unobrain	(1), (2), (3), (5), (7), (8)
Fit Brains	(1), (2), (3), (5), (7), (8)
Mensa Brain Training	(1), (2), (3), (4), (5), (6), (7), (8)
Cognifit	(1), (2), (5), (7), (8)
BrainyApp	(1), (2), (4), (5), (7), (9)

As shown, the most relevant gamified cognitive commercial solutions have largely incorporated game design elements which are considered as "non-suitable" for older adults taking into account the outcomes of the main publications previously reviewed, and also relevant items are missing. Therefore, it should be considered whether the engagement layer proposed through a gamification design is the most appropriate for a long-term motivation. The main objective of this kind of tools is to create healthy habits through a regular usage, an arduous and lasting purpose, more pronounced with older adults.

8.4 Design principles

To guide the process of the gamification design to older adults in the health context, behavioural objectives have been described, as follows:

- Encouraging the regular use of a cognitive tool (to create a habit).
- Promoting the best performances (put interest in it right).
- Foregrounding the social-collaborative achievements (create an influence community around the cognitive training).

Therefore, Preventive Neuro Health (PNH) is conceived as a gamified tool for the prevention of cognitive decline in healthy older adults or in early stages of dementia, which does not require professional clinic as supervision. The tool consists of a total of 38 exercises of cognitive stimulation designed by neuropsychologists for mobile devices (optimized for tablets), which covers the following cognitive domains: attention, memory, executive functions, calculation, orientation, gnosis, and praxis. The exercises (an example can be seen in Figure 8.1) are provided by descriptive information previous to the execution.

Accordingly, gamification has been designed by means of the FRAGGLE framework (without the specific items to learning environments) in presented in Chapter 4, and the

Figure 8.1 PHN exercise overview: Attention-Selective (Beta)

SPARC design validation of intrinsic motivation in Chapter 5. These dimensions have been applied as follows:

- **Sense**: the exercises must make sense to older adults and is coherent with the cognitive well-being process (first objective).
- **Purpose**: the designed exercises must have a clear purpose form the neuropsychologist. This purpose should be aligned with the cognitive training outcomes (cognitive impairment) (first objective).
- **Autonomy**: the exercise should be optional and let, even older adults can make their choices (first objective).
- **Relatedness**: each exercise performed should have some positive impact on the rest of older adult or the tool itself. (third objective).
- **Competence**: the exercises should ensure that older adults will be able to master it effectively by using the tool (second objective).

Additionally, three elements have been described: (1) the *rules*, which describe the basics of the activity mechanics; (2) the *metaphor*, which contextualizes the rules in the learning environment, giving sense to the whole activity so it may not be considered arbitrary by the students; and (3) the *tool* used to implement the rules and the metaphor.

8.4.1 Rules

The rules have been basically designed as a reward-based crowd-funding model where users run cognitive exercises and their performance have an impact in both individual (personal cognitive domains) and common scoreboard (group). Therefore, daily challenges formed by exercises have been presented to each user (pseudo-random selection of exercises) where every daily challenge will expire at the end of the day. A penalty is applied if the current day has been set as training day by the user and the exercises have not completed. Points are the basics, and the logic implemented is defined as follows:

*Exercise score (inputs) = RoundUp (0) [0,8 * (hits / hits + errors + omissions) + 0,2 * (total time - time spent / total time)] * 10*

To reach the maximum score (10 points), users should complete the exercise 100% successfully in less than half of the time expected in the exercise definition. The 0-10 scale has been selected to an easy understanding by the older adults. Note that the scoring mechanism is independent to the difficulty applied in the exercise. If the user closes an unfinished exercise, the system will divide the score obtained by the formula by two. Meanwhile, if a user exceeds the maximum expected time of the exercise, the system will not halt its execution and the maximum expected time will be set. Random rewards are allowed as multiplier of the points obtained at the end of the exercise or in the form of bonus time.

Regarding the individual progress, all users start with a default value of 50% in each of their cognitive domains. Thus, the update mechanism has been defined as follows: if the user has scheduled a training day and does not connect, all the domains will reduced by 2% with the minimum of 0%. When a user has not scheduled a training day and does not access to the system, no actions are taken. However, if the user has scheduled a training day and runs a minimum number of exercises, the cognitive domains stimulated with the exercise are updated according to the following formula (note that the process of updating the cognitive domains are totally independent to the exercise difficulty).

*Cognitive-status-function (inputs) = Round (0) [0.7 * (score / 10)] + 0.3 * (domain weight / 100)*

Moreover, a badge system has been also implemented to promote the regular performance. When a user overcomes the daily challenge during five consecutive days, a bronze medal is earned; when the user trains during ten consecutive days, a silver medal; finally, the gold medal is reserved for those users who have trained for fifteen consecutive days.

8.4.2 Metaphor

It has been inspired on a collaborative system based on a crowdsourcing model where, instead of money or resources contributions, users provide individual actions of cognitive training (usage of the tool). Through their training effort, they will receive points which are accumulated for a common goal shared between all the users: unlocking new features and contents within the solution. The cost of the new unlocked issues are assumed by this "virtual economy" based on points (effort and regular use) provided by the community as a group.

8.4.3 Tool

In contrast to the case studies presented in the educational context, PNH is an "ad-hoc" tool (it is not a close-ended software like Trello o TracWiki), therefore, all design elements developed in the framework are explicitly defined as follows.

User Stories

They are the expected behaviours from the user perspective. They must be aligned with the proposed objectives. Therefore, the User Stories have been described as follows. "As an older adult, I'm interested in my cognitive well-being, so I want to feel more committed to:

- ...freely perform the adequate cognitive training exercises for the cognitive improvement purpose".
- ...make the best performance in each exercise workout as possible, not being too boring or difficult for me".
- ...interact with people of the cognitive training community for the achievement of a common goal".

Acceptance tests

They are the items used for the measurement of the success of gamification design, regarding to the predefined objectives (metrics). Regarding the three types of objectives:

- **First objective**: daily active users, challenges passed, weekly sessions completed, training schedule updates, time of use.
- **Second objective**: optional exercises performed, status updates, records.
- **Third objective**: daily social interactions, feedback, ratings, reviews, support.

Table 8.2 Overview of design elements

Game design element	**Preferences**	**Stage**
Tutorial (not binding first trial)	(B)	(G),(H)
Daily challenge (regular training)	(B)	(G),(H),(I),(J)
Random reward (surprising)	(A)	(H),(I)
Status (cognitive improvement)	(B),(D)	(G),(H),(I),(J)
Progress bar (tool unlocks)	(B),(D),(E),(F)	(G),(H),(I),(J)
Emotional assessment (exercises)	(E)	(G),(H),(I),(J)
Design assessment (exercises)	(E)	(H),(I),(J)
Avatar (profile customization)	(C),(D)	(H),(I),(J)
Voting (quality of exercise)	(F)	(H),(I),(J)
Access (performance stats)	(B),(D)	(H),(I),(J)
Mentoring (recommendations)	(C),(E)	(I),(J)
Access (not mandatory exercises)	(B),(D)	(I),(J)

Game design elements

This phase comprises the description of the appropriate game design elements in accordance with user preferences (the gamification design toolbox can be applied): reward (A), expertise (B), relationships (C), autonomy (D), altruism (E), influence (F). It also depicts the suitable stages for enabling them: discovery (G), on-boarding (H), mid-game (I) and, end-game (J). Accordingly, Table 8.2 shows a summary of how the relationship between this three issues is carried out. Additionally, for each of these game elements, the features of the engagement cycle are described under the following structure: trigger (at the most likely and place to take an action), action (user), reward (a way to positively reinforce users for the actions that they perform) and investment (small investment to encourage better behaviour in the future) [36].

Thus, it is described an example of the engagement cycle designed by the game design element: “daily challenge” (see Table 8.3). Note that the design process described is iterative. Beyond carrying out a first approach, gamification design will be held to continuous improvement towards continuous measurements and updates, considering the values of metrics that will lead to the achievement of the proposed objectives.

Table 8.3 Overview of the engagement cycle: an example

Cycle	Description
Trigger	The system notifies (in a personalized way) to the user that has not yet overcome the daily challenge (set of cognitive training exercises) and today is active in calendar (user profile). Additionally, the system can also communicate the percentage of current users who have already succeeded the daily challenge in the community
Action	From dashboard, the user selects and performs the most appropriate exercises according to the cognitive domains that want to improve or their interests
Reward	When the user finishes each exercise, he/she receives a positive and personalized feedback: reinforcement, statics (successes, failures, abstentions, maximum time, and time spent), a cognitive update, and the contribution to the community purpose (unlocking functionalities)
Investment	The user perceives that the cognitive exercise has been carried out. If more exercises are missing to overcome the daily challenge, the trigger is launched again; else, the user is positively reinforced (the daily challenge is completed). Next, user is challenged to continue training by showing the remaining path to unlock the next crowdsourced achievement.

Interface design

One of main purposes in the Human-Computer Interaction is to provide a better user experience in the management of technological devices. In this sense, current multi-touch technology enables the possibility to create devices provided by very flexible user interfaces and characterized by its intuitiveness of use, being highly relevant for our target: older adults. Diverse studies reveal that touchscreen mobile interfaces are preferred and not too difficult to use, even by the older adults. Kobayashi et al. [90] find that mobile touchscreens are generally easy to use for the older adults and a week's experience generally improves their proficiency. Therefore, PNH user interface is conceived from the perspective of a User-Centered design to multi-touch technology for mobile devices (not being restricted to PC's or laptops, but non-recommended) by means of a fully responsive design. PNH's user interface design has been developed under the usability principles adapted to the users needed (older adults) being described as follows:

- **Simplicity**: background is proposed in a very light grey colour and texts are presented in black, while the most relevant content is highlighted in colour from on other elements. Furthermore, the information is set to functionality.
- **Legibility** and hierarchy: main texts are presented into a higher font (even, in uppercase for easy reading). The buttons have a greater surface from standard to be identified and can be touched more easily.
- **Pattern recognition**: the main actions are presented in buttons for intuitive and quickly identification. Since blue is the standard colour for hyperlinks, it is used to support the mental idea of buttons.
- **Help and documentation**: during the first contact with the system, the users receive instructions to identify previously each block of the interface and its functionality. This information is always accessible in dashboard section (more likely to lower memory in older adults).
- **Functional flow**: interaction flows are very well-defined providing to the user the minimum options available in order to reduce the elements of choice and avoid a saturation state. Additionally, all the content is presented on the screen and the scroll is never used.

Regarding to its usability principles, PNH presents diverse sections, taking the dashboard as the core of the application. It comprised of four different sections:

- **Daily challenges**: the exercises are presented as cards where users have the freedom to choose (regarding to their preferences or cognitive states they want to improve each moment) to overcome the daily challenge (an estimation of 10 minutes of daily training).
- **Cognitive domains**: users' status is represented as progress-bars based on each of the domains contained in the exercises designed by neuropsychologists.
- **Progress**: the community evolution in real-time is displayed in this section, as well the achievements and next unlockable.
- **Notifications**: it is conceived as a vertical section where the system displays information about the user and the others for triggering purposes.

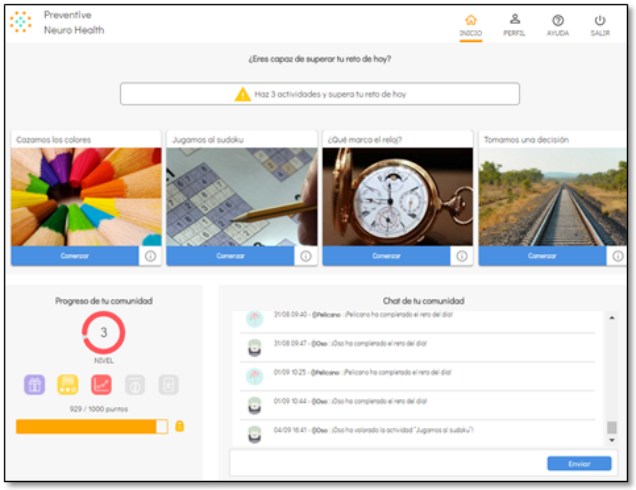

Figure 8.2 PNH dashboard

Figure 8.3 PNH profile section

Other relevant sections are described: profile section, which allows the users to set up certain parameters (such as the own schedule of training days, avatar, etc.), as well as, the personal evolution and how is reflected in the overall contribution in the community. Thus, Figures 8.2 and 8.3 show the PNH User interfaces.

8.4.4 Architecture

The proposed tool consists of a suite of Web-based (HTML5) exercises optimized for tablets for cognitive training aimed to offer older adults an engaging non-supervised service of tele-cognitive stimulation. It has been developed with Django framework[10]. It is an open-source web framework, written in Python, under the Model View Controller (MVC)

[10]https://www.djangoproject.com/

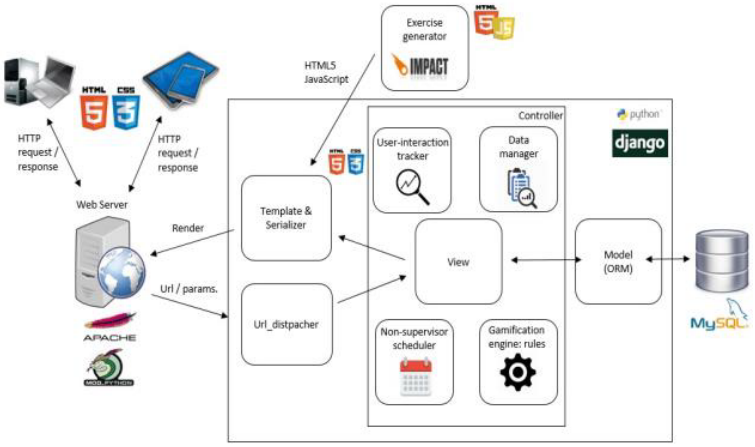

Figure 8.4 PNH architecture

architectural pattern. Apart from the components of this framework, PNH comprises the following incoming modules (as shown in Figure 8.4), which are totally interconnected, being highlighted and described in this paper the most relevant for the personalization of the gamified experience.

Automatic scheduler

It is an unsupervised planner with the purpose of scheduling the exercises (the base of daily challenges), and setting the associated difficulty according to the established inputs (settings). An imbalance proposal could lead to frustration (if the exercise is too difficult) or boredom (if it is too easy), regarding to the user skills [30]. Therefore, a scheduler algorithm sets the variables involved in the selection of specific exercises against others (e.g. difficulty, repetitions). On one hand, the proposal of exercises (most likely by the scheduler) is "influenced" by the cognitive domains of user status (more likely the exercises that work the lower values of cognitive domain of the user), user choices, and user assessment. This means that a low evaluation of an exercise has an impact in the probability to be proposed by the scheduler.

On the other hand, the difficulty set to each exercise is applied. It starts with the tutorial phase incoming (first trial in each exercise) and historic of executions (correct answers, wrongs, omissions, time spent and maximum time associated to each exercise according to the difficulty level). In addition, regarding the collaborative perspective of the gamification design, a user with lower cognitive abilities will not be penalized and disengaged by a lower individual performance in a low difficulty level and will contribute to the global achievements in the same way (contributions) as a user with almost intact cognitive abilities with a better

performance in high difficulty levels. All parameters applied to the exercises are presented in Appendix G. Thus, according to Solana et al. [177], the system defines three different ranges of performance regarding to each exercise's execution score:

- Therapeutic range, when the score is between 65% and 85% of correct answers. The user executes the exercise with an appropriate difficulty configuration in order to get the best effectiveness.
- Infra-therapeutic, when the score is below 65%. The difficulty level of the exercise is too high for the user's capacity and could also lead to frustration.
- Supra-therapeutic, when the score is above 85%. The difficulty level is too low for the user's capacity and the cognitive activation is not being high enough. Could also lead to boredom.

The process starts when the scheduler presents a daily challenge formed by a set of exercise with the possibility to run them as a "warm-up" mode. The purpose is to "offer" a first contact with each specific exercise without real impact. Therefore, the algorithm can adjust the level of difficulty previously. This feature is optional to user.

Gamification engine

The purpose of the gamification engine has been the management of the logic designed in the engagement cycle to support the gamified experience in real-time. The role of this engine is threefold: firstly, activating the adequate triggers (taking into account the user attributes and context), secondly, taking the inputs from users interaction (actions) for processing, and thirdly, managing and updating all game-related data according to the pre-established rules and states (contextual information of the user). Finally, the associated answer (reward) is established as reinforcement (investment). As it can be seen, the gamification engine works with diverse sources, either static data (attributes and rules), dynamic (user interaction and preferences) and contextual (states).

User Interaction Tracker

It has been developed for managing user interaction with the tool. It allows the monitoring and storage of all data from two points of view. Firstly, from a clinical viewpoint, with the aim of extracting behaviour patterns regarding to user interaction on each exercise. The acquired information will be an invaluable point for neuropsychologists, not only to assess the adequate design but to know how the exercise has been carried out by diverse users

according to their cognitive abilities and the settings (difficulty). Secondly, from a usability viewpoint, with the aim to ensure the requirements needed by age-related with their functional limitations. Designing for older adults requires the consideration of ergonomic and usability issues. Additionally, information is graphically displayed on a heat map in order to extract behavior patterns related to the interaction of the users with each exercise. The analysis of this information will reflects unwanted interaction patterns that would mean that the exercise may not have been correctly designed.

Data Manager

It provides to users and managers access to all processed data taken from other modules and the generation of valuable reports. Regarding older adults, it gives access on-demand to intuitive reports about their evolution by time: challenges completed, performances, cognitive progression, contributions, unlocks, and timeline. Regarding designers, reports allow them the assessment of the pre-defined metrics in the Acceptance Tests, a critical issue for the quantitatively evaluation of the proposed objectives. From the point of view of the iterative gamification design, it allows to carry out the necessary adjustments to maintain the engagement flow state and lead to the objectives.

Exercise generator

The labour of this module is "proposing" the cognitive training exercises. For this purpose, ImpactJS, a 2D game engine based on JavaScript language, offers the ability to easily manipulate the HTML5 canvas element. This library provides functionalities, which do not require any modification of the native Application Programming Interface (API) canvas. It is based on entity models where developers describe the behaviour (objects, interactivity, etc.) and is responsible of drawing and calculating collisions, between others specific functions.

8.5 Concluding remarks

At this point, the whole gamification design cycle (modeling and implementation) has been covered with the result of a software deployed. This outcome has allowed ICA Informática y Comunicaciones Avanzadas S.L. Barcelona to check the feasibility of applying the developed of the design framework to implement gamification in other health-related online tools. To verify the impact, a pilot study is planned to be carried out in two phases during 3 months at year 2018 to measure the impact. Firstly, an usability study with older adults is intended, to ensure that interaction does not involve an early barrier for the engagement purpose of

cognitive training. Secondly, a validation of the gamified design by means of the proposed engagement objectives is planned to be conducted. Accordingly, two groups formed by randomly healthy older adults will be recruited to run an A/B test, one group will use the gamified version of the tool (PNH) and the other one, using a reduced version of PNH (without gamification).

Part III

Summary and outcomes

The third part comprises the discussion on the research questions, the impact of the finding of this thesis in the industry, and the future works which can be developed taking the base of this thesis.

Chapter 9

Conclusions

9.1 Overview

The proposal of this thesis has been the development and validation of "a framework for agile design of personalized gamification services". Therefore, two different parts have been conceived to conceptualize the research on the design framework: the state of art and analysis of the motivational principles behind game components, and the evaluation through the development of diverse case studies in learning and health contexts.

9.2 Accomplishments

It is intended to answer the next research questions.

9.2.1 Which gamification design frameworks are available in the literature and which design elements are considered?

A literature review on gamification design frameworks has been initially conducted [123, 124]. It rely on a systematic process based on queries from databases, libraries, journals, and search engines, which have revealed a total of 2,314 unique works until February 2017. By means of this systematic procedure, a final list of 47 gamification design frameworks has been recorded and presented in detail. For the purpose of running a benchmarking, 35 non-theoretical gamification design frameworks have been thoroughly analyzed according to 24 game-related items grouped by six categories. This analysis has revealed a clear predominance of gamification design frameworks oriented to the business contexts, and a little less predominance of gamification design frameworks for generic purposes, learning and healthcare environments. Most of them are conceived as User-Centered design approaches,

and in less extension, technology-centered. Therefore, the objective of identifying and classifying the gamification design frameworks found in the literature from both academic and non-academic sources has been achieved in this research action (OB1).

In a more detailed manner, diverse issues analyzed such as risk, feasibility and investment have rarely been taken into account, even in the frameworks oriented to a business context. The participation of the stakeholders in the design process has been considered necessary in less than half of the approaches, in contrast to the widespread consideration given to the definition of objectives as an early premise. From a logical perspective, while the importance given to the engagement loop is extensive, only a few frameworks have considered the design of the on-boarding and endgame processes as relevant. Measurements seem to be a critical concern and the majority of the frameworks explicitly refer to the use of analytic and the importance of data collection. However, the definition of specific metrics is less widespread. Regarding dataset acquisition and treatment, the issue of ethics is given little consideration.

In addition, psychology presents a high relevance in almost all of the frameworks; all the studied frameworks agree it is a key element that should be present in any design process. However, broad-based consideration of issues about user typologies and their preferences for personalization is not widespread. Interaction principles are also extensively referred, emphasizing the gamification as a user experience itself. The need or desirability of developing software taking into account the possibilities provided by digital environments is extensively referenced too. Additionally, a closer relationship between the principles and elements of game design and gamification is shown. The results have revealed the heterogeneity of the analyzed frameworks, from a highly theoretical objective towards the conceptualization, including the perception of gamification from different contexts and areas of interest. Consequently, the objective of identifying the game design principles described by the frameworks from the literature has also been achieved in these research actions (OB2). All the findings presented to answer this research questions are examined in Chapter 2.

9.2.2 What are users' preferences for different gamification design elements and the way its implementation affects their motivations?

To answer this question, an exploratory study based on the Hexad User Types framework (generic and hybrid viewpoints), as well as on users' preferences for different game design elements has been previously conducted [125]. To accomplish this goal, a total of 925 worldwide participants have been asked to complete a 15-minute survey made up of questions focused on their preferences while using gamified systems within digital applications. 590 answers have been accepted to ensure the quality of dataset. It allows to gather reliable

information that may help deepen the experience of personalized gamefied design. The results have reported the effect of the demographics differences regarding age, gender, and culture of users' preferences. Thus, they support the assumption that participants' preferences for different game design elements are affected by their user types. In general terms, current findings suggest that challenges constitute an element expected or desired for almost any user type; leaderboards are preferred by Players; teams should be considered specially for Philanthropists and Socializers; voting mechanisms are enjoyed by Players and Achievers; Gifting should be used to motivate Players; and Exploration is better rated by Socializers and Philanthropists.

Accordingly, a weak correlation has been found between Philanthropists, teams and exploration, a moderate correlation between them and a positive attitude towards challenges, and no correlation has been found with gifting. Regarding Socializers, a weak correlations with teams has been found, as expected; however, a weak correlation has been also found with challenges and exploration. Free Spirits presents a weak correlation with challenges, as expected too. Moreover, Achievers presents moderate correlations with challenges and a weaker correlation with voting. The Disruptors user type is not correlated with the suggested game design elements voting or challenges. Finally, Players presents the highest number of correlations: weak correlations are observed with leaderboards, challenges, voting, and gifting.

Research outcomes fit to the knowledge of the relationships between users' preferences and the different gamification design components (OB3). However, some limitations should be considered although a large enough sample for the exploratory purpose has been achieved. For example, most of the participants are young people, perhaps due to the dissemination of the survey in higher education environments, and the survey has been limited to adults of legal age. Regarding culture, most respondents have come from western countries (mostly Spanish and English-speaking countries), and a large number of respondents form African and Asian countries have not been obtained. Regarding the game design approaches studied, it has been limited to six main game design elements. The presented findings have been broadly examined in Chapter 3.

9.2.3 Which components should be considered in a gamification design framework?

From than point on, a first approach of a conceptual framework for gamification design of learning experiences, called FRAGGLE, has been developed [127]. It has been initially conceived to learning environments, being extensible to others environments, by means of

the use of the Agile methodologies in order to obtain a fast MVP (gamified design) in a short time. The approach is based on an incremental development with minimal iterations, giving greater value to individual issues, a point that allowed to reach high effectiveness in unclear and dynamic environments. Concretely, it is based on low levels of abstraction for a step-by-step understandable application, inspired on the Lean UX principles and the Behaviour-Driven Development methodology. It consists of four main steps: declaration, creation, execution, and learning.

In the declaration phase, the definition and the necessary previous conceptualization for the design process are explained, meanwhile the creation phase covers user interaction issues. In the execution phase, tracking is carried out by means of user interaction. Finally, the learning phase addresses the analysis and measurement tasks, including management and prediction works necessary for improvement. A validation approach based on the principles of intrinsic motivation, called SPARC, has been also developed to ensure the design covers the basis of human motivation. It provides an empirically validated design toolbox which aims to support designers on the most appropriate game design elements for each type of user and motivation. This approach has covered the fourth objective defined about the development of a conceptual framework for the gamification design process based on the agile paradigm including the most relevant design principles (OB4). This approach can be found in Chapter 4.

9.2.4 How are users motivated in a gamified learning experience developed through a formal design process?

The second part of the thesis starts with the development of a case study thorough the design of a gamified online course in Computer Engineering degree [122]. It has relied on the application of game design elements and properties in non-leisure environments as its motivational foundation. The objectives have aimed towards two educational goals: improving the student motivation to go beyond just solving evaluative activities, and creating a sense of comradeship between students. A total of 60 students from two groups have voluntarily joined the experience, which has been evaluated at the end of the course from both a quantitative and qualitative standpoints. This analysis conducted have revealed a very good acceptance in all studied items related to the design experience and a high degree of engagement: 18.34% students have participated in one non-formative task (active students), 54.99% students have participated in two or more tasks (higher active participants), and there have been an increment of 35% over total posts in previous edition of the course. Additionally, the design process has been coherent and the final result are mostly aligned with

the *SPARC* validation items. Outcomes has revealed rates with a range of 53.13%-93.75% of acceptance in the five intrinsic elements. All the findings have been presented in detail in Chapter 5.

9.2.5 Which design components are the most relevant to user engagement in a gamified learning experience?

Diverse changes have been applied in a new case study in Computer Network design to know how engagement is affected [126]. A total of 31 students voluntarily have joined the course in two groups. The proposed objectives of engagement have been moderately reached by participants, although most of them initially decided not to join. Accordingly, diverse keys design elements have been analyzed to explain the engagement differences perceived compared to a previous similar experience. In this previous experience, most of the key design elements are related to competence and purpose: lack of initial skills to face an experience and achieve the mastery (such as, the use of a non-native language and hard tasks), a short on-boarding period, fast transition to mid-game, complex rules (specially at the beginning), difficulties using the tool, and usefulness of the tool to the learning process.

These two experiences have been developed under the paradigm of the "one-size-fits-all", with the same experience to all participants. Regarding the RE study presented in the Chapter 5, a great difference has been perceived between the participation of students in the two gamified courses: 63.82% and 26.72% of total students in the RE and the NT, respectively. Regarding the achievements, a total of 62.00% and 80.00% in two groups in RE have been obtained, in contrast to 61.12% and 52.17% in NT. This research outcomes have covered the analysis of the effects of gamification in different case studies (OB5) with the limitations of sample sizes and characteristics due to the predominance of adult learners (an average age higher than 30 years old, which is over the average age in higher education in Spain). These findings have been examined in Chapter 6.

9.2.6 What is the effect of a personalized design versus "one-size-fits-all" in user engagement in a gamified learning experience?

A new case-control study have presented the design and analysis of a personalized gamification learning experience within a Computer Network Design course [121]. The general purpose has been to determine how a personalized gamification learning experience affects the students' engagement in comparison to the "one-size-fits-all" design. A total of 81 students have voluntarily joined the experience in two groups: 60 of them in an experimental group and 21 in the control group. This experience has been assessed at the end of the course

from the behavioral and emotional engagement viewpoints. Both quantitative and qualitative standpoints have been considered through the logs of the tool and results of a survey. A descriptive statistic process and different non-parametric tests have been conducted. Thus, results have revealed that personalization seems to work better regarding the behavioral and emotional engagement of the students.

Considering the impact of the online personalized gamification learning experience on students' engagement versus generic from a behavioural engagement viewpoint, the outcomes have revealed that 65.00% of all the students who have joined a personalized gamification learning experiences have been active vs 51.00% in non-personalized. From the emotional engagement viewpoint, students have valued their emotional perception of the experience as 3.84 and 3.47, respectively in a five-level Likert scale with values from 1 to 5. Moreover, the interest to join in a similar experience has been mentioned by 78.43% of the students who experienced personalization, a much higher value than 52.63% in the "one-size-fits-all" condition. However, the differences in samples' sizes has not lead to any statistically significant result, which would have allowed to provide more definitive outcomes. These research outcomes have allowed to address the objective of evaluating the differences in user engagement in a personalized gameful experience versus a "one-size-fits-all"(OB6). Findings are presented in detail in Chapter 7.

9.2.7 How is the applicability of the gamification design framework in an industry case?

Thereby, a big step towards the knowledge transfer to industry, beyond the scope of the learning environments, has been achieved through the design and development of a gamified cognitive tool for the prevention of dementia, called Preventive Neuro Health [120]. It has consisted of a broad set of tasks from therapeutic nature, which aim to minimize the impact of cognitive impairment in daily activities. It has been developed by means of the proposed framework with the purpose to improve the adherence and engagement of older adults. Initially, an analysis and benchmarking of the available commercial solutions has also been conducted, showing the weaknesses of these tools for user engagement. Consequently, a collaborative-based environment has been proposed through a crowdsourcing approach due of the large suitability for the target: older adults. A long-term A/B test is planned to be carried during 2018 year jointly with a sanitary entity, one of them would interact with the "gamified" version of the tool, and the other one, in a "non-gamified" version of it. Therefore, the objective of integrating gamification to a online health service and analyzing the impact

has been partially covered, since the run of a pilot test is in progress at the end of this thesis. This approach has been examined in Chapter 8.

9.3 Impact

Some dissemination actions have been also carried out. It is worth noting the organization of the Barcelona Gamification Meetup in a non-academic format with gamification practitioners. Addittionally, to join academia and business, the 1st International Workshop on Gamification and Games for Learning in Tenerife by the Open University of Catalunya and the University of La Laguna (see Appendix H) in conjunction to CIVE'17, have been organized. The main goal of this event was to bring together stakeholders with the purpose of exchanging ideas and experiences and encouraging networking between academia and industry in the field of. This event is going to be continued in a second edition of the workshop as a Special Session within the EDUCON2018 – IEEE Global Engineering Education Conference.

Finally, it should be highlighted that the accomplishment of this thesis has been developed within the Industrial Doctorate Program whose objective is to contribute to the competitiveness and internationalization of the Catalan industry. The business objective has been the creation of a personalized design framework that allows a technological company the development of gamified solutions based on services for being adaptable to different environments (special attention to the health and wellness scopes) by means of a clear and affordable methodology. Research outcomes from this thesis have had an impact in software-based projects deployed such as Preventive Neuro Health as well as current projects under the paradigm of open innovation.

9.4 Future work

The research niche where this thesis is located presents several paths to continue a progression in this scope. Therefore, the following recommendations for future research are proposed. From the foundations, first, the study of the impact of the elements that are referenced to a lesser extent in the reviewed frameworks (ethics, endgame conditions, player taxonomies for penalization, and the resources for deploying a gamified experience) can be enhanced to know if are relevant to gamification design. Second, the study of the development of the design toolbox can be expanded through a more thoroughly research to know how the different non-game environments affect to the preferences of user types (education, health, human resources, etc.). Thirdly, from the personalization viewpoint, new case studies could be conducted to check the impact of additional mechanisms of personalization. This way, it

would be considered the study of the ratio of design-effort and impact of personalization on the students' experiences. Fourthly and finally, the evaluation of the impact of gamification on older adults' adherence in a long-term through the Preventive Neuro Health tool, can be explored.

Appendix A

Gamification design frameworks: items' comparison

A.1 Overview

As follows, a table A.1 with the whole list of compared frameworks in the study (rows) compared to the 21 most relevant design items (columns) is presented. The possible values of each table's cell are:

- **Explicit**: the item is present in the proposal.
- **Implicit**: the item is not explicitly present in the proposal. It has been inferred by the authors, referring to other sources or clarified by means of directly contacting the authors.
- **Not referred**: the item is not present in the proposal.

Table A.1 Review summary by item

Ref.	OB	FE	RI	IN	ST	EN	EG	ON	RU	AN	ME	ET	FU	MO	SO	BE	PR	TA	NA	EX	TE
[191]	E	I	I	I	I	E	E	E	E	E	E	I	E	E	E	E	E	E	I	E	E
[95]	E	U	U	U	U	E	U	E	E	E	E	E	E	E	E	E	E	U	E	I	E
[49]	E	E	E	E	E	U	U	U	E	U	U	U	I	E	E	E	U	U	U	U	U
[79]	E	I	I	I	I	E	E	E	E	E	E	I	E	E	E	E	E	E	I	E	E
[67]	E	U	I	U	E	I	I	U	E	E	E	I	I	E	I	I	U	U	I	E	E
[153]	E	E	E	U	E	U	U	U	U	E	U	E	I	E	I	E	U	U	E	U	E
[16]	E	E	E	I	I	E	E	E	U	E	E	U	E	E	E	E	E	U	E	E	I
[63]	E	E	U	U	E	U	U	U	E	E	U	U	E	E	U	E	E	U	U	E	E
[135]	E	U	U	U	E	U	U	U	E	E	E	U	E	E	E	E	E	E	E	E	U
[13]	E	U	U	U	E	E	U	I	E	E	U	U	I	E	E	E	E	U	E	E	E
[161]	E	I	E	I	E	U	U	E	E	E	E	U	E	E	E	E	E	U	E	E	E
[156]	E	U	U	U	E	I	E	U	E	E	U	U	E	E	E	E	U	U	I	E	I
[65]	E	E	E	E	U	E	U	I	U	E	E	U	U	E	I	E	E	E	U	U	E
[193]	E	U	U	U	U	E	U	U	U	E	U	I	E	E	E	E	E	E	E	U	U	E
[159]	E	U	U	U	U	E	U	U	U	E	E	U	E	E	E	E	E	E	U	U	E	E
[83]	E	E	U	U	U	U	U	U	E	E	U	U	E	E	E	E	E	E	U	U	E	U
[110]	E	U	U	U	U	E	U	U	E	E	U	E	I	E	E	E	E	U	E	E	U
[43]	E	U	U	U	U	U	U	U	E	E	E	U	E	E	E	E	E	E	U	E	E	E
[112]	E	E	U	U	E	E	U	E	U	E	E	U	E	E	E	E	E	E	E	U	U	E
[119]	E	U	I	U	E	E	U	E	E	E	E	U	E	E	E	E	E	E	E	E	I	E
[25]	E	I	I	I	U	E	E	E	E	E	E	I	E	E	E	E	E	E	E	E	I	I

Continued on next page

Table A.1 – *Continued from previous page*

Ref.	OB	FE	RI	IN	ST	EN	EG	ON	RU	AN	ME	ET	FU	MO	SO	BE	PR	TA	NA	EX	TE
[41]	E	E	E	U	U	I	U	U	E	E	E	E	E	E	E	E	E	U	E	E	E
[87]	E	U	U	U	U	E	U	U	E	E	U	U	U	E	E	E	U	U	U	E	E
[129]	E	E	E	I	E	E	U	U	I	E	E	E	I	E	U	E	E	E	E	E	E
[115]	E	E	U	U	E	E	U	E	U	E	I	U	E	E	E	E	E	E	E	E	U
[175]	E	U	E	U	U	I	U	U	E	E	U	U	E	E	E	E	E	U	U	E	E
[134]	E	U	U	U	U	E	U	E	E	E	E	U	E	E	E	E	U	U	E	E	I
[69]	E	E	E	U	U	U	U	E	E	E	E	U	E	E	E	E	E	U	E	E	U
[194]	E	E	U	U	U	E	U	U	U	E	U	U	U	E	E	I	U	U	U	E	E
[123]	E	E	E	U	U	E	E	E	E	E	E	E	E	E	E	E	E	U	E	E	E
[92]	E	U	U	U	U	U	U	U	E	U	U	U	E	E	E	E	E	U	E	E	I
[88]	I	U	U	U	U	E	U	E	E	E	E	U	E	E	E	E	E	E	E	E	E
[4]	E	U	U	U	I	E	U	E	U	E	E	U	E	E	E	E	E	E	E	U	E
[157]	E	E	E	E	E	I	U	U	U	E	U	U	E	E	U	E	E	U	U	U	E
[22]	E	U	U	U	E	U	U	U	U	E	U	U	E	E	E	E	E	E	E	E	E

Appendix B

Gamification design toolbox: ethics clearance

UOC
Universitat Oberta de Catalunya

Evaluation of the "Personalization of Gamification" exploratory study by the Ethics Committee of the UOC

Dr. Marta Aymerich Martínez, president of the Ethics Committee of the Universitat Oberta de Catalunya

CERTIFIES

That the Committee has evaluated the proposal submitted by UOC Ph.D student NIT Programm Alberto Mora Carreño regarding the **"Personalization of Gamification"** exploratory study, led by HCI GAMES Group at the University of Waterloo Canada, and in which, he will participate by collecting and having access to research data.

AND

that regarding the "**Personalization of Gamification**" study

- The ability of the researchers and their collaborators, and the facilities and resources available are adequate to carry out the study.
- The established experimental protocol ensures the integrity and dignity of the participants.
- The protocol is adequate to the objectives of the study and the possible risks and discomfort for participants are adequate given the expected benefits.
- The procedure for obtaining informed consent of participants, including the information sheet, and the procedure for the recruitment of subjects are adequate.

Having met on 20th July 2016, and having considered the ethical implications concerning human experimentation and the processing of personal data, this committee APPROVES the "Personalization of Gamification" exploratory study.

For the record, I sign this document in Barcelona, date of decision 20th July 2016.

Signed:

Dr. Marta Aymerich Martínez

Av. Tibidabo, 39-43
08035 Barcelona – Spain
Tel. +34 93 253 23 00
Fax +34 93 417 64 95

Figure B.1 UOC's ethics clearance notification

UNIVERSITY OF WATERLOO

OFFICE OF RESEARCH ETHICS

Notification of Ethics Clearance of Application to Conduct Research with Human Participants

Faculty Supervisor: Lennart Nacke	**Department:** Drama & Speech Communication
Student Investigator: Alberto Mora Carreño	**Department:** Drama & Speech Communication
Student Investigator: Gustavo Tondello	**Department:** Computer Science, School of
Collaborator: Carina González	**Department:** University of La Laguna
Collaborator: Joan Arnedo-Moreno	**Department:** Open University of Catalonia

ORE File #: 21645

Project Title: Personalization of Gamification

☑ *Human Research Ethics Committee (HREC)* ☐ *Clinical Research Ethics Committee (CREC) is pleased to inform you the above named study has been reviewed and given ethics clearance.*

Approval to start this research is effective on the ethics clearance date which is: 8/11/2016 *(m/d/y)*

University of Waterloo Research Ethics Committees are composed in accordance with, and carry out their functions and operate in a manner consistent with, the institution's guidelines for research with human participants, the Tri-Council Policy Statement for the Ethical Conduct for Research Involving Humans (TCPS, 2nd edition), International Conference on Harmonization: Good Clinical Practice (ICH-GCP), the Ontario Personal Health Information Protection Act (PHIPA), the applicable laws and regulations of the province of Ontario. Both Committees are registered with the U.S. Department of Health and Human Services under the Federal Wide Assurance, FWA00021410, and IRB registration number IRB00002419 (HREC) and IRB00007409 (CREC).

The above named study is to be conducted in accordance with the submitted application (Form 101/101A) and the most recent approved versions of all supporting materials.

Ethics clearance for this study is valid until: 8/11/2017 *(m/d/y). Multi-year research must be renewed at least once every 12 months unless a more frequent review has otherwise been specified by the Research Ethics Committee (Form 105). Studies will only be renewed if the renewal report is received and approved before the expiry date. Failure to submit renewal reports by the expiry date will result in the investigators being notified ethics clearance has been suspended and Research Finance being notified the ethics clearance is no longer valid.*

Level of review:

☑ *Delegated review*

☐ *Full committee review meeting date:* _____ *(m/d/y)*

Signed on behalf of: ☑ *HREC Chair* ☐ *CREC Chair*

☐ *Jannet Ann Leggett, JD, Chief Ethics Officer, jannet.a.leggett@uwaterloo.ca, ext. 36005*

☑ *Julie Joza, MPH, Senior Manager, jajoza@uwaterloo.ca, ext. 38535*

☐ *Sacha Geer, PhD, Manager, sgeer@uwaterloo.ca, ext. 37163*

Figure B.2 UW's ethics clearance notification

Universidad de La Laguna

Comité de Ética de la Investigación y Bienestar Animal

CEIBA

Comité de Ética de la Investigación y Bienestar Animal

Vicerrectorado de Investigación y Transferencia de Conocimiento

Universidad de La Laguna. 38071, La Laguna

ceiba@ull.es

Proyecto de Investigación: Personalización de la gamificación: estudio exploratorio

Investigador Principal: CARINA SOLEDAD GONZALEZ GONZALEZ

Organismo: -- Otro (inidicar en observaciones) --

Número de Registro: CEIBA2016-0208

En su reunión del 29 de julio de 2016, el Comité de Ética de la Investigación y Bienestar Animal de la Universidad de La Laguna ha revisado el proyecto de investigación arriba mencionado. Tras adecuada deliberación emite el siguiente informe:

Se trata de un estudio basado en un cuestionario anónimo, en el que los participantes pueden indicar voluntariamente su identificación si lo desean para ponerse en contacto con el equipo investigador. El protocolo del estudio analiza pormenorizadamente los beneficios (y posibles riesgos) de responder al cuestionario. El proyecto está bien diseñado y respeta los criterios de la ética de la investigación.

Por tanto el proyecto presentado satisface los requerimientos de la ética de la investigación y el Comité emite un informe **positivo** y da la autorización solicitada para la realización del estudio en los términos propuestos.

La Secretaria del CEIBA

Figure B.3 ULL's ethics clearance notification

Appendix C

Gamification design toolbox: a survey

C.1 Overview

Gamification is commonly known as the application of game design elements and game principles in non-game contexts with motivational purposes. You are invited to participate in a research study conducted by the investigators listed above. This research intends to explore user's main type of interaction with gameful digital applications (based on the HEXAD User Types framework) and user's preferences for gameful design elements. If you decide to volunteer, you will be asked to complete a 10-15minute online survey. Survey questions focus on your preferences while using digital applications and games. It consist of a total of 66 questions:

- 4 questions about demographic.
- 2 questions about habits.
- 24 questions (Likert scale of 7 levels) about interaction.
- 30 questions (Likert scale of 7 levels) about preferences.
- 4 questions about contact.

Participation in this study is voluntary. You can withdraw your participation at any time by not submitting your responses. In case you feel uncomfortable reflecting on any question, you may withdraw your participation at any time by closing your browser window without saving your answers. It is important for you to know that any information that you provide will be confidential. All of the data will be summarized for publication and no individual could be identified from these summarized results. Furthermore, the web site is programmed

to collect responses alone and will not collect any information that could potentially identify you (such as machine identifiers).

If you decide to enter your email address for participation on the gift cards draw or followup interview, we will protect your confidentiality by storing the information in a password protected computer and deleting your email address as soon as it has been used for the intended purpose. Because this is an anonymous survey, the researchers have no way of identifying you or getting in touch with you should you choose to tell us something about yourself or your life experiences.

When information is transmitted over the Internet confidentiality cannot be guaranteed. University of Waterloo practices are to turn off functions that collect machine identifiers such as IP addresses. The host of the system collecting the data such as LimeSurvey™ may collect this information without our knowledge and make this accessible to us. We will not use or save this information without your consent. If you prefer not to submit your survey responses through this host, please contact one of the researchers so you can participate using an alternative method such as through email or paper-based questionnaire. The alternate method may decrease anonymity but confidentiality will be maintained. The data, with no personal identifiers, collected from this study will be maintained on a password protected computer database in a restricted access area of the university. As well, the data will be electronically archived after completion of the study and maintained for seven years and then erased.

As part of the survey we will ask if you would be willing to participate in a follow up interview. If you decide to give your contact information for this the follow up interview, you might receive just one message from us in a few months with an invitation for an online interview. We will then use your email address to link your two responses together and will delete your address afterwards. We will not use your email for any other purpose. Participation in this follow up interview is optional. Your agreement for subsequent contact does not oblige you to participate in future studies. You can decide this at the time of contact.

In appreciation of the time you have given to this study, you can enter your email into a draw for two 50 € Visa virtual gift cards (or equivalent in another currency). You will have one ticket into the draw for completing the survey and an additional ticket for the availability for a possible follow up interview. Your odds of winning the prize are based on the number of individuals who participate in the study. We expect that approximately 1000 individuals will take part in the study. Information collected to draw for the prize will not be linked to the study data in any way, and this identifying information will be stored separately, and then destroyed after the prize has been provided. The draw will occur after responses to the

survey are collected. The amount received is taxable. It is your responsibility to report this amount for income tax purposes.

Should you have any questions about the study, please contact either investigators listed above. This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee and Ethics Committee of Open University of Catalonia. However, the final decision about participation is yours. By signing this consent form (by clicking "Next" button), you are not waiving your legal rights or releasing the investigators or involved institution from their legal and professional responsibilities. With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

C.2 Demographic

- Age.
- Gender (male, female, other).
- Country.
- Native language.

C.3 Game habits

How many days in a typical week do you usually play games or videogames at least 10 minutes?

Which of these platforms do you usually play?

- Boardgames / Cardgames.
- PC/Mac.
- Tablet.
- Smartphone.
- Hand console.
- Console.
- Other.

C.4 Preferences

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree). It was taken from the Hexad User Types scale [184].

- It makes me happy if I am able to help others.
- I like helping others to orient themselves in new situations.
- I like sharing my knowledge with others.
- The wellbeing of others is important to me.
- Interacting with others is important to me.
- I like being part of a team.
- It is important to me to feel like I am part of a community.
- I enjoy group activities.
- It is important to me to follow my own path.
- I often let my curiosity guide me.
- I like to try new things.
- Being independent is important to me.
- I like defeating obstacles.
- It is important to me to always carry out my tasks completely.
- It is difficult for me to let go of a problem before I have found a solution.
- I like mastering difficult tasks.
- I like to provoke.
- I like to question the status quo.
- I see myself as a rebel.
- I dislike following rules.

- I like competitions where a prize can be won.
- Rewards are a great way to motivate me.
- Return of investment is important to me.
- If the reward is sufficient I will put in the effort.

C.4.1 Personalization (leaderboards)

Have you ever played a game or videogame that uses leaderboards? (it is a scoreboard, on which the names, etc., of the leading competitors are displayed)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like leaderboards which are regularly reset so that newcomers are not at a disadvantage.
- I like leaderboards which display how far away (positions) I am from the next status.
- I like leaderboards that only display users from my peer group and friends.
- I like manipulating leaderboards to generate an additional random component.
- I like leaderboards in which I can transfer points to others to help them. climb up

C.4.2 Personalization (teams)

Have you ever played a game or videogame that uses teams? (it is a number of persons associated in some joint action)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like the freedom to join and leave a team whenever I wish.
- I like teams that have minimum requirements to join them.
- I like teams in which members depend on one another (one for all, all for one).
- I like comparisons between different teams.
- I like teams without pre-established rules.

C.4.3 Personalization (challenges)

Have you ever played a game or videogame that uses challenges? (it is a difficult or demanding task, esp. one seen as a test of one's abilities or character)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like challenges with multiple paths for success.
- I like challenges where I know I will be rewarded for overcoming them.
- I like to create challenges for other people.
- I like challenges that must be completed in teams.
- I like helping others to overcome their challenges.

C.4.4 Personalization (voting mechanism)

Have you ever played a game or videogame that uses a voting mechanism? (it is the action of giving a vote: to exercise the right of suffrage to express a choice or preference by ballot or other approved means)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like always voting for positive consequences.
- I like it when my voting effort is rewarded.
- I like it when voting is not open because a status is required.
- I like to know how other people voted before I vote.
- I like to have the freedom to choose a positive, blank, or negative vote.

C.4.5 Personalization (gifting)

Have you ever played a game or videogame that uses gifting? (to endow or furnish with gifts)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like anonymous gifting.
- I like to customize my gifts.
- I like to know how much others value my gifts.
- I like it when gifting is not restricted to objects (e.g.,invitations, access).
- I like it when gifting is considered valuable.

C.4.6 Personalization (exploratory tasks)

Have you ever played a game or videogame that uses exploratory tasks? (tasks built for the purpose of exploration, esp. constructed or selected for exploration or observation of the surrounding area)

- Yes.
- No.

Please rate how well the following statements describe you from 1 (Strongly disagree) to 7 (Strongly agree).

- I like it when exploratory tasks provide additional advantages for me.
- I like it when exploratory tasks are required for my progress.
- I like to be able to influence the exploratory tasks of others.
- I like exploratory tasks that facilitate social connections.
- I like it when my feedback can help other users in their exploratory tasks.

C.5 Participants

Table C.1 Participants' parent countries (alphabetically ordered)

Country	**Frequency**	**Country (cont.)**	**Frequency (cont.)**
Andorra	1	Mexico	29
Argentina	18	Netherlands	5
Australia	3	Nigeria	1
Bolivia	1	Norway	1
Brazil	28	Pakistan	1
Canada	74	Panama	4
Chile	1	Peru	1
China	6	Poland	3
Colombia	13	Portugal	6
Cuba	1	Republic of South Korea	1
Denmark	1	Republic of Moldova	1
Ecuador	2	Romania	2
Finland	1	Russian Federation	1
France	3	Singapore	1
Germany	10	Slovakia	1
Greece	4	Slovenia	1
Guinea	1	Spain	316
India	3	Switzerland	1
Indonesia	1	Trinidad and Tobago	1
Iran	2	United Kingdom	6
Ireland	1	United States of America	19
Italy	3	Venezuela	8
Jamaica	1	Vietnam	1
Luxembourg	1		

Appendix D

“One-size-fits-all” gamification design: a case of study in Requirements Engineering

D.1 Post-questionnaire

Have you participated in the gameful experience?

- Yes.
- No.

D.1.1 Case “Yes”

Did you know the Trello tool before taking this course?

- Yes.
- No.

Do you think that the tasks proposed have made sense in the context of this subject?

- Yes.
- No.

Approximately, how many tasks have you developed throughout the semester?

- Less than 5.

- Between 5 to 10.
- More than 10.

Have you freely chosen the tasks you wanted to develop?

- Yes.
- No.

Do you think that you had the necessary skills to solve the tasks that have been proposed?

- Yes.
- No.

Do you think that this activity has allowed you to create a companion bond with the other students that have participated?

- Yes.
- No.

Do you think the initial goals of Backlog have been achieved? Answer Yes/No/DK-NA

- Objective 1: Motivate the learning process of students.
- Objective 2: Motivate the participation of students in the formative activities (those that are not evaluated).
- Objective 3: Encourage teamwork.
- Objective 4: Learn to use project management tools that are used in a real professional environment (in this case, the Trello tool).

Do you think it is positive that all classroom students benefit from the special conditions achieved through the Backlog to the same extent even if they have not participated?

- Yes.
- No.

To what extent have you participated motivated exclusively by the rewards? (four-level Likert scale)
Do you think the Trello tool is suitable for managing a Backlog like that of the subject?

- Yes.
- No.

Would you like to find this initiative in other subjects of the studies you are studying?

- Yes.
- No.

Do you want to say something more about this experience?

- Yes.
- No.

D.1.2 Case"No"

Why did not you participate in the gameful experience? (Select all that apply)

- I had not enough time.
- I did not find any sense.
- It was too complex.
- I did not agree that all the team members benefit.

If you were back to having the opportunity to participate in the Backlog, would you do it?

- Yes.
- No.
- Not sure.

Do you want to say something more about this experience? (Open-ended question)

Appendix E

Personalized gamification design: a case-control study in Computer Network Design

E.1 Assignation test

This test was adapted from Hexad User types test [184] in the context of an online learning environment. Students were allowed to answer in a Five-level Likert scale from “Strongly disagree” to “Strongly agree”.

E.1.1 Philanthropist

- It makes me happy if I am able to help others students.
- I like helping others students to orient themselves in new situations.
- I like sharing my knowledge to other students.
- The well being of my classmates is important to me.

E.1.2 Socializer

- Interacting with others students is important to me.
- I like being part of a student’s group.
- It is important to me to feel like I am part of a the virtual classroom.

- I enjoy group-based learning activities.

E.1.3 Free Spirit

- It is important to me to follow my own learning path.
- I often let my curiosity guide when I'm learning.
- I like to study new contents.
- Being independent in my learning process is important to me.

E.1.4 Achiever

- I like defeating learning obstacles.
- It is important to me to always carry out my tasks completely.
- It is difficult for me to let go of a task before I have found a solution.
- I like mastering difficult tasks.

E.1.5 Disruptor

- I like to provoke in class.
- I like to question the status quo of class.
- I see myself as a rebel in learning.
- I dislike following rules in class.

E.1.6 Player

- I like learning competitions where a prize can be won.
- Rewards are a great way to motivate me in learning.
- Return of investment is important to me in learning.
- If the reward is sufficient I will put in the effort in the learning process.

Appendix F

Personalized gamification design: a case-control study in Computer Network Design

F.1 Post-questionnaire

F.1.1 Demographic

- Year of birth.
- Genre (male, female, other).

Which of these situations apply to your case?

- I already have a university degree.
- Full-time work.
- I am economically independent.
- I have a son / sons.

F.1.2 Participation

Have you participated in the experience (in at least one activity)?

- Yes.
- No.

If so, between the two types of activity, which one do you prefer?

- Self-assessment test.
- Packet Tracer.
- Both.

F.1.3 Evaluation of the experience

Rate the following statements on a scale of: "Very Disagree (1)" to"Very Agree (5)"

- I consider that the experience has not been superfluous and has made sense in the context of the subject.
- I consider that the experience was adapted to a learning purpose and was consistent with the teaching plan of the subject.
- I consider that experience gave me a degree of autonomy when choosing my actions.
- I consider that experience has given me the possibility to interact more closely with my classmates.
- I consider that in the experience activities have been proposed adjusted to the competences of the subject.

F.1.4 Evaluation of the metaphor

Rate the following statements on a scale of: "Very Disagree (1)" to "Very Agree (5)"

- I believe that the metaphor employed (Lost, underwater base) was attractive.
- I consider that the rules used (markers) have been adequate.
- I think that the rules used (markers) were easy to understand.
- I consider that the tool (Trello) was adequate to manage the proposed activities.

F.1.5 Evaluation of the "crisis"

Rate the following statements on a scale of: “Very Disagree (1)” to “Very Agree (5)”

- “Insert the code”.
- “Secret letter from Prof. Chang”.
- “The different alerts (fog, bear, opportunity, etc.)”.

F.1.6 Conclusions

Rate the following statements on a scale of:“Very Disagree (1)” to “Very Agree (5)”

- How would you rate your own participation?
- How would you rate the participation of your teammates in the station?
- What is your overall assessment of the proposed experience?

Do you think that your performance in the different activities would have been the same in a traditional UOC course format?

- Higher.
- Lower.
- No effect.

Have you previously participated in a similar experience in a learning environment?

- Yes.
- No.

If you were to have the opportunity to participate in a similar experience in another UOC subject, would you do it?

- Yes.
- No.

Appendix G

Preventive Neuro Health: Exercises and Parameters

G.1 Overview

As follows, table G.1 presents the task list of Preventive Neuro Health tool (rows) being described regarding the estimated time (seconds), level parameter and the different values that determine the difficulty (columns):

Table G.1 Exercise's settings

Exercise	Time	Parameter	Level 1	Level 2	Level 3	Level 4	Level 5
bossamonedes	240	duration	1	1.5	2	2.5	3
bingo	180	presentation	4	3.5	3	2.5	2
puzzle	90	columns	3	4	5	6	7
aparellament	120	stimulus	80	108	108 (abs)	120	120 (abs)
submari	180	duration	1	1.5	2	2.5	3
operconc	180	stimulus	4 (slow)	6 (slow)	6 (fast)	8 (slow)	8 (fast)
simulatani	240	pictures	4	5	6	7	8
ordretemporal	240	pictures	4	5	6	7	8
recordvf	120	lines	6	7	8	9	10
posicio	240	picture	4	5	6	7	8
verbrelaciona	240	stimulus	3	4	5	6	7
memory	300	level	4 (slow)	6 (slow)	6 (fast)	8 (slow)	8 (fast)
visrelaciona	240	stimulus	3	4	5	6	7
quatreratlla	360	difficulty	1 (games 3)	2 (games 3)	2 (games 5)	3 (games 3)	3 (games 5)
gonogojoc	120	presentation	2000	1500	1500	1000	1000
zigurat	360	difficulty	0 (games 1)	1 (games 1)	1 (games 3)	2 (games 5)	2 (games 5)
construiroracio	360	level	5	6	7	8	9
fragments	360	fragments	4	6	8	10	10
categoritzacio2	120	categories	3	2	2	1	1
categoritzacio3	360	level	0	1	1	2	2
calculomental	120	mode	1 (time 1)	2 (time 2)	2 (time 3)	3 (time 2)	3 (time 3)

Continued on next page

Table G.1 – *Continued from previous page*

Exercise	**Time**	**Parameter**	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
sudoku	300	level	0	1	1	2	2
euros	120	stimulus	3	4	5	6	7
analogico	60	level	low	medium	medium	high	high
escenas	60	mode	2 (answ. 3)	3 (answ. 3)	4 (answ. 3)	5 (answ. 5)	6 (answ. 5)
sequencial	240	pictures	4	5	6	7	8
reconpregunta	120	lines	6	7	8	9	10
reconordena	120	lines	6	7	8	9	10
decideix	240	stimulus	3	4	5	6	7
mateixordre	240	stimulus	3	4	5	6	7
presordrealeat	240	stimulus	3	4	5	6	7
selecciona	240	stimulus	3	4	5	6	7
decideix	240	stimulus	3	4	5	6	7
mateixordre	240	stimulus	3	4	5	6	7
simordrealeat	240	stimulus	3	4	5	6	7
gonogoest	180	presentation	1200	1000	800	700	600
digital	60	level	low	medium	medium	high	high

Appendix H

Dissemination: 1st International Workshop on Gamification and Games for Learning

H.1 Overview

Raph Koster once famously said in his book "A theory of fun for game design" [91] that "fun is just another word for learning. Games teach you how aspects of reality work, how to understand yourself, how to understand the actions of others, and how to imagine". Games are indeed powerful motivators for learning and positive behaviour change. To celebrate games and their potential, the First International Workshop on Gamification and Games for Learning (GAMILEARN'17)[1] was held in June 5-6, 2017, Puerto de La Cruz, Tenerife, Spain in conjunction with the Fifth International Conference of Videogames and Education (CIVE'17)[2].

The workshop was organized by two Spanish institutions: Universitat Oberta de Catalunya and Universidad de La Laguna [3], and sponsored by the HCI Games Group [4] at the Games Institute of the University of Waterloo in Ontario, Canada, the Spanish chapter of the ACM SIGCHI (CHISPA) [5], and the IEEE Education Society [6]. Contributions from all researchers, practitioners, and industry on the application of gamification and games in learning environments were accepted into GAMILEARN workshop.

[1] http://gamilearn.webs.ull.es/
[2] http://eventos.ull.es/event$_{d}etail/7679/detail.html$
[3] https://www.ull.es/
[4] http://hcigames.com/
[5] http://chispain.org/
[6] http://www.ieec.uned.es/es/IEEE$_{E}duc_{s}oc.htm$

Thus, the inclusion of game experiences in the design of learning materials has been positively shown to motivate students. These experiences are introduced in courses either by considering game design principles in the course structure layout (gamification, gameful design) or directly using games as discrete learning resources (serious games). This topic has garnered great interest in both academia and industry, as reflected by the amount of academic publications in the recent years, especially those showing case studies, hands-on experiences, or business growth of the enterprises specialized in gamification or the development of games for learning.

This international workshop broadly covered all aspects of gamification and games for learning, including user studies, design frameworks, techniques and strategies, methodologies, tools and applications, ecosystems, analysis and assessment, personalization approaches, systems integrations, data management, architectures, innovations to market, as well as any works in progress. The main goal of hosting this event was to bring together stakeholders for the purpose of exchanging ideas and experiences and encouraging networking between academia and industry. Submissions from academia and industry were distinguished for the proceedings.

Therefore, a total of 27 manuscripts from seven different countries, such as Spain, Portugal, Italy, Germany, the United States, Canada, and Chile were submitted. The accepted manuscripts were presented in one of the following tracks: gamification platforms and design, gamification case studies, learning through games, impact of games, and games and industry.

Within the gamification design track, participants presented platforms for offering gamification elements as a service, as well as systems to engage employees in enterprise knowledge learning and social learning environments. The design scope was covered through learning design patterns that intend to systematize gamification-based solutions, and some analyses about how designers self-perceive their gameful learning activities. Moreover, one of the presentations described insights from gameful design and when it can lead to disengagement in an online course.

Diverse gamified design cases studies had a large presence in the workshop, a specific track was created for this purpose. To motivate students, results from the gamified learning experiences took a wide scope, such as engineering, education or humanities were presented. A special interest was noted on social relationships, student cooperation, integrated narratives, and continuous progression.

Furthermore, several studies on the social impact of games for learning were present in the workshop too. They revealed the high impact that games can achieve in the acquisition of professional skills, emotions.

The process of learning through games was discussed too, through a quiz-based serious game to teach University-level knowledge, an approach which combined game-based and competence-based learning. Different health-related topics were also discussed, from the promotion of nutrition and prevention of obesity in children through video games, to game resources to improve the knowledge and training of professionals in hospitals.

A special track was dedicated to industry contributions, with the presentation of a novel tool that allows creating team-based competitions, while incorporating lessons and concepts about the stock market and businesses. Another talk highlighted the relevance of localization in games or methods based on tutorials. Finally, an enterprise presented their experience in designing, creating, and deploying 3D immersive simulations and serious games using game-based learning technology for training.

Each author with an accepted manuscript had a total of 15 minutes for presenting the work at the conference, as well as 5-10 minutes for questions from attendees, while discussions were promoted by the session chairs. Presentations in the industry track employed 30 minutes. All of the submissions accepted from academia in the workshop were published in an open access-publication (a digital version with an ISBN). The best papers from academia received an award at the closing session and were invited to publish an extended version of their work in the Journal of Information Technology Research (JITR) and the International Journal of Interactive Multimedia and Artificial Intelligence (IJIMAI).

It should be highlighted the high quality of the submissions received. At least two members of the academic program committee, plus one member of the organizing committee reviewed all the papers. Thus, the relevant work of the academic committee that ensured the level of quality of all accepted papers, as well as providing comments to improve the final accepted papers.

Additionally, recognized keynote speakers in the area of Human-Computer Interaction (HCI) and games, such as Dr. Lennart E. Nacke, Director of the HCI Games Group and Associate Professor for HCI and Game Design at the University of Waterloo participated in this event. He introduced five gamification design languages for the first time with examples of how to apply them in a gamified learning context, so that designers can self-assess a gamification language and comprehend the language of other designers.

Moreover, Dr. Baltasar Fernández-Manjón, Full Professor in the Department of Software Engineering and Artificial Intelligence at the Complutense University of Madrid, an expert in the field of serious games, talked about gamification in medical training, from content and procedures to game-like applications. He presented his experience when creating different game-like applications for medical training in different domains and his cooperation in

projects with different medical institutions (e.g., Spanish National Transplant Organization, Complutense Medical School, and Harvard-MGH).

Finally, Isidro Quintana, CEO at Promineo Studios, talked about the possibilities of learning from entertainment, highlighting that the knowledge of players' needs is key and measuring their behaviour can help assess their needs. He showed how we can learn from our players to increase retention on casual games, and how we can make earnings grow with effective monetizing strategies.

In addition to keynotes, the organizing committee promoted and developed a panel discussion on opportunities, challenges, and critical issues on gamification of learning.

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