Dynamic Personalization of Gameful Interactive Systems

by

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Author’s Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

This thesis includes first-authored peer-reviewed material that has appeared in a journal article published by Elsevier, two conference proceedings published by the Association for Computing Machinery (ACM), and a conference proceeding published by Springer.

The materials from which I have adapted content are the following:

Chapter 3:

Gustavo F. Tondello, Rita Orji, and Lennart E. Nacke. 2017. Recommender Systems for Personalized Gamification. In *Adjunct Publication of the 25th Conference on User Modeling, Adaptation and Personalization - UMAP '17*, 425–430. ACM. https://doi.org/10.1145/3099023.3099114

Chapter 4:

Gustavo F. Tondello, Alberto Mora, Andrzej Marczewski, and Lennart E. Nacke. 2019. Empirical Validation of the Gamification User Types Hexad Scale in English and Spanish. *International Journal of Human-Computer Studies* 127, 95–111. Elsevier. https://doi.org/10.1016/j.ijhcs.2018.10.002

Chapter 5:

Gustavo F. Tondello, Alberto Mora, and Lennart E. Nacke. 2017. Elements of Gameful Design Emerging from User Preferences. In *Proceedings of the 2017 Annual Symposium on Computer-Human Interaction in Play - CHI PLAY '17*, 129–142. ACM. https://doi.org/10.1145/3116595.3116627

Chapter 6:

Gustavo F. Tondello, Dennis L. Kappen, Marim Ganaba, and Lennart E. Nacke. 2019. Gameful Design Heuristics: A Gamification Inspection Tool. In *Human-Computer Interaction. Perspectives on Design. Proceedings of HCI International 2019. LNCS 11566*. Springer. https://doi.org/10.1007/978-3-030-22646-6_16

Figure 6-1 (Summary of all the gameful design heuristics) was originally created by Dennis L. Kappen and Marim Ganaba for a poster presented at CHI PLAY '16 representing the following paper: Gustavo F. Tondello, Dennis L. Kappen, Elisa D. Mekler, Marim Ganaba, and Lennart E. Nacke. 2016. Heuristic Evaluation for Gameful Design. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Extended Abstracts - CHI PLAY EA '16*, 315–323. ACM. https://doi.org/10.1145/2968120.2987729. It was published online by the HCI Games Group in 2017 under a Creative Commons Attribution - Non-Commercial - No-Derivatives 4.0 license at http://gamefuldesign.hcigames.com/.

Some parts of the Related Work sections of the publications listed above also appear in Chapter 2.

Abstract

Gameful design, the process of creating a system with affordances for gameful experiences, can be used to increase user engagement and enjoyment of digital interactive systems. It can also be used to create applications for behaviour change in areas such as health, wellness, education, customer loyalty, and employee management. However, existing research suggests that the qualities of users, such as their personality traits, preferences, or identification with a task, can influence gamification outcomes.

It is important to understand how to personalize gameful systems, given how user qualities shape the gameful experience. Current evidence suggests that personalized gameful systems can lead to increased user engagement and be more effective in helping users achieve their goals than generic ones. However, to create these kinds of systems, designers need a specific method to guide them in personalizing the gameful experience to their target audience. To address this need, this thesis proposes a novel method for personalized gameful design divided into three steps: (1) classification of user preferences, (2) classification and selection of gameful design elements, and (3) heuristic evaluation of the design.

Regarding the classification of user preferences, this thesis evaluates and validates the Hexad Gamification User Types Scale, which scores a person in six user types: philanthropist, socialiser, free spirit, achiever, player, and disruptor. Results show that the scale's structural validity is acceptable for gamification studies through reliability analysis and factor analysis. For classification and selection of gameful design elements, this thesis presents a conceptual framework based on participants' self-reported preferences, which classifies elements in eight groups organized into three categories: individual motivations (immersion and progression), external motivations (risk/reward, customization, and incentives), and social motivations (socialization, altruism, and assistance). And to evaluate the design of gameful applications, this thesis introduces a set of 28 gameful design heuristics, which are based on motivational theories and gameful design methods and enable user experience professionals to conduct a heuristic evaluation of a gameful application.

Furthermore, this thesis describes the design, implementation, and pilot evaluation of a software platform for the study of personalized gameful design. It integrates nine gameful design elements built around a main instrumental task, enabling researchers to observe and study the gameful experience of participants. The platform is flexible so the instrumental task can be changed, game elements can be added or removed, and the level and type of personalization or customization can be controlled. This allows researchers to generate different experimental conditions to study a broad range of research questions.

Our personalized gameful design method provides practical tools and clear guidelines to help designers effectively build personalized gameful systems.

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During this research, I was also inspired by the publications and ideas of many of my peers from the gamification research community. All of them have my gratitude not only for the inspiration, but for strengthening the field of gamification in the world.

I also had many opportunities to interact with members of the gamification professional community in social media, online meetings, or conferences. This has helped me better understand the world of gamification. Ultimately, I hope that my work will be useful to help them improve their practice. A special thanks goes to Andrzej Marczewski. None of the work on Chapter 4 would have been possible without his collaboration, and he has always been available to discuss new ideas. I also thank Hardy Premsukh and all the people at FlourishiQ for a very interesting internship and the opportunity to apply gameful and user experience design to a promising application.

Finally, I am very grateful to my family for their support. This work would not have been possible without the collaboration of my beloved wife, Emeline, who joined me in the adventure of moving to another country to pursue these studies and understood and supported me throughout the long work hours. I also thank my parents, Cendar and Rosi, and my brothers, Alexandre and Guilherme, for the support and encouragement over the years.

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List of Abbreviations

ANN	Artificial Neural Network
ANOVA	Analysis of Variance
BFI	Big-Five Inventory
CARS	Context-Aware Recommender System
CBR	Case-Based Reasoning
CD	Compact Disk
CFA	Confirmatory Factor Analysis
DDA	Dynamic Difficulty Adaptation
DGD1	First Demographic Game Design model
DGD2	Second Demographic Game Design model
DRARS	Dynamic Risk-Aware Recommender System
EFA	Exploratory Factor Analysis
FFM	Five-Factor Model of personality
FRAGGLE	Framework for Agile Gamification of Learning Experiences
GAME	Gather, Act, Measure, Enrich
GEM	Game Elements and Mechanics
GFI	Goodness of Fit Index
GPS	Global Positioning System
GUR	Games User Research
HCI	Human-Computer Interaction
HIT	High Intelligence Task
IMI	Intrinsic Motivation Inventory
JP	Jonckheere-Terpstra test
KEG	Kaleidoscope of Effective Gamification
KMO	Kaiser-Meyer-Olkin test
KW	Independent-samples Kruskal-Wallis test
MBTI	Myers-Briggs Type Indicator
MDA	Mechanics-Dynamics-Aesthetics
MDL	Motivational Design Lenses

MMO	Massive Multiplayer Online (game)
MMORPG	Massive Multiplayer Online Role-Playing Game
MAP	Minimum Average Partial test
MUD	Multi-User Dungeon
NEO-FFI	NEO Five-Factor Inventory
NEO-PI	NEO Personality Inventory
PCA	Principal Component Analysis
PENS	Player Experience Need Satisfaction scale
PLEX	Playful Experience(s)
RAMP	Relatedness, Autonomy, Mastery, Purpose
RMSEA	Root Mean Square Error of Approximation
RMSR	Root Mean Square of Residuals
RS	Recommender System(s)
SDT	Self-Determination Theory
SPARC	Sense, Purpose, Autonomy, Relatedness, and Competence
SPSS	Statistical Package for the Social Sciences
TIPI	Ten-Item Personality Inventory
UI	User Interface(s)
UX	User Experience

"To make future generations happier than ours will be the greatest prize one can aspire to. There is no value comparable to the accomplishment of this great mission which consists in preparing, for the future of mankind, a better world."

González Pecotche [109:252]

Chapter 1 Introduction

Gamification is the use of game design elements in non-game contexts [77,78] or the enhancement of a service with affordances for gameful experiences to support users' overall value creation [132]. Gameful design is the process of creating systems using these elements, which then become gameful systems [179]. These game design elements are the building blocks that are characteristic to games, meaning that they are found in many (but not necessarily all) games, and play a significant role in the emerging player experience [77]. Similarly, we can refer to gameful design elements as those elements that are used as the building blocks to many (but not necessarily all) gameful systems. They are generally employed as motivational affordances, which are properties added to an object that allow its users to experience the satisfaction of their psychological needs [73,351], usually by facilitating intrinsic and extrinsic motivations [296,298].

Gameful design can be used as a method to increase user engagement, activity, and enjoyment of digital interactive systems. It can also be used to create applications aimed at promoting behaviour change in a broad range of domains, such as health, wellness, education, training, online communities, customer loyalty, marketing, and staff management [142,233,281,306]. Nevertheless, these psychological effects of gameful applications, systems, or services, such as behavioural changes or increased motivation and engagement, are still not fully understood. Empirical studies have sometimes reported only partially positive or even negative results [120,142,262,306], meaning that sometimes the user engagement levels or behaviour change that are sought with gamification are achieved, but other times they are not achieved or they are even undermined. For example, Hamari et al. [120] identified that the influence of context on the gamification, such as the application domain and the level of interaction with other users, as well as the qualities of the users, such as their personality traits, preferences, or identification with the task that is being gamified, can be confounding factors on the study of gamification.

Given how the qualities of a user shape the gameful experience, it is important to understand how to personalize gameful systems [36,45,208]. Personalized interactive systems (including gameful systems) can be more effective for fostering user engagement than generic systems [208,263]. This is because personalized systems let the user engage more often with the specific kind of experiences that they enjoy instead of generic experiences. Thus, more enjoyable personalized interactions can potentially lead to increased engagement. This increase in engagement also makes personalized gameful systems more effective than generic ones in helping users achieve their goals, which often involve educating them about certain topics, supporting them in attitude or behaviour change, or engaging them in specific topics [45]. Results have shown the higher value of using personalized approaches over generic ones in user interface (UI) design [11,249], persuasive technologies [152,154], and games [21,259,260,269]. However, the study of personalized gamification is still in its infancy, and past work has been mostly focusing on identifying different personality traits [87,140] or preferences for personalization [263,265], although methods for personalized design have also been proposed recently (e.g., [35,181]).

Research on gameplay motivations has shown that players have diverse personal preferences regarding how and what they play [121,274,347]. Researchers have developed player type models [24,121,234] or gamer motivation scales [345,347] to capture the diverse styles of play exhibited by different players. This information has been increasingly used in gamification to model user behaviour and design for more engaging gameful systems. Nevertheless, none of these models have studied elements used specifically in gameful design, except the Hexad gamification user types [198], which had been proposed but not systematically validated when I started this thesis. Most existing models were focused on games in general because the field of game research is older and more established than gamification research [175]. Thus, to select design elements that can appeal to different motivations, designers still relied on player typologies or classifications of game elements, such as Bartle's player types [24,25], the BrainHex player types [234], or the gamer motivation profile [345]. However, the applicability of these models to gamification is not supported by empirical evidence because all were developed by asking participants about their experiences when playing games.

In summary, the existing evidence suggests that personalized gameful systems can lead to increased user engagement and be more effective in helping users achieve their goals than generic ones. However, there were two open research problems when I started working on this thesis in 2015, which I address in my work:

- Lack of specific user preference models for gamification, so designers had to rely on models previously developed for games, even if there is no evidence that they also work for gamification;
- Lack of a specific method to guide designers in creating these types of systems.

Therefore, the gamification community will benefit from the validation of user preference models from games or the development of specific models to use with gameful design, as well as the development of a method for personalized gameful design. This thesis provides solutions for both needs.

1.1 Research Goals and Outcomes

In this thesis, I propose a method for personalized gameful design, which can help designers create systems that can be tailored to the preferences of each user. Based on the existing evidence, it can be expected that these personalized systems will be more engaging and provide a better user experience than generic systems. Therefore, such systems will be more likely than generic systems to help the user achieve the intended goals, such as learning new topics, achieving specific behavioural changes, complying with specific routines, or engaging with certain topics. In this thesis, I introduce a method with three steps for personalized design: (1) classification of user preferences, (2) classification and selection of gameful design elements, and (3) heuristic evaluation of the design.

In addition, there are yet many open topics for investigation regarding personalized gamification, which are often difficult to study because of the high requirements for setting up the experimental conditions. Examples of such topics are how the participants' behaviours are related to their demographic and psychographic characteristics, how their experience and performance may vary with different personalization or customization features, and how the context of gamification can influence participants' preferences for different gameful design elements. To address this issue, I designed and implemented a customizable gamification platform for conducting experimental studies. This platform is flexible enough to help researchers easily implement these different studies in shorter times and with lower costs.

1.1.1. Classification of User Preferences

To close the theoretical and practical information gap on player typologies for gamification, Marczewski [198] developed the Gamification User Types Hexad model. The first version was introduced in 2012 and the current one in 2015. It was based on research on human motivation, player types, and practical design experience. He also suggested different game design elements that may support different user types [199]. This suggestion was based on his empirical experience of applying the game design elements most commonly used by gamification practitioners. Thus, designers could now use these tools to select game design elements that he proposed to be more appealing to specific user types. However, there was still a lack of a standard assessment protocol for user's preferences based on the Hexad model. There was also no empirical validation that associated Hexad user types and game design elements, validating Marczewski's intuitive associations.

Therefore, I led an international research project with the University of Waterloo and the Austrian Institute of Technology, in which we validated the Hexad model and created a scale for scoring user's preferences towards different game design elements according to the model [329]. We also evaluated the potential of the Hexad model to personalize user experience (UX) in gameful systems. The initial results were promising as correlations were found between the Hexad user types and 32 design elements commonly employed in gameful design that had been tentatively associated with the user types by Marczewski. These results have already been made available to the gamification community in a 2016 publication [329], thus offering a initial solution to the first research problem identified in the previous section (lack of specific user preference models for gamification).

However, the initial evaluation of the Gamification User Types Hexad scale was conducted on a small sample ($N = 133$). Therefore, an empirical validation with a larger sample was still needed to ensure that the scale could be trusted and employed for personalized gameful design. Therefore, we executed a series of three studies to further validate the scale, which we published in 2018 as part of this Ph.D. work [323]. The first two studies collected enough evidence to support the validity of the scale's factor structure with large participant samples ($N = 556$ and $N = 1,328$) but suggested some minor improvements in the wording of a few items. The third study validated the final scale with the implemented improvements.

1.1.2. Classification and Selection of Gameful Design Elements

Current gameful design practice often involves selecting design elements from a list to try and recreate patterns found in games, with little guidance regarding how each design element affects the user experience [75,225,230,239]. Design elements are usually classified by their motivational significance or structural characteristics [75], but these classifications do not help designers choose the best pattern to solve specific user needs. As a result, designers often rely on some combination of a small subset of design elements, such as points, badges, and leaderboards, simply because these are the easiest elements to implement. Therefore, a better understanding of how users perceive different elements to be related in their preferences was needed, or in other words, which groups of elements users are likely to enjoy when they are applied together in designs. This knowledge would make it easier for designers to combine a wider variety of elements to solve specific needs while satisfying the user's preferences.

While the Hexad model offered some guidance regarding preferred gameful design elements per user type, it did not offer a comprehensive classification of gameful design elements. Thus, we propose a new conceptual framework for classifying gameful design elements based on participants' self-reported preferences, with the goal of understanding user behaviour in gamification, which we published in 2017 as part of this Ph.D. work [324].

Our work contributes with the fulfillment of the need for better design guidance because the classification of gameful design elements based on user preferences allows designers to better understand the potential effect of each element on user enjoyment. Thus, designers can make more informed design decisions. For example, a designer can begin by choosing one game element that they want to become the central part of the gameful experience, such as achievements, exploration, or competition. Next, our classification provides information about what related game elements users are more likely to enjoy together with the chosen central element, thus facilitating the task of selecting additional elements for the design.

1.1.3. Heuristic Evaluation

After designing a gameful application, it is also necessary to evaluate its effectiveness in keeping the user engaged and helping them achieve their goals. This is part of evaluating the user experience (UX), which refers to all aspects of the interaction of the user with the system [248]. Nevertheless, when I started my work, there were no standard evaluation methods or guidelines to evaluate a gameful implementation early in a project.

While it has become more common to conduct user tests with gameful applications (just as games user researchers have done in the video game industry), user tests are conducted after a prototype has already been implemented. On the other hand, heuristic evaluation or inspection methods [240,242] are commonly used in other established areas of UX (such as usability) as evaluation tools during the project design and early implementation phases. If similar tools were available for gamification, they would help the UX team in evaluating the potential of their gameful designs for fostering the intended engagement level. Being able to assess the design solution early and propose improvements is important to decrease the costs of the project and increase its potential to achieve the intended goals.

To address this need, we developed a new set of guidelines for heuristic evaluation of gameful design in interactive systems [321,322]. The proposed *Gameful Design Heuristics* are the first inspection tool focused specifically on evaluating gameful design through the lens of intrinsic and extrinsic motivational affordances [73,351]. Their aim is to enable any UX professional to conduct a heuristic evaluation of a gameful application more easily, even if they have no extensive background expertise in gameful design or motivational psychology. This is different from other heuristic evaluation methods, which usually require a certain level of background knowledge to conduct the evaluation. We designed our gameful design heuristics with this characteristic in mind so it could be used by any UX professional without requiring a long learning period on gameful design before conducting the evaluation. And they have already been successfully used in the field.

1.1.4. A Platform for the Study of Personalized Gameful Design

To tailor the experience for each individual user, the system must be able to offer the types of interactions that the user is most likely to enjoy among all the offered possibilities. Thus, a personalized gameful system should include different types of activities, game elements, and persuasive strategies that could be appealing to different types of users. Then, some mechanism must be implemented to allow the system to activate those features that would be appealing to each specific user, while deactivating other features. The selection can be automatic (the system's behaviour is modified without intervention from the user) or manual (the user can select the best elements for their experience).

For automatic personalization, one family of methods that could be used for the system to select the gameful design elements for each user is that of recommender systems [287]. Recommender systems can keep track and contrast the interactions of the current user with those of other users, so it can infer the preferences of the current user and suggest the gameful activities that the user is more likely to enjoy [325]. On the other hand, when the selection is manual, it is also commonly known as customization, meaning that the user is responsible for tailoring their own experience through customization options offered by the system.

In this thesis, we designed and implemented a platform that researchers can build upon to design specific experimental studies of personalized gamification. This platform allows the researcher to selectively enable or disable several gameful design elements (such as progress feedback, levels, challenges, badges, leaderboards, etc.) around a central instrumental task (e.g., an image classification task) to observe and study how the user experience and performance differs with different personalized systems. It is also possible to enable customization by allowing users to select the gameful design elements that they want to use. With the availability of this platform for gamification researchers, we expect to contribute with the execution of experimental studies of personalized gamification in the future with lower costs and development times than if each researcher had to build their own specific platform for their study.

1.2 Summary of Contributions

In summary, this thesis introduces a three-step gameful design method for personalized interactive systems and presents the following contributions to the field of Human-Computer Interaction (HCI) and Gamification research:

1. A large-scale empirical validation of the Gamification User Types Hexad model and scale;
2. A conceptual framework for classifying gameful design elements based on user preferences and user types;
3. A heuristic evaluation tool for gameful interactive systems;
4. The design and development of a flexible and customizable gamification platform that can be used for a variety of experimental studies of personalized gameful design.

1.3 Organization

The remainder of this document is organized as follows. Chapter 2 introduces the necessary background on UX, gamification, and personalization, as well as the related work on personalized gamification and persuasive technologies. Chapter 3 presents the method for personalized gameful design, details its three steps, and explains how they can be integrated into existing gameful design methods. Chapter 4 presents the validation of the Gamification User Types Hexad model and scale. Chapter 5 presents the classification of gameful design elements based on user preferences. Chapter 6 presents the Gameful Design Heuristics. Chapter 7 presents the design and development of the customizable gameful platform for the execution of experimental studies on personalized gamification. It also reports the results of a pilot study that gathered initial insights into the user experience and performance when interacting with a customizable gameful system. Finally, Chapter 8 concludes this thesis with a summary of contributions, limitations of this research, and suggestions for future work.

Chapter 2 Background

In the early days, HCI research focused almost exclusively on the achievement of behavioural goals in work settings [125]. Therefore, the user's *task* was the focal point, with research aiming at increasing the user's performance in reaching their instrumental goals. However, this narrow focus was repeatedly challenged, and many researchers argued for the importance of non-instrumental goals. This led to the increasing concern with hedonic aspects of HCI, such as stimulation, identification, evocation, and emotions, alongside the pragmatic aspects of interactive products [125]. Thus, HCI research began to also study the *user experience (UX)*, a phrase that was first used by Norman in the early 1990s, when he headed the "User Experience Architect's Office" at Apple [221,247]. Subsequently, the term was also popularized by Garret's book [100], and is nowadays commonly employed in both research and practice. According to Hassenzahl and Tractinsky [125], "UX is a consequence of a user's internal state (predispositions, expectations, needs, motivation, mood, etc.), the characteristics of the designed system (e.g. complexity, purpose, usability, functionality, etc.) and the context (or the environment) within which the interaction occurs (e.g. organisational/social setting, meaningfulness of the activity, voluntariness of use, etc.)." Thus, UX design encompasses the traditional HCI design and extends it by also addressing all aspects of a product of service as perceived by the user. Moreover, the process of UX design consists in first envisioning the desired user experience, to only afterwards designing the product that will afford such experience [124]. However, it is not possible to design an experience, we can only design *for* an experience, meaning that we can create affordances for the desired experience, but the experience ultimately emerges from the interaction between user and system [125].

The interest in UX research and design cleared the path for the appearance of gamification, which consists on improving the user experience by using elements and ideas from games.

2.1 Gamification

2.1.1. Origins and Definition

In the last 10–15 years, we have seen the rise of the idea of using game design elements in non-game contexts to motivate and increase user activity and retention [77,306]. This phenomenon has been named *gamification*. Gamification as a term originated in the digital media industry, with the first documented usage by Nick Pelling in 2002 [338], followed by a widespread adoption from 2010 onwards [77]. As a result, the term is used by practitioners with a great degree of variation, ranging from systems that merely include one design element inspired from games, to the adoption of fully-fledged games with the goal of achieving instrumental results. Many gamification practitioners have presented their own definition of *gamification*, most of them around the idea of using game elements or "game thinking" to address non-entertainment goals (e.g., [42,53,200,271,353]).

In the HCI literature, the usage of the term *gamification* appeared both as a need to study the phenomenon that was occurring in the industry and as a maturation of the idea of studying video games to enrich the user interface (UI) and experience (UX) design practices [77]. For example, since the 1980s, Malone [193] was already deriving heuristics for designing enjoyable UIs from videogames, and Carroll and Thomas [50] were suggesting redressing routine work activities in varying metaphoric cover stories to make them more interesting. In the following decades, more researchers began to study the properties of games that could be transferred to other applications, in a research field that was known as *funology*—the science of enjoyable technology [34]. Next, multiple researchers explored the concept of *playfulness* as a desirable type of user experience [170]. An exemplar result of this research field is the PLEX (Playful Experiences) framework [15,192], a categorization of 22 playful experiences, which can also be used as a design support tool. In the 2000s, HCI researchers also became interested in studying the design and experiences of videogames, developing methods to evaluate their experience (e.g., [29,71,235,317]) and design components of games (e.g., [96,131,302]), leading to the establishment of the field of *Games User Research* (GUR) [83].

The currently accepted definition in the HCI literature was proposed in 2011 by Deterding et al. [77,78] and states that gamification is "the use of game design elements in non-game contexts." This definition highlights that gamification refers to *games*, not to *play*. This distinction is tied back to Caillois's concept of *paidia* and *ludus* [46], where *paidia* (playing) refers to unstructured, free-form recombination of behaviours and meanings, while *ludus* (gaming) refers to playing by rules and competitive strife towards goals. Figure 2-1 illustrates gamification between these poles.

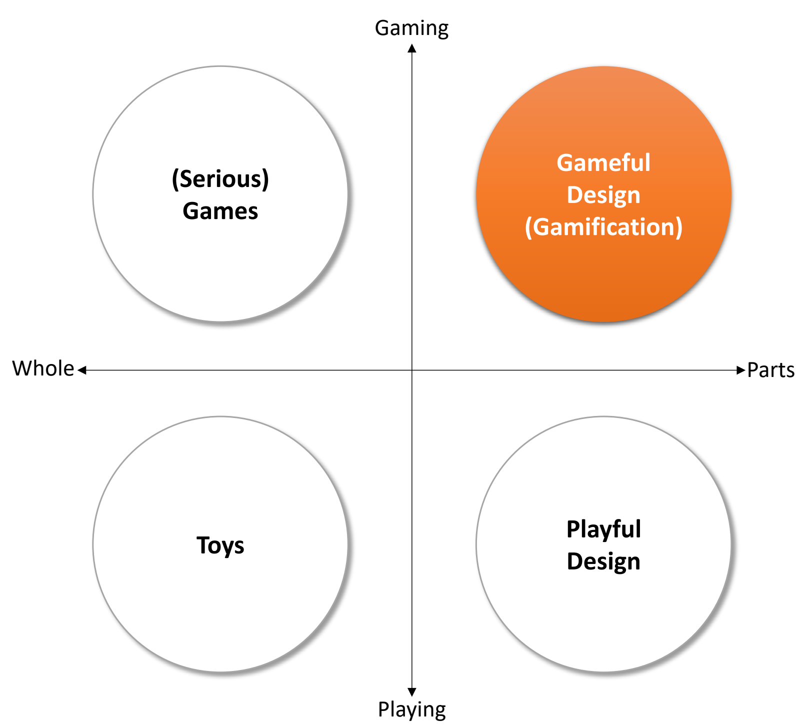


Figure 2-1. Gamification situated between game and play, whole and parts. Adapted from [77].

Additionally, gamification refers to the merely incorporation of elements of games into non-game applications. This differentiates gamification from related approaches, such as *serious games* or *games with a purpose* [62], in which a full-fledged game is employed to achieve instrumental goals. In this definition, elements of games are “elements that are found in most (but not necessarily all) games, readily associated with games, and found to play a significant role in gameplay.” [77] Furthermore, gamification refers to the use of design elements from games, rather than game-based technologies of other game-related practices. Finally, gamification refers to elements of games being used in non-gaming contexts, meaning that there is an instrumental goal to be achieved other than pure entertainment, and the gameful experience of the user is usually supporting the instrumental goals rather than being the focus.

Regarding the non-gaming contexts where gamification has been employed, leading examples include health and wellbeing [142], education [80,315], and organizational settings [281]. Other application areas also include online communities, crowdsourcing, sustainability, marketing, and computer-supported cooperative work [306], as well as social media, research, science, politics, citizenship, and urban planning [336].

Another widely accepted definition, originated from the service marketing literature, states that gamification “refers to a process of enhancing a service with affordances for gameful experiences in order to support users’ overall value creation” [132]. In contrast with Deterding et al.’s definition, which emphasizes the way that the system is constructed (by using game design elements), this distinct definition by Huotari and Hamari focuses on the overall goals of gamification: to enhance a core service and to afford a gameful experience. Additionally, Hamari proposes that gamification consists on three causally linked main parts: “1) system affordances that invoke (2) psychological mediators and/or outcomes, which ultimately invoke (3) behavioural outcomes” [116:43].

It is important to note that Huotari and Hamari’s definition is agnostic to the nature of the core system and does not restrict gamification to non-game contexts. Thus, a game itself can be the core system that is further gamified to generate some sort of meta-game. In addition, the distinction between a gamified service and a full-fledged game becomes blurrier under this perspective. According to Huotari and Hamari, one needs to consider what is the core service that is being provided to understand whether it has been gamified or not. If the core service being provided is already a game (and it does not have an added layer of a meta game), then gamification did not occur. However, if the core service offered by a system was not previously a game and the gameful experience was added to enhance it, then the service was gamified.

Central to both definitions of gamification is the concept of a ‘gameful experience’, which is the expected result of adding game elements to a system (according to Deterding et al.) or of enhancing a service with motivational affordances (according to Huotari and Hamari). Nonetheless, ‘gameful experience’ has been a loosely defined concept until 2018, when Landers et al. [179] proposed a formal definition.

2.1.2. Gameful Experience

The first mentions of the concept of 'gameful experience' in the literature were usually offered as an additional point in publications whose central topic was gamification or gameful design. It was often also addressed by the term 'gamefulness'. For example, McGonigal introduced the term 'gamefulness' broadly in 2011 [215], without explicitly defining it. She later defined gameful experiences and systems as those that "effectively integrate some of the key structural and aesthetic elements of games" [216]. In contrast, Deterding et al. [77] defined gamefulness as the "experiential and behavioral qualities" of gaming, whereas Huotari and Hamari [132] defined it as "an experiential condition unique to games." While researchers agreed that people experience something unique when they play games, there was no clarity about what psychologically occurs [179].

Building a theoretical foundation of what constitutes a 'gameful experience', Landers et al. [179] defined it as "a psychological state resulting from the interaction of three psychological characteristics: perceiving presented goals to be non-trivial and achievable, being motivated to pursue those goals under arbitrary externally-imposed constraints, and believing that one's actions within these constraints to be volitional."

This definition was reached after a thorough literature review and a synthesis of the main components of games or the experiences fostered by them. According to it, a person must have all these three characteristics over time to maintain a gameful experience throughout the interaction with a system. If any of these characteristics is totally absent, there is fundamentally no gameful experience.

Based on this concept, Landers et al. also further refined the definitions of gameful systems and gameful design from the extant literature. For them, a 'gameful system' is "any system that creates for its users a gameful experience" [179]. Accordingly, 'gameful design' is the process of designing a system with characteristics to afford these three elements of a gameful experience. Therefore, to create a gameful system through gamification (gameful design), it must be (re)designed "to provide non-trivial and achievable behavioral goals bound by rules limiting how those goals can be achieved while simultaneously affording the users with motivation to choose to pursue these goals" [179]. It is important to note that gameful systems only carry the *potential* to create a gameful experience. Whether this experience will emerge or not will depend on the user voluntarily engaging with the system and accepting its goals and rules.

We previously mentioned that Deterding and colleagues' definition of gamification excludes games themselves because a game cannot be considered a non-game context. On the other hand, Huotari and Hamari's definition of gamification states that games can also be gamified if the core service is further enhanced with affordances for gameful experiences. In contrast, Landers et al. [179] state that gameful systems exist on a continuum, which ranges from *not gameful at all* to *completely gameful*. Therefore, a game can be understood as a system that is completely (or at least highly) gameful. Nonetheless, they argue that it is important to further differentiate games and gameful systems to enable the study, understanding, and design of both types of systems. Hence, although games and less gameful systems are both intended to afford gameful experiences, the difference lies in their relationship with the instrumental (outside of the game/system) goals: games are self-contained, whereas gameful systems are not. This means that the outcome of a game does not determine the outcome of an external goal, if any. Even in persuasive and serious games, which have a clear external purpose, a player can win or lose a game, but this victory state is not necessarily related to the external outcome that is sought by the creators of the game. On the other hand, a gameful system is usually designed such that the users' actions have direct external persistent outcomes, while at the same time affording a gameful experience.

2.1.3. Gamification Science

According to Landers et al. [175], *gamification science* is situated as a subdiscipline of game science. In this context, *game science* refers to the study of games using various tools of natural science, social science, and engineering. In turn, *gamification science* is defined as "a social scientific, post-positivist subdiscipline of game science that explores the various design techniques, and related concerns, that can be used to add game elements to existing real-world processes" [175]. In addition, they note that gamification science is currently most strongly influenced by HCI, which is itself an interdisciplinary crossing of computer science and social science.

More specifically, gamification science studies four core construct classes [175]:

The predictor constructs are the *game elements*. They are the building blocks of gameful systems and are operationalized in gamification research as the causes of the effects of interest; thus, they can be experimentally manipulated to induce outcomes of interest. However, there is no common agreement yet regarding the list of all specific game elements. Therefore, we contribute to the mapping of the commonly used elements in Chapter 5.

The criterion constructs are the *outcomes of interest from gamified processes*. These can vary greatly because the outcome can be whatever the researcher or practitioner wants it to be. Some common examples of studied outcomes are improved learning, behavior change, improved health or wellbeing, organizational performance, among others.

The mediator constructs explain *how gamification results in change*. These might be for example psychological changes, attitude changes, or behavioural changes that are causes by the predictors (game elements) and that lead to the outcomes.

Finally, the moderator constructs are the *circumstances in which gamification is successful*. These can be factors such as the context where gamification is applied, the user's personality, age, gender, or culture, user types, previous psychological attitude or predisposition to change, among others. Studying the moderators and how to effectively design around them is an important topic for personalization of gameful systems. Therefore, the extant knowledge on potential moderating factors in persuasive technologies, games, and gamification are further addressed in Sections 2.2 and 2.3. Moreover, two types of moderators, namely user types and preferences for different types of gameful experiences, are central to the gameful design method presented in this thesis, and are thus explored in Chapter 4 and Chapter 5 respectively.

2.1.4. Supporting Psychological Theories

Gamification research and practice is a multidisciplinary activity, which draws knowledge from the psychological theories of personality and human motivation, game design methodologies, games user research, UX design, and knowledge from the domain area where it is being applied. Within HCI, gamification research usually focuses on establishing the theoretical grounds to explain how and why it works, devising design and evaluations methods, and collecting empirical evidence of the results of gamified interventions and systems [233,306].

Because gamification is often employed to foster user motivation, psychological theories of motivation are commonly used as the fundamental ground on which gamification theory is built. Self-determination theory (SDT) [65,66,296] is arguably the most used theory [225,306]. However, it is often received through popularized representations, leading to partially erroneous representations, or variously mixed with other models into new untested models of motivation [75]. Thus, the recent appearance of empirical studies properly based on the theory is a sign of maturity of the research field [233]. Other suggested psychological models include [177,327]: theories of learning via conditioning (classical [130] and operant [137,311] conditioning), expectancy theories [335], and goal-setting theory [188,189].

Moreover, gamification researchers are often interested in understanding why individuals respond differently to similar motivational affordances, particularly when studying about personalization of gameful systems. In this case, they often turn to the psychological theories of personality, which generally explain why people behave differently in each situation. By far, the most widely used theory of personality for games and gamification research is the five-factor model [64,107,211], although some earlier research in games also employed the Myers-Briggs type indicator [212,232].

2.1.4.1. Self-Determination Theory

Due to the importance of self-determination theory as a supporting theoretical background for this thesis, this subsection summarizes it and its relation to gamification research.

Within HCI research in general, the principles of SDT [66,296–298] are often used to explain behaviour motivation in interaction with digital technologies. SDT suggests that individual motivation to engage in a task can be located within different grades of internalization, ranging from wholly external to wholly internal motivation. In a simplified model, motivation can be *intrinsic* (i.e., afforded by the individual's perception of a task as enjoyable by itself), or *extrinsic* (i.e., afforded by factors outside of the task, such as expected outcomes that may result from completing the task).

Figure 2-2 illustrates the detailed taxonomy of human motivation according to SDT's subtheory Organismic Integration Theory, which details the different forms of extrinsic motivation and the factors that either promote or hinder internalization and integration of the individual's regulation of behaviours [296,297]. The types of motivation are arranged from left to right in terms of the extent in which the motivation emanates more from the external (left) or more from one's self (right). Therefore, at the far left is *amotivation*, when the person lacks an intention to act. Just to the right is *external regulation*, which motivates behaviours only to satisfy external demands or obtain external rewards. Since this is the most external type of motivation, it is what was typically contrasted with intrinsic motivation in early discussions [297]. The next type of extrinsic motivation is *introjected regulation*, which still represents quite controlled behaviour that is motivated by the feeling of pressure to avoid guilt or anxiety or to attain ego-enhancement or pride. A more autonomous form of extrinsic motivation is *identification*. In this case, the person identifies the personal importance of the action and has thus accepted the regulation as their own. Finally, the most autonomous form of extrinsic motivation is *integrated regulation*, which occurs when identified regulations have been fully assimilated into the self. This means that the person has fully identified with the reasons for action, and thus, feels self-determined to do it. Of course, at the far right of the figure is *intrinsic motivation*, which as explained before, occurs when the behaviour is totally self-determined because the action is innately enjoyable.

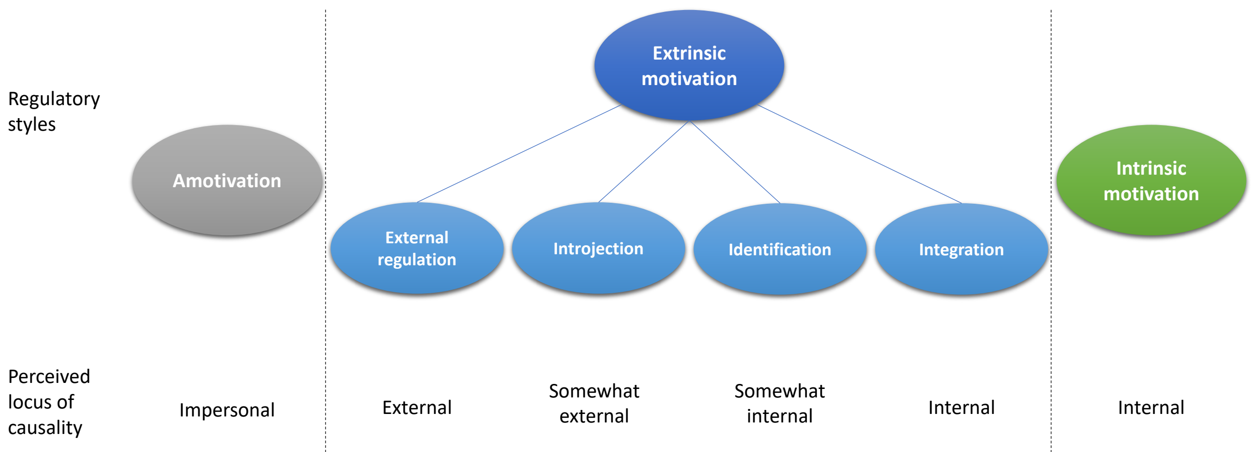


Figure 2-2. The taxonomy of human motivation from SDT. Adapted from [297].

Additionally, SDT posits that a task is more likely to be intrinsically enjoyable or internalized when it supports three basic human psychological needs: *competence*, the feeling of having the skills needed to accomplish the task at hand; *autonomy*, the perception of being in control of a situation; and *relatedness*, the feeling of involvement with others. Additional work in the field notes the importance of these three pillars and indicates that they can make a strong and positive contribution to a person's mental health [299]. Therefore, any situation that provides the satisfaction of these psychological needs is said to facilitate internalization, helping the regulation move from the more external to the more internal locus of causality. However, this does not mean that the task will become intrinsically motivated, even if it becomes more internalized [297]. This is an important distinction because the gamification literature often mentions that fostering these psychological needs leads to more intrinsically motivated actions, when it would be more accurate to say that it leads to higher internalization of extrinsic motivation, unless the activity was already intrinsically enjoyable to begin with, so internalization was never needed.

Another effect on motivation that is often considered is the *undermining effect*, which is the idea that when extrinsic incentives are presented for an initially enjoyable task, the intrinsic motivation will be subsequently reduced [51]. However, Cerasoli et al. [51] conducted a meta-review to study this effect and concluded that intrinsic motivation and extrinsic incentives are not antagonist, but they can be used together to increase task performance. Specifically, they found that intrinsic motivation was a stronger predictor of task performance involving quality. Thus, for complex tasks that involve heavy cognitive or creative work, being intrinsically motivated is more important. On the other hand, for task performance involving quantity, extrinsic incentives appeared as a more important predictor even though the influence of intrinsic motivation did not disappear entirely. The reasoning is that tasks that need more quantity than quality are usually less complex and may not be so intrinsically enjoyable. Moreover, the effects of incentive on task performance were stronger when the size of the incentive was directly linked to the performance than when it was not. These findings demonstrate that intrinsic and extrinsic motivation should be carefully considered together when designing interactive applications aimed at motivating users to achieve specific goals or engage with specific tasks.

Ryan et al. [298] were the first to suggest that the principles of SDT can also explain the motivational pull of games. In a series of studies, they developed and employed the Player Experience Need Satisfaction scale (PENS) to demonstrate that games are motivating to the extent that players experience competence, autonomy, and relatedness while playing. Since one of the common goals of gamification interventions is to increase the user's motivation or engagement with a system and knowing that the satisfaction of these three psychological needs is what make games motivating, gamification researchers and practitioners thus began to employ SDT as the background theory for their work. Accordingly, it can be said that gameful design (i.e., the design of a system to afford gameful experiences) will also result on an improvement of the system's ability to satisfy the user's psychological needs.

Following this conceptualization, HCI researchers began to investigate specifically how intrinsic and extrinsic motivation and the satisfaction of psychological needs explain or mediate the outcomes of gamification (e.g., [76,219,293]). Similarly, some gameful design methods have been using SDT as their supporting psychological theory. One such example is the Gamification User Types Hexad [198,329], which is further described in Section 2.2.2 and used throughout this thesis, particularly in Chapter 4. SDT is also be the supporting theory used for the development of our Gameful Design Heuristics, which is detailed in Chapter 6.

2.1.4.2. The Five-Factor Model of Personality

The five-factor model (FFM; [64,107,211]) of personality (also kwon as the "Big-Five" traits) is employed as the theoretical framework for personality in this thesis, as in much of gamification research. This model originated from lexical studies of the adjectives that are used to label individual characteristics in the English language, and has been developed over decades by several researchers through factor analysis or other methods [107]. It is currently accepted by many personality researchers and the results have been replicated in many countries and many languages [107]. The five psychological traits are [64,211]:

Neuroticism (versus Emotional Stability) is defined by terms such as worrying, insecure, self-conscious, and temperamental.

Extraversion (or Surgency) corresponds to people who are sociable, fun-loving, affectionate, friendly, and talkative.

Openness to Experience (or Intellect or Intelligence) is best characterized by original, imaginative, broad interests, and daring.

Agreeableness (versus Antagonism) is defined by trustfulness, sympathy, cooperativeness, and flexibility.

Conscientiousness (or Will to Achieve, versus Undirectedness) is characterized by the adjectives hardworking, ambitious, energetic, and persevering.

The structure of personality traits is hierarchical. Each of the five broad traits is composed of more specific traits (or facets) [64]. However, the theory is usually employed in games and gamification research by looking at the five broad traits, rather than the more specific facets.

Individual scores in the five traits are usually measured with a questionnaire, with the most complete and accepted one currently being the third version of the NEO Personality Inventory (NEO-PI-3; [214]), which is available since 2005. It is a 240-item questionnaire that assesses 30 specific traits (facets), six for each of the broad personality traits. However, administration of the full questionnaire is sometimes impractical due to its length, particularly for online studies. Therefore, shorter versions were also developed, such as the 60-item NEO Five-Factor Inventory (NEO-FFI; [63,213]), the 10-item Big-Five Inventory (BFI-10; [283]), or the Ten-Item Personality Inventory (TIPI; [112]). These shorter questionnaires can only measure the five broad traits, not the specific facets. Additionally, the 10-item versions are inferior to the standard longer instruments, although they have been shown to reach adequate levels of convergence and reliability. Even so, they should only be used in situations where shorter measures are needed, personality is not the primary topic of interest, and researchers can tolerate the diminished psychometric properties of shorter instruments [112].

Due to its ability to model individual differences and behaviours, the FFM has been often used to support research in games (e.g., [86,139,143,274,346,348]), gamification (e.g., [140,263]), and persuasive technologies (e.g., [6,115]). These works are further described in Section 2.3. Furthermore, we also use the FFM as a supporting theory in Chapter 4 and Chapter 5.

2.1.5. Gamification vs Gameful Design

The terms 'gamification' and 'gameful design' are often used interchangeably in the literature and sometimes even considered to be the same. However, Deterding et al. [77] suggest that both terms frame the same phenomenon but differ in their intentional properties. Gamification has the intention of using game elements in non-leisure contexts, while gameful design aims to create gameful experiences. However, the use of game elements (gamification) usually leads to gameful experiences, and one of the best ways to create gameful experiences (gameful design) is by using game elements. Therefore, they argue that the results are usually similar in practice irrespective of what intention was present. Similarly, Landers et al. [175,179] situate gameful design within the broader concept of gamification, in that gameful design specifically aims to attain the outcome goals by designing a gameful experience, whereas gamification can use game elements or merely inspiration from games to achieve any goal, without necessarily creating a gameful experience. As an example, they argue that the mere addition of a progress bar to a non-game process (e.g., a survey) is a gamification intervention without gameful design because it is inspired by games, but it is aimed at capitalizing on the psychological effects of progress bars to improve survey completion without the intention to afford a gameful experience (or maybe introducing a very weak gameful experience). On the other hand, the definition of gamification by Huotari and Hamari ("a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation" [132]) specifically states that gamification is aimed at affording gameful experiences. Therefore, they argue that gamification should not be designed to increase certain behaviours without focusing on the emerging gameful experiences, otherwise the design can lead to a conflict between the goal of changing people's behaviours and that of creating valuable experiences. In turn, even granting that gamification without gameful design can be used to achieve the desired outcome goals, Landers et al. [175] argue that it can be criticized as being manipulative or unethical.

Throughout this thesis, we refer often to gamification and gameful design. When we talk about *personalized gameful design*, we are referring specifically to the design with the intention of affording personalized gameful experiences, which in turn might be intended to mediate more distal outcomes. Therefore, the orientation towards creating gameful experiences is always present in our work.

2.1.6. Gameful Design Methods and Frameworks

A variety of gameful design methods have been proposed in the literature, both from academic and non-academic sources. However, academic research on gameful design is still in its infancy [75] and there is no agreed-upon method [175]. Moreover, many academic gameful design frameworks have not seen yet any widespread adoption outside of the research group where they were developed. On the other hand, gamification practitioners generally do not rely on methods developed academically, preferring to create their own frameworks. Several of them have been documented and published in books, blogs, or online courses. It can be assumed that many practitioners follow or at least have been influenced by some of the gameful design methods published by the most well-known authors. However, to our knowledge, there are no official figures.

Mora et al. [225] carried out a systematic review of gamification design methods and identified 40 academic and non-academic frameworks. They observed that 14 of those were general-purpose frameworks, which in theory could be used in any context. In contrast, 18 methods were intended to be used specifically for business applications, six for educational applications, and two for health applications. Additionally, they classified 24 frameworks as user-centred, meaning that the user is the main focus of the design process, whereas nine frameworks are technology-centred, which focus mainly on the design of technological artefacts, and seven frameworks are game-centred, meaning that the design focuses on the game artefacts and game play.

Deterding [75] also reviewed several academic and non-academic gameful design methods. However, he criticized them for their lack of formative research, reliance on player typologies, appeals to motivational psychology, pattern-based approach, lack of guidance in game pattern choice, lack of interactive prototyping, and over reliance on data-driven design. Thus, he aimed to address these issues with the introduction of his "Lens of Intrinsic Skill Atoms" design method.

Table 2-1 summarizes the gameful design methods existing in the literature and that we came across throughout this thesis development. It was initially based on the systematic review by Mora et al. [225], which covered works published until 2015. Then, we added the additional methods that we found during our studies, in particular the publications that came after 2015.

Table 2-1. A summary of gameful design methods and frameworks in the literature.

Framework / Method	**References**	**Academic / Industry**	**Target Applications**
Ethics & Gamification design	Versteeg [334]	Academic	Generic
Framework for Agile Gamification of Learning Experiences (FRAGGLE)	Mora et al. [227], Mora [228]	Academic	Education
Game Thinking	Kim [159]	Industry	Generic
Gamicards	Ferro et al. [88], Ferro [89]	Academic	Generic
Gamification by Design	Zichermann and Cunningham [353]	Industry	Generic
Gamification Design Framework	Manrique [194]	Industry	Generic
Gamification Design Framework	Fitz-Walter [91]	Academic	Generic
Gamification Design Framework	Kuutti [173]	Academic	Marketing
Gamification Design Framework	Lamprinou and Paraskeva [174]	Academic	Education
Gamification Design Principles in mHealth Applications	Miller et al. [223]	Academic	Health
Gamification Design Method	Morschheuser et al. [230]	Academic	Generic
Gamification for Internet Based Learning in Health	Rojas et al. [291]	Academic	Health
Gamification Framework	Francisco-Aparicio et al. [93]	Academic	Generic
Gamification Framework	Wongso et al. [342]	Academic	Education
Gamification Framework for Learning Activities of Computational Thinking	Kotini and Tzelepi [171]	Academic	Education
Gamification in Change Management	Schönen [304]	Academic	Business
Gamification in eLearning Systems	Tomé Klock et al. [319]	Academic	Education

Gamification Model Canvas	Jiménez [141]	Industry	Business
Gamification Modeling Language	Herzig et al. [129], Herzig [128]	Academic	Business
Gamification of Education	Nah et al. [236]	Academic	Education
Gamification of Learning and Instruction	Kapp [146]	Academic	Education
Gamification of Learning in Virtual Worlds	Herbert [126]	Academic	Education
Gamification of online surveys	Harms et al. [122]	Academic	Online surveys
Gamification on Crowdsourcing Systems	Brito et al. [40]	Academic	Crowdsourcing
Gamification: A tool to improve sustainability efforts	Menino de Paz [220]	Academic	Generic
Gamify	Burke [42]	Industry	Generic
Gamification Design Thinking	Marczewski [200]	Industry	Generic
The Kaleidoscope of Effective Gamification (KEG)	Kappen and Nacke [150], Kappen [147]	Academic	Generic
The Lens of Intrinsic Skill Atoms (Motivational Design Lenses)	Deterding [75]	Academic	Generic
Loyalty 3.0	Paharia [271]	Industry	Generic
Player Centered Design	Kumar and Herger [172]	Industry	Business
Process of Gamification	Marache-Francisco and Brangier [195]	Academic	Generic
The RECIPE for Meaningful Gamification	Nicholson [239]	Academic	Generic
Responsible gamified enterprise systems	Raftopoulos [280]	Academic	Business
Role-Motivation-Interaction (RMI)	Gears and Braun [102]	Academic	Business
Octalysis Framework	Chou [53]	Industry	Generic
Participatory Design Framework	Charles and McDonough [52]	Academic	Health
Six Steps to Success	Werbach and Hunter [338,339]	Academic	Generic
Social Gamification Framework	Simões et al. [310]	Academic	Education
Super Better	McGonigal [217]	Industry	Generic
Sustainable Gamification Impact (SGI)	AlMarshedi et al. [7]	Academic	Generic
Value-Based Design for Gamification	Sakamoto et al. [300]	Academic	Generic

A detailed description of all these gamification design frameworks is out of the scope of this literature review. However, we review in the next subsections the methods that are more closely related or that have influenced the development of this thesis. They are presented by chronological order of their first publication.

2.1.6.1. Six Steps to Gamification (2012)

Werbach and Hunter [338,339] proposed a gamification process with six steps:

1. **Define the business objectives**: identifying the specific performance goals of the gamified system;
2. **Delineate target behaviours**: identifying the behaviours (what users will do) and metrics (how the user outcomes will be measured);
3. **Describe the players**: description of the users' motivations. The authors also suggest segmenting them to ensure that the system will be appropriate for all subgroups. Although the framework is not tied to any specific user model, Bartle's player types [24,25] are described as an example;
4. **Devise activity cycles**: the framework instructs the designer to create two types of activity cycles: engagement loops (player actions that result from motivation, which in turn produce feedback from the system, which in turn motivate the user to take further actions) and progression stairs (the user journey, specifying how the goals and activities will evolve over time);
5. **Don't forget the fun**: this is a check to ensure that the model so far will provide engaging user experiences;
6. **Deploy the appropriate tools**: selection and implementation of the game mechanics and components appropriate to create the designed activity cycles.

2.1.6.2. Marczewski's Gamification Framework (2013–2018)

Marczewski has been continuously publishing gamification design tips in blog[1] format since 2012. Therefore, his gamification framework is often being updated. Nonetheless, the books published in 2013 [196], 2015 [200], and 2018 [205] provide pictures of the framework at each time.

The first version of the framework [196] consisted of a series of eight questions that the designer should ask himself or herself throughout a gamification project, which provided a sequence of steps for gameful design:

1. I know WHAT I am going to gamify;
2. I know WHY I am gamifying it;
3. I know WHO will be involved;
4. I know HOW I am gamifying it;
5. I have ANALYTICS set up;
6. I have TESTED it with users;
7. I have ACTED on feedback;
8. I have RELEASED the solution.

The next update [200] introduced a framework called GAME (Gather, Act, Measure, Enrich). It organized the basic steps and processes to go through when designing a gameful solution:

[1] https://www.gamified.uk

1. **Gather**: collecting information about what is being gamified, why is it being gamified, who is the gamification for, and how is it being measured;
2. **Act**: designing the best solution for the goals and testing it with the users;
3. **Measure**: measuring the activities of the users and the outcomes, comparing them with the goals, and using the feedback to iterate improvements;
4. **Enrich**: an iterative process to keep adding new challenges and improving the solution over time.

The current version [205], which is called Gamification Design Framework, consists of three main phases: Define, Design/Build, and Refine.

1. **Define**: also known as the Discovery phase, it is about understanding the problem that needs to be solved and the people who are involved. Besides defining the problem and the users, it includes defining the success metrics for the project;
2. **Design/Build**: it consists on designing the user journey, meaning that the experiences are specified for each of the five phases of the user experience: *discovery* (when the user is first introduced to the system), *onboarding* (when the user learns how to interact with the system), *immersion* (when the user begins to feel more comfortable with the system and immerse themselves with the main activity loop), *mastery* (when the user completes all activities and learn to use all the advanced features of the system), and *replay* (when the user decides to repeat the experience, trying to improve it or do something different). For each one of these phases, the designer should specify the *behaviours* (what the user will do), *motivation* (why the user wants to do the behaviours), *emotions* (how the designer wants the user to feel), *mechanics* (the implementation of the user's actions), and *action or feedback* loops (the core activities that the user should be repeatedly carrying out, together with the feedback provided by the system).
3. **Refine**: Over time, as the outcomes are measured, the system should be continuously improved, for example, by adding new core loops and new mechanics, or adapting the existing ones.

Furthermore, during the Design phase (or the Act phase on the previous iteration of the framework), the designer can refer to the Intrinsic Motivation RAMP and the Hexad user types as aids for motivational design. The Intrinsic Motivation RAMP (relatedness, autonomy, mastery or competence, and purpose) is a dressing of the psychological needs described by self-determination theory (see Section 2.1.4.1), in a format that is suited as practical design advice. The Gamification User Types Hexad [198] is a representation of different user preferences in gameful systems. It can be used in design as a means to survey the target user population to design according to their preferences, as a means to include gameful design elements in the system to appeal to specific user types [199,202], or as design lenses to help the designer think about different kinds of user experiences in the system [203,206]. The User Types Hexad is described in more details in Section 2.2.2.

2.1.6.3. The Kaleidoscope of Effective Gamification (2013)

The Kaleidoscope of Effective Gamification (KEG; [150]) focuses on how to design effective gameful systems, with effectiveness in this context understood as "the successful engagement of a player through effective game design." In turn, *effective gamification* is defined as "influencing human behaviour through engaging experiences, using game design principles in decision-making applications and services." The framework is structured in layers, with the first (centre) layer representing the design goal, the intermediate layers representing the design steps, and the last (outer) representing how the user sees and interacts with the system:

1. **Effective Gamification Core**: represents the nucleus of player experience, which is the goal of effective gameful design, and thus, a result of the other layers;
2. **Motivated Behaviour Layer**: the identification of user needs and their intrinsic (competence, autonomy, and relatedness) and extrinsic (points, badges, leaderboards, and incentives) motivations (which are based on SDT; see Section 2.1.4.1);
3. **Game Experience Layer**: creation of the gameplay experience by integrating actions, challenges, and achievements to promote the identified intrinsic and extrinsic motivations;
4. **Game Design Process Layer**: integrating game design elements and lenses to create the fun experiences specified by the game experience layer;
5. **Perceived Layer of Fun**: this is what a player can see and aesthetically experience in terms of audio, visuals, interface design, tangible interactions, and intangible experiences. Gamification is considered effective when the user experiences motivation through a feeling of delight or fun when using the system.

2.1.6.4. Gamify – Player Experience Design Process (2014)

The Player Experience Design Process proposed by Burke [42] breaks gameful design down to seven steps:

1. **Define the business outcome and success metrics**: the outcomes and metric should be specific and measurable, to ensure that the business objective of the gamification project is clear;
2. **Define the target audience**: the main goal is to put boundaries around the people the organization needs to engage. Then, Burke suggests getting to know and understand the audience, to design specific solutions. He suggests documenting the audience into player personas, which are imagined individuals who represent some of the common traits of a group of people;
3. **Define player goals**: analyzing where business outcomes and player goals overlap and where they do not. Burke suggests that the shared goals represent the best opportunities for gamification;
4. **Determine the player engagement model**: deciding how to structure the gamified solution. This includes deciding about parameters such as collaborative/competitive, intrinsic/extrinsic, multiplayer/solitary, campaign/endless, and emergent/scripted.

5. **Define the play space and plan the journey**: the play space is the environment where players engage with the game and with one another, whereas the player journey is the path that players take through the solution. Burke suggests presenting the player with a series of action or engagement loops that they will need to master;
6. **Define the game economy**: this involves designing the incentives and rewards that players are awarded for successfully completing tasks;
7. **Play test and iterate**: gamified solutions should evolve over time, adding new functionality, to engage the audience in new ways and keep the novelty.

2.1.6.5. Gamicards (2014–2017)

Gamicards [88,89] is a deck of cards aimed at helping designers prototype gameful design ideas, with a focus on tailoring game elements and mechanics based on player preferences. A prototype version was first described in 2014 [88], but a refined version was then described in 2017 as part of Ferro's thesis on personalized gameful design [89] (which is further reviewed in Section 2.3.4). In the most recent version, there are four types of cards:

1. **User Cards**: a classification of user's demographics, aims, objectives, outcomes, rules, schedules, and motivation;
2. **Context Cards**: a classification of the interaction in business, education, or personal contexts;
3. **Game Elements**: a list of experiences that the player can find in games;
4. **Game Mechanics**: a list of the activities that players do in games.

2.1.6.6. The RECIPE for Meaningful Gamification (2015)

Nicholson [238] expressed concern about what he called "reward-based gamification", or in other words, gamification that is solely based on giving extrinsic rewards to control the behaviour of individuals. In response, he introduced the concept of *meaningful gamification*, which he defined as "the integration of user-centered game design elements into non-game contexts." The focus of this definition is that the design must be user-centred. Therefore, in pursuing to help the users achieve their goals (as opposed to solely helping the organization achieve its goals in detriment of the individual goals), gamification designed this way should be more focused on intrinsic motivation and opportunities for self-reflection and learning. Later, Nicholson [239] introduced the RECIPE for Meaningful Gamification, which is a framework to help designers create meaningful gameful systems. It is composed of six elements, which the designer can think about while designing the system:

1. **Play**: facilitating the freedom to explore and fail within boundaries;
2. **Exposition**: creating stories for participants, or letting them create their own stories, that are integrated with the real world;
3. **Choice**: letting participants choose and create their own experiences;
4. **Information**: using game design and elements to allow participants to learn more about the real world;

5. **Engagement**: encouraging participants to discover and learn from others;
6. **Reflection**: assisting participants in finding other interests and reflecting about past experiences to help them deepen engagement and learning.

2.1.6.7. The Lens of Intrinsic Skill Atoms (2015)

The Lens of Intrinsic Skill Atoms [75] is a gameful design method focused on identifying the challenges inherent in the user's goal pursuit and reframing them with motivational affordances for gameful experiences. It works by identifying the skill atoms (the smaller reoccurring particles or user action and system feedback) and using motivational design lenses (ways of looking at the design space to devise motivational affordances for the system) to restructure them. The skill atoms are feedback loops composed of goals, actions, objects, rules, feedback, challenge, and motivation.

The design process entails five steps:

1. **Strategy**: the designer determines the goals and parameters of the project, including target outcomes, metrics, audience, and activities.
2. **Research**: through formative research, the designer models the user needs, motivations, and hurdles underlying the target activities. The activities of the user should be translated into behaviour chains or user journey maps. At the end of this step, the designer should check if gameful design is appropriate for the project, which happens when there is a user need that is lacking motivation and that has inherent challenges with learnable skills.
3. **Synthesis**: the skill atoms of the user activities or behaviours are identified, forming triplets of activity, challenge, and motivation.
4. **Ideation**: The designers brainstorm and prioritize ideas, which are then sketched into storyboards. Next, the motivational design lenses can be used to evaluate and refine them.
5. **Iterative Prototyping**: Concept sketches are implemented into low-fidelity prototypes and playtested.

The motivational design lenses that are used to refine the design ideas are composed of a name, a concise statement of a design principle, and a set of focusing questions that allows the designer to take on the mental perspective of the lens. The initial set contains 26 lenses in the following categories:

1. **Goal and motivation lenses**: interim goals, viral calls to action, next best action, intrinsic rewards, secrets, templates, and traces of others;
2. **Action and object lenses**: bite-sized actions, interesting choices, limited choice, micro flow, small pieces loosely joined, expressive objects, under-determination, and sensual objects;
3. **Feedback lenses**: immediate, juicy, actionable, appealing to motivations, glanceable, varied, surprising, and graspable progress feedback;
4. **Challenge lenses**: scaffolded complexity, varied challenge, and onboarding.

2.1.6.8. Actionable Gamification – Octalysis Framework (2015)

The Octalysis Framework [53] is a set of guidelines and a process for *Human-Focused Design*, a name that Chou often uses instead of 'gamification' to emphasize that the design should optimize for human motivation in a system, as opposed to focusing only on the instrumental goals in detriment of individual motivation. It presents eight *Core Drives*, which represent different types of motivations. Chou suggests that any human action only occurs when one is motivated by one or more of these Core Drives. He also suggests that if none of these Core Drives are present behind an action, no behaviour will happen. Therefore, before applying the Octalysis design process, the designer is supposed to understand these eight Core Drives:

1. **Epic Meaning & Calling**: believing that one is doing something for a reason greater than themselves;
2. **Development & Accomplishment**: the intrinsic motivation of making progress, developing skills, achieving mastering, and overcoming challenges;
3. **Empowerment of Creativity & Feedback**: the intrinsic motivation to express one's creativity and create new solutions or ideas;
4. **Ownership & Possession**: the motivation that arises when one owns or controls something and when one receives rewards;
5. **Social Influence & Relatedness**: the intrinsic motivation towards social interactions of any kind;
6. **Scarcity & Impatience**: the desire to obtain something just because it is rare, exclusive, or difficult to obtain;
7. **Unpredictability & Curiosity**: the motivation to be engaged because of the uncertainty of what will happen next;
8. **Loss & Avoidance**: the motivation to avoid something negative from happening.

The Octalysis framework is applied to gameful design or analysis of existing systems in five levels. The first level corresponds to analyzing the strengths and weaknesses of a system with respect to user motivation. This is done by thinking about how the eight Core Drives are used and what game mechanics and techniques are used to activate them. The second level optimizes this analysis with an optimization of the experiences for the four different phases of the user journey: Discovery (why people would want to try the experience), Onboarding (where the user learns how to use the system), Scaffolding (the regular repeated actions towards a goal), and Endgame (how to retain the veteran users). The third level expands the analysis even further by considering the differences in the experience for different user types. Although the framework does not impose the use of any particular user model, Bartle's player types [24,25] and Marczewski's User Types Hexad [198,329] are mentioned as examples. Both models are reviewed in detail in Section 2.2. The fourth and fifth levels of the Octalysis framework are currently not published, and their description is reserved to in-person training by the Octalysis Group.

Finally, to design new systems, the framework prescribes the construction of an Octalysis Strategy Dashboard, which consists of the definition of the following items:

1. **Business metrics**, which will be translated into game objectives;
2. **Users**, which will be the players of the game;
3. **Desired actions**, which are the activities that the designers want the users to be doing, and that lead to **win states**, which represent points where the user success is recognized and rewarded;
4. **Feedback mechanics**, which should trigger the user motivation to perform more desired actions;
5. **Incentives**, which are the rewards that users earn when they reach the win states.

2.1.6.9. SuperBetter (2015)

SuperBetter [217] is a gameful design method aimed at teaching how to live and overcome every life obstacle with a gameful mindset. McGonigal [216] argues that every individual can learn how to acquire the positive traits of a gamer to face real life challenges. These traits include a strong motivation and goal orientation, confidence in one's own capabilities, enjoying the pursuit of new challenges, perseverance in the face of obstacles, and a passion for learning new skills. The SuperBetter method consists of choosing a real-life goal or challenge and employing seven gameful rules. Each rule comprises a series of activities that should be repeated towards the achievement of the chosen goal or challenge [217]:

1. **Challenge yourself**: decide what real-life obstacle to tackle, or what positive change to make;
2. **Collect and activate power-ups**: good things that reliably make one feel happier, healthier, or stronger;
3. **Find and battle the bad guys**: anything that blocks progress or causes anxiety, pain, or distress;
4. **Seek out and complete quests**: simple, daily actions that help one reach their bigger goals;
5. **Recruit your allies**: friends and family members who will help one along the way;
6. **Adopt a secret identity**: pick a heroic nickname that highlights one's unique personal strengths;
7. **Go for an epic win**: an awe-inspiring outcome that helps one be more motivated and less afraid of failure.

2.1.6.10. The Framework for Agile Gamification of Learning Experiences (2016–2018)

The Framework for Agile Gamification of Learning Experiences (FRAGGLE; [227,228]) is based on agile design practices and is focused on the context of educational applications. It also takes the user types of the students into consideration, based on the Hexad framework (see Section 2.2.2), so that the gameful learning experiences can be personalized to each individual. The design process consists of four phases:

1. **Declaration**: covers the acquisition of necessary information. During this phase, the designer must identify the problem (the target goal to be solved with gamification), the

root cause (the reasons for the occurrence of the problem), the user stories (which are descriptions of the desired outcomes, from the point of view of the user—in this case, the student), and the acceptance tests (the list of expected user behaviours that can be measure to determine if the desired goals were achieved).

2. **Creation**: for each of the acceptance tests, appropriate gameful design components are selected, considering the interests and motivations of different user types. Each design component includes the description of the players (the Hexad user types that are the focus of the design component, as well as their particular interest in the context of the learning experience), the game mechanics (with a particular focus on leaderboards, teams, challenges, voting, gifting, and exploration, which are mechanics that have been previously mapped to different user types), the stages (which are the different phases of the learning journey: discovery, onboarding, mid-game, and end-game), the actions (the specific educational activities that will be carried out by the student as the implementation of the selected game mechanics), and the triggers (the feedback in response to student actions, which should motivate additional behaviours). Moreover, the students' motivations should be taken into account by considering five motivational dimensions: sense, purpose, autonomy, relatedness, and competence (which together form the acronym SPARC). By the end of this phase, a prototype (minimum viable product) should be implemented.
3. **Execution**: the prototype is deployed, and students carry out the designed learning experiences. In this phase, "'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" [228:85]. The user interactions should be tracked and logged to enable the evaluation of the efficiency and effectiveness of the promoted actions.
4. **Learning**: the analysis and measurement of activities to evaluate the achievement of the acceptance tests. Based on the results, the design can be improved in the next iteration (for example, the next term of a course).

As part of the development of FRAGGLE, Mora also studied how different designs of the same gamification element can be more or less enjoyable for people with high scores for different Hexad user types (see Table 2-2).

Table 2-2. User preferences for different designs of six gameful design elements. Adapted from [228:84].

Gameful 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 scores 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 for 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

2.1.6.11. How to gamify (2017)

Morschheuser et al. [230] conducted a literature review and a series of interviews with gamification experts and synthesized their findings into a gameful design method that captures the best practices in the literature and from practitioners. It consists on seven phases:

1. **Project preparation**: it begins with the identification of the problem to be gamified and the project goals; then, it should be assessed whether gamification is applicable and suitable; if it is, a project plan with defined objectives, requirements, and conditions is written;
2. **Analysis**: it consists of a study of the context where gamification will happen (identification, understanding, and definition of success metrics) and the target users (identification of user needs and motivations, followed by the creation of user personas);
3. **Ideation**: the design of the gameful activities, which is generally carried out through an ideation process that involves an iterative brainstorming activity (to come up with a large amount of ideas) and a consolidation of ideas to create a list for the next phase;
4. **Design of prototypes**: with a focus on the elaboration of evaluable and playable prototypes (using for example paper prototypes, sketches, or wireframes) that are iteratively tested and improved to come up with the final design idea;
5. **Implementation**: this involves the development of a pilot, which can be used for evaluation of the gameful design. This can be achieved by developing a new system or by using and configuring one of the existing commercial gamification platforms;
6. **Evaluation**: with the goal of assessing if the developed gamification solution meets the defined objectives. This can be achieved through a variety of methods, such as surveys, interviews, impact studies, A/B testing, or playtesting;
7. **Monitoring**: where the system usage is collected at regular intervals after its implementation, and the collected data is used to evaluate and improve the implemented mechanics over time.

2.1.6.12. Game Thinking (2018)

Game Thinking [159] is a product design method that aims to put the skill-building power of games into the hands of product leaders. It is based on game design, lean and agile methods, and design thinking. Its focus is on the user journey, more specifically in the personal transformation that happens as the backbone of gameplay. According to Kim, the player, as the protagonist of a game, has the agency to face a series of choices and challenges along a journey towards mastery. Game thinking, thus, aims to replicate this kind of journey in the design of any product. The process has five steps:

1. **Hypothesize**: a step based on user research, which consists on a series of experiments to identify the user needs and state them in the form of assumptions;
2. **Empathize**: finding hot-core early customers, which are particularly interested in the product being designed, to test the hypothesized assumptions and refine the knowledge about the user needs and the product goals;

3. **Design**: as mentioned above, the design process focuses on mapping the user journey, devising a path that users can follow to mastery, while learning how to journey from beginner to expert within the system. The user journey contains four phases: *discovery* (when visitors learn about the product), *onboarding* (when newcomers take their first steps within the system), *habit-building* (when regular users reengage in a cyclic loop that helps them achieve their goals), and *mastery* (when experts are ready for something more);
4. **Playtest**: again, Kim suggests testing the prototype first with "superfans" (people passionate about the product), then with other users that can help validate the assumptions and the designed user journey;
5. **Reflect**: summarizing the lessons learned from the previous steps and planning what to do for the next iterations.

2.1.7. Gamification as Persuasive Technology

A *persuasive technology* is an "interactive computing system designed to change people's attitudes or behaviors" [92]. This change is operated on the individual by the system through influence and must be voluntary. Moreover, Fogg clearly states that it must not occur through coercion or deception. These types of computer systems have been built for many years, but the specific study of them in HCI gained momentum after Fogg defined them as persuasive technologies in 2002 [92] and the Persuasive Technology conference was established in 2006. These multidisciplinary studies look at persuasive systems from several points of view, such as the persuasive techniques that can be used, the methods that can be employed to design and implement them, and the psychological effects that they intend to achieve.

Regarding persuasive strategies and tools, Fogg [92] identified seven types: (1) *reduction* (reducing the complexity of the task we want to engage user with), (2) *tunnelling* (guiding the user through a sequence of steps), (3) *customization* (tailoring the presented information according to the user and context), (4) *suggestion* (presenting a suggestion to the user at the right time), (5) *self-monitoring* (allowing people to monitor themselves to help them change their behaviour), (6) *surveillance* (allowing an user to monitor the behaviours of others to learn from them), and (7) *conditioning* (reinforcing positive behaviours through operant conditioning [312]).

Although gamification research and practice did not originate from persuasive technology research, gameful applications often share a similar goal, that of changing people's attitudes of behaviours through influence. This is not always the goal of gameful systems, but when this is the case, then these gameful systems can also be classified as persuasive technologies. They are often referred to as "gameful persuasive systems" or "persuasive gameful systems".

Llagostera [187] carried out a theoretical analysis of gameful persuasive systems and noted that four of the seven types of persuasive tools described by Fogg present overlaps with gamification: tunnelling (when the system guides users through a step-by-step process), self-monitoring (when the system tracks the user's actions and performance and makes the data available so the user), surveillance (when the data is also made available to others, thus enabling the social mechanism of persuasion), and conditioning (when gamification focuses on reward systems as a form of extrinsic motivation).

Moreover, Hamari et al. [119] conducted a literature review of empirical studies in persuasive technologies and gamification. They conceptualized persuasive technologies broadly as systems that use motivational affordances that lead to psychological outcomes, which in turn lead to behavioural outcomes. This conceptualization is very similar, although it is simpler, than the theoretical model of gameful systems and gameful experiences proposed by Landers et al. [175,179]. The main difference is that any motivational affordance can be used in persuasive technologies, leading to any kind of experiences, whereas in gameful systems, the expectation is that the motivational affordances that will be designed will be affording gameful experiences. In this context, gameful persuasive technologies are clearly a subset of persuasive technologies in general. In fact, Hamari et al. identified several types of motivational affordances commonly used in persuasive systems, some of which could reasonably be expected to lead to gameful experiences (e.g., objectives, goals, rewards, points, competition, and leaderboards) and others which are probably motivational without necessarily creating gameful experiences (e.g., visual or audio feedback, persuasive messages, reminders, suggestions, and advice). Similarly, Orji and Moffatt [262] conducted a literature review of persuasive technologies, which focused on health and wellbeing applications, and that found that some of the reviewed systems employed game-based technologies and affordances.

In another study of the relationship between gamification and persuasive technology frameworks, Orji et al. [268] demonstrated that user models devised for gameful systems can explain user preferences for different persuasive strategies. This shows that there is a connection between the gameful experience that happens when the user interacts with a gameful system with the persuasion that is expected of such systems. We review this study in more details in Section 2.3.4.

As the studies of gameful and persuasive systems have been connected more and more often in recent publications, this thesis too will include models and frameworks from the domain of persuasive technologies that are useful for our purposes, even though our research is broad and aimed at any type of gameful systems (including those that are persuasive, but also those that have other goals that do not include persuasion).

2.1.8. Empirical Evaluation

Regarding empirical studies of gameful systems, these initially focused on describing what gamification is and on trying to answer if gamification works in general [120,306]. Therefore, these initial studies usually compared a gamified version of a system against a plain (non-gamified) version and measured an outcome of interest (e.g., metrics of user experience, self-reported attitude or behaviour change, or actual behaviour change, such as adherence to fitness programs). This initial phase occurred broadly from 2011 to 2014. Hamari et al. [120] and Seaborn and Fels [306] conducted good systematic reviews of these works. They noted that results were generally positive, meaning that researchers measured a selected behavioural outcome (observed changes in the user's actions within a system or service) or psychological outcome (such as motivation, attitude, or enjoyment) and were able to show that a gamified system led to higher levels of improvement in such outcome than the plain system. However, other results reported mixed results (some measured outcomes improved, but not all), and a few even reported negative results (i.e., the measured outcomes were worst in the group of participants that interacted with the gameful system) [120,142,306]. Therefore, these initial studies showed that gamification can generally work; however, there are factors that influence the success of gameful interventions, which need to be understood so gamification practitioners can design systems with higher chance of positive results.

In consequence, gamification research began to mature from 2015 onwards and the most recent empirical studies have aimed to apply the theoretical background and further analyze the empirical findings, aiming at understanding and predicting when and how each particular design will be effective or not [233]. For example, Mekler et al. [219] used self-determination theory to study the effects of individual game design elements (points, levels, and leaderboard) on participants' intrinsic motivation and performance. In their study, the game elements did not significantly affect intrinsic motivation, but they significantly increased participants' performance (measured by the number of tags generated on an image classification task). Landers et al. [176] used a different approach, goal-setting theory [188,189], to understand the effects of leaderboards in gameful tasks. They observed that specific principles from goal-setting theory were useful to explain these effects, such as setting specific, difficult goals and committing to these goals.

Regarding badges, Hamari [117] conducted a large-scale, two-year study with an on-line peer-to-peer trading platform. He observed that awarding badges to the participants led to an increase of all types of activities in the platform. Van Roy et al. [292] decided to further analyze how users appraise the functional significance or badges as a psychological stimulus based on self-determination theory. They observed that participants reported experiences with two online gameful educational platforms in which they attributed nine different psychological meanings to the badges they received. This experiment showed that game elements may work differently for each user, and future research may be needed to understand these nuances.

Other game elements that have also been receiving attention are competition and collaboration. Morschheuser et al. [229] studied three versions of gamified crowdsourcing system: competitive, collaborative, and inter-team competitive. They observed higher system usage, crowdsourcing participation, engagement with the gamification, and willingness to recommend the platform for the inter-team competitive version. In another study, Landers et al. [178] investigated the effect of competition alone for a brainstorming task. Adding competition to the task improved the creativity and the quantity of ideas in comparison to the control group. Interestingly, the effects were not dependent on the participants' trait competitiveness and intrinsic motivation.

Another intriguing study was conducted by Lieberoth [185] and showed that even just framing an activity as a game may have some psychological effect, even without implementing a game. In his study, he assigned participants to a condition in which they participated of a competitive discussion, or another in which they had the same game artifacts, but no actual game mechanics. In both conditions, the psychological effects were similar, and interest and enjoyment were significantly superior to controls.

In summary, the most recent research has evolved to well-thought studies employing theories such as SDT and goal-setting to better understand how specific game elements work and what effects they promote when employed in gameful systems. These studies are certainly very useful to the nascent field of personalized gameful design because a deep understanding of the psychological effects of each element in different users is needed for the design of better personalized systems.

2.1.9. Gamification and Ethics

Gamification has received its share of critics since it became popular in 2010. For example, Robertson [289] argued that it should be called *pointsification* because it consists on the process of taking the things that are least essential to games (points and badges) and representing them as the core of the experience. Bogost wrote a popular article [37,38] saying that "gamification is bullshit" and that *exploitationware* would be a more accurate name for it. He posits that gamification is just a marketing trick to capitalize on the cultural moment through services that only benefit the consultants who provide them.

Nonetheless, in the following years, more balanced voices studied the ethics of gamification and argued that it can result in positive or negative outcomes for those involved with it. But the conditions that lead to one or another outcome are complex. For example, Marczewski [204] argues that gamification is just a tool and thus, the designer is responsible for deciding how to use it. In this sense, gamification is not inherently ethical or unethical. Instead, the ethics are associated with the intention of the person using it. The onus is on the designer to use the tools available to them to make gamification ethical. In addition, Marczewski suggests four simple questions to assess the ethics of a system: "1. Does the system offer a choice? 2. What is the intention of the designer? 3. What are the potential positive and negative outcomes of being in the system? 4. Are the beneficial outcomes weighted toward the needs or desires of the user or the designer?" [204].

Versteeg [334] studied ethics and gameful design from the point of view of three normative ethical theories: *utilitarian* [222], which judges actions to be morally right or wrong on the measure of happiness they bring to the people involved; *deontological* [145], which posits that one must consider the goals and expected outcomes of one's actions; and *virtue ethics* [133], whose central concept is Aristotle's *eudaimonia* [12,13], a state of wellbeing characterized by living through virtue and being a "good human being." Based on these theories, Versteeg proposed a moral gamification design framework, which indicates four things that designers can do to systematically signal and address potential ethical issues: (1) have a basis of moral principles and values, (2) conduct a conceptual investigation to envision potential positive and negative outcomes to stakeholders, (3) corroborate the results of the conceptual investigation by empirically gathering stakeholders' feedback and opinions, and (4) evaluate and iterate the design ideas.

Raftopoulos [280] proposed a conceptual framework for the development of responsible gamified enterprise systems. It is centred around a "Values and Ethics" activity, which aims to manage the potential negative impacts of seven value-destroying risks that can occur in detriment of value-creation benefits: (1) coercive participation, instead of engagement and motivation; (2) leaking information, instead of performance data analytics; (3) channeling the employees through a "technological whip", instead of improving learning and collaboration; (4) homogenisation of the workforce, instead of shaping behaviour and performance; (5) disempowerment and loss of human agency, instead of empowerment and productivity improvement; (6) illusion or charge, instead of workplace and process transformation; and (7) being shallow and inauthentic, instead of fun.

Deterding [74] suggested that ethical gamification should not be only about avoiding coercion or harm on others. Instead, he proposes the approach of *eudaimonic design*, in which design aims to promote the "good life" from Aristotelian eudaimonia. Thus, ethical gamification would be a potential tool for positive design [68] or positive computing [48], actively supporting human flourishing, being a practice performed virtuously and excellently in itself, and realizing or at least being congruent with living a good life with others. A similar approach, also based on positive design and positive computing, was disseminated by the Positive Gaming Workshop [326], organized by the author of this thesis and collaborators within the ACM CHI PLAY 2017 conference.

Another critique of simplistic gamification, also based on virtue ethics, is that of Sicart [309]. He suggests that better gamification can be achieved by focusing on letting the user freer to experience play instead of constrained by too much rules, and that this playful experience should be oriented to living the good life. Sicart also argues that over-reliance on gamification may undermine the capacity for self-reflection, which is essential to living the good life. Similarly, Selinger et al. [307] posit that over-reliance on gamification to extend one's willpower to achieve their goals may result in weakening one's own internal willpower and thus, their character.

Other authors focused more on identifying what could be the negative consequences or the "dark side" of gamification, so that designers can be aware and avoid them. For example Callan et al. [47] describe ten potential scenarios in which gamification could be misused in organizations by not being adequately linked to the organizational goals and employee motivations. They suggest that these issues could be avoided by following the recommendations and best practices from psychological research literature. Kim and Werbach [161] recommend that designers should be precautious about whether their use of gamification takes unfair advantage of workers (exploitation), infringes any involved persons' autonomy (manipulation), harms anyone involved, or has a negative effect on the moral character of involved parties. On the other hand, Kim [160] further studied the issue and did not find clear grounds for believing that gamification of labor is necessarily exploitative, although this does not mean that it may not incur in other wrongs.

Toda et al. [318] conducted a systematic review to identify the potential negative effects of gamification in education. They found that the most common negative effects are indifference, loss or performance, undesired behaviour, and declining effects. Hyrynsalmi et al. [135] also carried out a systematic review to identify the potential negative consequences of gamification. They identified limiting issues, such as lack of focus in the task and failure to achieve the best possible performance, as well as harmful and potentially unethical issues, such as loss of productivity or encouraging users to perform behaviours only when rewarded.

The issue of gamification and ethics has also been discussed over the years among the community of practitioners. As a result, two codes of ethics have been proposed for gameful designers. The first was published in 2012 by Zichermann [352] and is based on three principles: (1) striving to design systems that will help individuals, organizations, and societies achieve their true potential; (2) not obfuscating the game mechanics with the intent to deceive users about the real goals of the system; and (3) making an effort to share knowledge about motivating behaviours with the community. The second code of ethics [197] was first published in 2013 by Marczewski and reviewed in 2015. It is based on five principles: (1) *honesty*, by giving clients realistic expectations about the potential results and not using gamification as a way to dishonestly gather information; (2) *integrity*, by using gamification within the accepted legal and social practices where it is applied and avoiding manipulating users; (3) *transparency*, by encouraging openness about the system to users and clients, providing free access to information, and not sharing personal data without consent; (4) *quality*, by always providing the best possible service; and (5) *respect*, by considering the impact of gamification projects in the environment and not encouraging or justifying violence, LGTB-phobia, racism, abuse, misogyny, or similar.

2.2 User Models

User models can be used for a variety of goals in HCI, for example, to better understand the user needs and expectations for user-centred design, or to tailor the content or the features of the system to each user. In the domain of games, player models (or player typologies) have been studied for years to better understand how players interact with games and how their motivations differ from player to player. More recently, specific models for gameful experiences have also been developed. This section reviews the user models in the literature in the context of games and gamification. The next section reviews how these models are being used to personalize the user experiences in games and gameful systems.

2.2.1. Player Typologies

Researchers in games and HCI have been studying different motivations and playing styles for over a decade and representing them as player typologies. One of the oldest and most frequently cited player type models is Bartle's [24]. Bartle studied what players desired from Multi-User Dungeons (MUDs) through a discussion between dozens of senior players. He identified four player types based on two axes that express the player's desire to interact with or act on the virtual world or on other players: 'Achievers' (acting on the world), 'Explorers' (interacting with the world), 'Socialisers' (interacting with other players), and 'Killers' (acting on other players). Although this model is often cited in its original form, Bartle later extended it by adding a third dimension [25]: implicit or explicit (i.e., whether the player actions are automatic and unconscious or considered and planned). Thus, each of the four original types was divided into two sub-types. The 'implicit' sub-types are, respectively, 'Opportunists', 'Hackers', 'Friends', and 'Griefers'. The 'explicit' sub-types are, respectively, 'Planners', 'Scientists', 'Networkers', and 'Politicians'.

Based on a factor analysis of questions inspired by the original Bartle's player types, Yee [344,347] identified three main components of player motivation with ten sub-components: achievement (advancement, mechanics, competition), social (socializing, relationship, teamwork), and immersion (discovery, role-playing, customization, escapism). Although Yee's analysis provides a solid base for understanding player motivation, it was strongly focused on one specific game genre (Massively Multiplayer Online Role-Playing Games – MMORPGs). It therefore suffers from the same issue as Bartle's: both are hard to generalize to different types of games. More recently, Yee [345] expanded on his previous work by conducting a factor analysis with a large number of participants and developed a 'Gamer Motivation Profile' comprising 12 dimensions grouped in six clusters: Action (Destruction and Excitement), Social (Competition and Community), Mastery (Challenge and Strategy), Achievement (Competition and Power), Immersion (Fantasy and Story), and Creativity (Design and Discovery). Although this study aimed to define player motivations in relation to a large variety of games, and is empirically supported by factor analysis, they have not presented a publicly available standardized assessment tool.

The first Demographic Game Design model (DGD1) [27] tried to identify a broader range of player types by adapting the Myers-Briggs Type Indicator (MBTI) [232] to games. It proposed the player styles 'Conqueror', 'Manager', 'Wanderer', and 'Participant'. The second Demographic Game Design model (DGD2) [26] explored what was termed the 'hard-core to casual' dimension, and interrogated different skill sets as well as players' preferences for single- and multiplayer gameplay. These two models served as the basis for the BrainHex player typology. BrainHex [26,234] is a top-down player typology, which takes inspiration from neurobiological player satisfaction research [28], previous typology approaches, discussions of patterns of play, and the literature on game emotions. It features seven archetypes denoting distinct player motivations. The seven BrainHex archetypes are: 'Achiever' (motivated by completion), 'Conqueror' (motivated by challenge), 'Daredevil' (motivated by excitement and risk), 'Mastermind' (motivated by strategic reasoning), 'Seeker' (motivated by exploration and curiosity), 'Socialiser' (motivated by social interactions), and 'Survivor' (motivated by frightening experiences). BrainHex supplements existing research with a more diverse array of player types and has been used in a number of recent studies in HCI (e.g., [30,269,350]). However, initial assays at empirical validation have shown that BrainHex does require further improvement, as demonstrated by its significantly low reliability scores [44,328].

Xu et al. [343] developed a player typology from an empirical evaluation of a health game for younger adults. They proposed five player types: 'Achievers', 'Active Buddies', 'Social Experience Seekers', 'Team players', and 'Freeloaders'. These types include both motivational and behavioural factors. However, they have not been investigated regarding their validity in personalizing games and they are mostly focused on the health domain.

Hamari and Tuunanen [121] conducted a systematic review of player type models to investigate their commonalities. The authors note that MMOs and online games are more frequently covered than other genres in several of these studies, and thus that this compromises the generalizability of these models. Furthermore, they compared all the analyzed models and suggested that they could be synthesized in five key dimensions pertaining to motivations of play: 'Achievement', 'Exploration', 'Sociability', 'Domination', and 'Immersion'.

An issue with several of these prior attempts to understand player preferences is that they try to classify players into types. However, type theories have been criticized as inadequate in personality research, giving ground to trait theories [64,107,212]. Trait theories interpret an individual as a sum of different characteristics, whereas type theories try to classify people in separate categories. However, player type models rarely work in practice because people actually have several overlapping motivations, some weaker and some stronger. Rarely is someone motivated by a single factor. Therefore, trait theories have been suggested to also be a better approach to classify player motivations and behaviours in games [26,121,328]. Motivated by this suggestion and the lack of reliability of the BrainHex model, Tondello et al. [320,328] developed a new player traits model to replace it, which is based on five traits: goal orientation, challenge orientation, social orientation, immersion orientation, and aesthetic orientation.

With a different approach, Tondello et al. [330] noted that past attempts to studying player types and preferences have ignored the relationship between those types and the activity elements of games. Those works focused only on high-level factors such as achievement or immersion. However, Tondello et al. argue that this makes the application of all those frameworks to the design of games difficult. Hence, they decided to map game constructs on an intermediate granularity level, commonly referred to as game dynamics or elements. In addition, they also address the different modes or styles of play such as a preference for single or multiplayer gameplay. These game playing styles can be combined with various game elements to create a variety of experiences. The game elements identified by their work were classified into nine groups: strategic resource management, puzzle, artistic movement (such as music or painting), sports and cards, role-playing, virtual goods (dynamics of acquisition and collection), simulation, action (fast-paced play), and progression. In turn, the identified game playing styles were classified in five groups: multiplayer (including cooperative and competitive), abstract interaction (such as from an isometric point of view), solo play, competitive community (such as streaming and e-sports), and casual gaming.

Similarly, Vahlo et al. [333] also provide a categorization of common game dynamics, structured in five factors: assault (dynamics of killing and murdering), manage (acquisition and development of resources), journey (exploration of the game world), care (showing affection and taking care of pets), and coordinate (matching tiles or music). In addition, they propose a clustering of player preferences based on their scored interest for each one of these groups of dynamics, identifying seven player types: mercenary, adventurer, commander, daredevil, companion, patterner, and explorer.

2.2.2. The Gamification User Types Hexad

While the abovementioned models are often used for personalizing gameful systems, they were built for games. However, in gameful design, only elements of games are included in non-game applications. Therefore, there is no evidence of the generalizability of game motivation models to gameful design because users might experience game elements embedded into applications differently than how they are experienced in games. They might also be less practical for direct use on gameful design because some types of common game elements are not usually employed in gameful systems, such as shooting or fighting. Consequently, recent works have proposed new models specifically built to explain user preferences in gameful systems.

In the context of gamification, Marczewski [198] proposed six user types that differ in the degree to which they can be motivated by either intrinsic (e.g., self-realization) or extrinsic (e.g., rewards) motivational factors when interacting with gameful systems. The user types are personifications of people's intrinsic and extrinsic motivations, as defined by SDT.

Accordingly, the Hexad model derives three of its intrinsically motivated types from SDT's psychological needs: 'Achievers' (*competence*), 'Free Spirits' (*autonomy*), and 'Socialisers' (*relatedness*). Furthermore, there is evidence that *meaning* (purpose) facilitates internalization, increasing the motivation to carry out uninteresting but important activities [65,114], and leads to increased happiness and life satisfaction [134,275]. This evidence informs the Hexad model's 'Philanthropist' user type. On the other hand, the 'Player' user type is derived from SDT's notion of extrinsic motivation, i.e., it describes users who are mainly motivated to interact with a system in pursuit of external outcomes, such as rewards.

On Figure 2-3 and below, we list the user types and further detail their identifying characteristics [198,329], as well as the gameful design elements initially recommended by Marczewski for each user type [202].

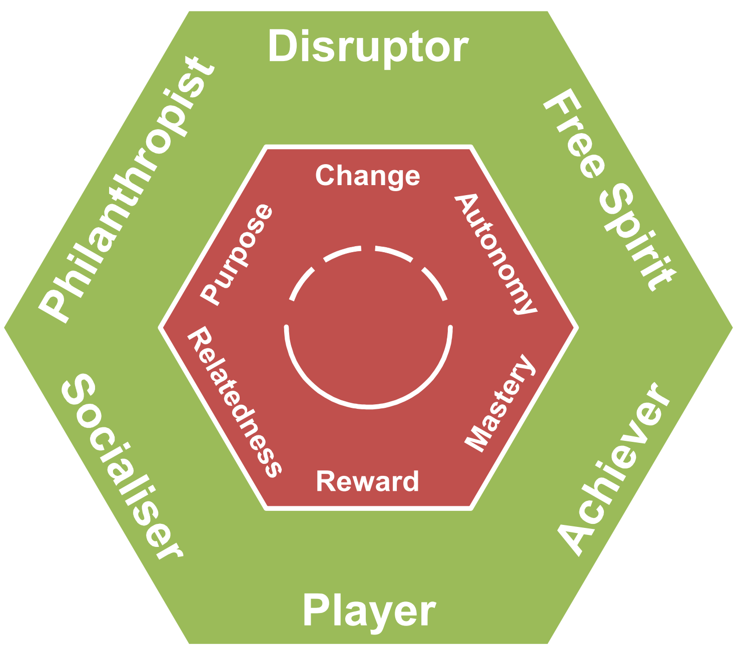


Figure 2-3. The Gamification Hexad User Types [198].

Philanthropists are motivated by *purpose*. They are altruistic and willing to give without expecting a reward. *Suggested design elements*: collection and trading, gifting, knowledge sharing, and administrative roles.

Socialisers are motivated by *relatedness*. They want to interact with others and create social connections. *Suggested design elements*: guilds or teams, social networks, social comparison, social competition, and social discovery.

Achievers are motivated by *competence*. They seek to progress within a system by completing tasks or prove themselves by tackling difficult challenges. *Suggested design elements*: challenges, certificates, learning new skills, quests, levels or progression, and epic challenges (or 'boss battles').

Free Spirits are motivated by *autonomy*, meaning freedom to express themselves and act without external control. They like to create and explore within a system. *Suggested design elements*: exploratory tasks, nonlinear gameplay, Easter eggs, unlockable content, creativity tools, and customization.

Players are motivated by *extrinsic rewards*. They will do whatever to earn a reward within a system, independently of the type of the activity. *Suggested design elements*: points, rewards or prizes, leaderboards, badges or achievements, virtual economy, and lotteries or games of chance.

Disruptors are motivated by the triggering of *change*. They tend to disrupt the system either directly or through others to force negative or positive changes. They like to test the system's boundaries and try to push further. This type is not derived from SDT, but from empirical observation of this behaviour within online systems [201]. Although disruption can sometimes be negative (e.g., caused by 'Cheaters' or 'Griefers'), this is not always the case, because disruptors can also work to improve the system. *Suggested design elements*: innovation platforms, voting mechanisms, development tools, anonymity, anarchic gameplay.

The user types slightly overlap because some of their underlying motivations are related. Achievers and Players are both motivated by achievement but differ in their focus: Those in the Player category focus on extrinsic rewards while Achievers focus on competence. Philanthropists and Socialisers are both motivated to interact with other players. However, they differ because a Socialiser's interest resides solely in the interaction with other players, while Philanthropists are motivated in their interactions to help others (altruism). Finally, Free Spirits and Disruptors are both motivated by autonomy and creativity. However, Free Spirits stay within the system limits without a desire to change them, while Disruptors seek to expand beyond these boundaries to change the system.

2.2.2.1. The Gamification User Types Hexad Scale

While the Hexad model was proposed a priori based on SDT, as explained above, Tondello et al. [329] later developed a standard survey scale to score an individual's inclination towards each one of the Hexad user types. They followed a three-step procedure to create the scale: an expert workshop to generate a pool of suggested items for each user type, an expert rating (with a different group of experts) to verify the content validity of the suggested items and select the five best items for each user type, and an initial empirical validation study. The study collected data from 133 undergraduate and graduate students from the University of Waterloo, Canada, to test the scale's internal reliability and conduct a factor analysis; as well as follow-up data from 40 of the original participants to test the scale's test-retest stability. During the study, the authors decided to remove the least reliable item from each subscale, proposing a final 24-item (four items per subscale) standard survey for the Hexad User Types (see Table 2-3).

Table 2-3. The Gamification User Types Hexad Scale items. Adapted from [329].

User Types	Items	
Philanthropist	P1	It makes me happy if I am able to help others.
	P2	I like helping others to orient themselves in new situations.
	P3	I like sharing my knowledge.
	P4	The wellbeing of others is important to me.
Socialiser	S1	Interacting with others is important to me.
	S2	I like being part of a team.
	S3	It is important to me to feel like I am part of a community.
	S4	I enjoy group activities.
Free Spirit	F1	It is important to me to follow my own path.
	F2	I often let my curiosity guide me.
	F3	I like to try new things.
	F4	Being independent is important to me.
Achiever	A1	I like defeating obstacles.
	A2	It is important to me to always carry out my tasks completely.
	A3	It is difficult for me to let go of a problem before I have found a solution.
	A4	I like mastering difficult tasks.
Disruptor	D1	I like to provoke.
	D2	I like to question the status quo.
	D3	I see myself as a rebel.
	D4	I dislike following rules.
Player	R1	I like competitions where a prize can be won.
	R2	Rewards are a great way to motivate me.
	R3	Return of investment is important to me.
	R4	If the reward is sufficient I will put in the effort.

Note. The scale is used by asking users to rate how well each item describes them in a 7-point Likert scale. Items should be displayed without identifying the corresponding type and in random order. Then, the scores of the items corresponding to each subscale should be separately added.

Furthermore, the results of the study showed that all subscales had an internal reliability $\alpha \geq .698$ and a test-retest stability $r \geq .631$, except for the Player subscale, which had $r = .357$. Regarding the distribution of the user types in the sample, Philanthropists, Free Spirits, and Achievers showed the highest averages, closely followed by Socialisers and Players, whereas Disruptors showed the lowest average among all types. Moreover, the usefulness of the Hexad user types to personalize gameful applications was demonstrated by investigating the correlations of each user type with 32 game design elements commonly used in gamification. Tondello et al. [329] presented a table that significantly correlates several design elements with each user type and suggested that this information could be potentially useful in personalization (see Table 2-4). To this end, a designer could assess the target user cohort's user type profiles (or an individual user's profile) by employing the proposed survey scale; next, they could focus the gameful application's design efforts on those game design elements that are more likely to be enjoyable for the predominant user types in the profile, according to the correlation table.

Table 2-4. Suggested game design elements for each Hexad user type. Adapted from [329].

	Suggested Associations	
User Type	**Principal Elements**	**Additional Elements**
Philanthropist	-	
Socialiser	Guilds or Teams Social Networks Social Comparison Social Competition Social Discovery	
Free Spirit	Exploratory Tasks Nonlinear Gameplay Easter Eggs Unlockable Content Learning Anonymity Anarchic Gameplay	Customization Challenges Creativity Tools
Achiever	Challenges Certificates Quests	Anonymity Learning Badges or Achievements Levels or Progression
Disruptor	Innovation Platforms Voting Mechanisms Development Tools Creativity Tools	Social Competition Anarchic Gameplay Challenges
Player	Points Rewards or Prizes Leaderboards Badges or Achievements Virtual Economy Levels or Progression Collection and Trading	Social Comparison Social Competition Social Discovery Anonymity Challenges Certificates Quests

It is important to note that player typologies have often been criticized for discussing types as discontinuous psychological factors, instead of presenting and measuring the traits in the form of a continuous scale [121]. However, this is not the case with the Hexad model, which measures each user type score on a continuous scale and presents the results as a collection of six scores, corresponding to each type. In this way, and similar to other typologies, the Hexad user types should be understood as an archetypical categorization, where the types represent users for whom certain motivations are stronger than others [121,323]. For example, a user who scores higher in the Free Spirit category and could be, thus, labeled singularly as being a 'Free Spirit', will be more motivated to pursue autonomous interactions with a gameful system, although the other motivations should still be present in a weaker degree.

2.3 Personalization

The concept of *marketing segmentation* was introduced by Smith [314] in 1956, as the adjustment of products and marketing efforts according to the requirements of the consumer or the user. It was an important strategy to deal with the heterogeneity of the market (due to different products being offered and to consumers having different preferences), by viewing it as several smaller homogeneous markets. Consumers could thus be segmented based on characteristics such as demographic information or preferences and habits regarding product use. An extension of this idea was *life style segmentation* [279], which also considered the different personalities of the consumers based on the theories of psychological types and classified them based on a wide range of activities, interests, and opinions. According to Plummer [279], life style segmentation was able to identify whole persons instead of isolated fragments. Marketing and life style segmentation allowed marketers to avoid focusing on average numbers, which do not really represent any consumer in particular. Instead, they could split their consumer into groups and focus product development, advertising, and promotions to each specific group [279,314].

In HCI, *personalization* is a logical extension of marketing segmentation [55]. Thus, personalization can be defined in e-commerce as "the act of specifically selecting content, in the sense of Web page or other digital content, for individual customers based on properties of the customer with the goal of increasing business outcomes for an e-commerce platform" [153]. In the broader domain of Internet applications and services, it is about "filtering content to satisfy an individual's particular tastes", according to Churchill [55]. Adomavicius and Tuzhilin [4] reviewed several definitions and summarized that personalization "tailors certain offerings (such as content, services, product recommendations, communications, and e-commerce interactions) by providers (such as e-commerce Web sites) to consumers (such as customers and visitors) based on knowledge about them, with certain goal(s) in mind." When they published their communication (2005), examples of personalized offerings included: content (such as Web pages and links); product and service recommendations (such as books, CDs, and vacations); email; information searches; dynamic prices; and products for individual consumers (such as custom CDs) [4]. We can notice that electronic commerce was an important field of application for personalization since the beginning, due to the inheritance from marketing practices.

Furthermore, the literature generally agrees that personalization can be initiated by the system or by the user [14,33,265,308]. *System-initiated personalization* (or system-controlled personalization) occurs when the content is automatically tailored to the user, usually with little to no involvement of the later [14,308]. It is often found in e-commerce applications, such as the products recommendations made by Amazon based on the users' and the products' shopping histories [186], or in media libraries, such as the movie recommendations made by Netflix [108]. Another common example is the simple tailoring of web page contents (and more recently, mobile applications too), such as greeting the user by name or offering targeted information (such as weather information) based on location.

On the other hand, *user-initiated personalization* (or user-controlled personalization) occurs when the system does not tailor contents on its own, but it offers affordances so that the user can make changes to the form and contents of the interface [14,308]. This form of adaptation is more commonly referred to as *customization*. Many digital interactive systems offer some form of customization, which can range from the simple selection of the display fonts and colours, to complex selections of digital content, activation or deactivation of specific features, or modifications of games. Whereas personalization is a passive process for the user because the content is filtered for them, in customization the user actively dictates the content that they will see and interact with [308]. However, Blom [33] cautions that the difference between personalization and customization should be seen as a dimension rather than a dichotomy because often both the system and the user participate of the process.

There is also the related concept of *adaptivity*. In computer systems in general, *adaptivity* refers to systems that adapt automatically according to a change in the existing conditions [106]. But this can refer to any kind of condition, some of which may be directly related to user preferences, some not, whereas personalization always refers to conditions related with the user. Therefore, *personalizing* is the same as *adapting towards a specific user*; implying that personalization is a special kind of adaptation [99]. In this subsection, we review works that address both personalized gamification and adaptive gamification, due to their proximity and similarity. However, in the remaining chapters, this thesis focuses on personalized gamification rather than adaptive gamification.

Results have shown the higher value of personalized over generic approaches in user interface (UI) design (e.g., [11,249]), persuasive technologies (e.g., [152,154]), and games (e.g., [21,259,260,269]), which we review in more detail in the next subsections.

One technology that is currently widely used to implement personalization in digital systems is that of *recommender systems*, which are software techniques that can suggest to user the items that they are more likely to enjoy, based on their profile [286]. Thus, we review the current literature on recommender systems in the next subsection.

Moreover, the personalization of persuasive technologies, games, and gameful systems is a topic that has gained considerable attention specially in the past four years. As a result, three editions of the International Workshop on Personalization in Persuasive Technologies have happened recently (co-located with the PERSUASIVE conference in 2016 [267], 2017 [266], and 2018 [256]), as well as two editions of the Workshop on Personalization in Serious and Persuasive Games and Gameful Interactions (co-located with CHI PLAY in 2015 [45] and with UMAP in 2017 [208]). Therefore, personalization of persuasive technologies, games, and gameful systems are the final subsections within this section.

2.3.1. Recommender Systems

Recommender systems (RS) are software tools and techniques that are capable to recommend users with suggestions for items they might want to utilize [286]. Service providers have been increasingly adopting them in the last 20 years, as they seek to differentiate themselves and achieve a competitive advantage. Recommender systems can be used by service providers, for example, to personalize the user experience, better understand what the user wants, increase the user satisfaction and fidelity, or increase the quantity or diversity of sales [286]. On the other hand, users might be interested in using recommender systems, for example, to find good items in a collection, browse items that might be of interest, annotate items in a context, find a recommended sequence or bundle of items, express themselves, or help or influence others [127,286].

2.3.1.1. Data Sources

Recommender systems are information processing systems that actively work to gather various kinds of data to build their recommendations [286]. The kinds of data collected may vary depending on the application domain and recommendation technique. Nevertheless, as a general classification, data used by recommender systems can refer to three kinds of objects: items to suggest, users that will receive the recommendations, and transactions (i.e., relations between items and users) [286]. More recently, recommender systems have also been expanded to consider contextual information, i.e., information about the user's situation in a specific time or location, resulting in context-aware recommender systems (CARS; [5]).

Items are the objects that are recommended to users [286]. They can be as diverse as the number of different applications of recommender systems. For example: web pages in search engines, products in e-commerce sites, movies or music in media applications, or documents in a repository. Item representation varies with the domain and technique used, and can range from a simple identification, to a set of attributes, to an ontological representation. Information about items might also include complexity and value. A more detailed description of items is needed for content-based recommender systems, whereas collaborative filtering techniques are less dependent on knowledge about the items (see next subsection).

Users are the individuals that will receive the recommendations and they can have diverse goals and characteristics [286]. There are many ways of modelling users, which will depend on the application domain and the recommendation technique. Most personalization systems are based on some sort of user profile, i.e., an instance of data representing a single user [101,152]. User profile representation can range from keywords, to sets of attributes, to semantic representations. User information collection can be explicit or implicit. Explicit collection methods rely on information input by the users, whereas implicit collection methods rely on automatic data collection, e.g., by logging user behaviour or browsing history. Hybrid methods also exist, which combine both information collected explicitly and implicitly.

Transactions are recorded interactions between the user and the recommender system [286]. They are generally log-like data that store information generated during the interaction of the user with the system. Transaction data may contain information about user behaviours, such as visiting specific pages, viewing specific products, or watching specific movies; about user preferences; or about user feedback, such as ratings or tags. The way in which transaction data is represented and used is dependent on the chosen recommendation technique.

Contextual information identifies the circumstances in which the recommendation occurs and that can affect the recommended items [5]. Examples of contextual information include time, location, company, and mood. For example, a travel recommendation system may suggest different vacation packages for Winter or Summer trips; a restaurant recommendation system might suggest different restaurants depending on the time of the day or the company (e.g., if the user plans to dine alone, with their significant other, or with business partners); and a movie recommendation system might suggest different content based on the user's current mood. Contextual information is often represented by different context types (e.g., time, location, mood, etc.), each one containing a set of possible attributes and values that do not change often through time [5,82]. Contextual information collection can occur explicitly (relying on information entered by the user), implicitly (relying on automatic data collection, such as time information or GPS location), or by inferring the context using statistical or data mining methods [5].

2.3.1.2. Recommendation Techniques

In order to implement its core function, a recommender system must predict items that are worth recommending [286]. This is usually achieved by analyzing the collected item ratings for a user. These ratings can have any format, from some sort of an explicit rating score provided by the user, to an overall rating calculated by a complex algorithm based on the characteristics of the item or the recorded transaction history between the user and the item. In any case, the rating is a measure of the usefulness or preference of the item to the user. Once the recommender system has access to this initial set of ratings, it tries to estimate a rating for the pairs of user and item that have not yet been rated by the user using a function $R: User \times Item \rightarrow Rating$ [5]:

Different types of recommender systems vary in terms of the addressed domain, the knowledge used, and especially regarding the recommendation algorithm, i.e., how the rating function is computed and how the recommendation is built and presented to the user [286]. The common recommendation techniques include content-based recommendation, collaborative filtering, hybrid recommendation, context-aware recommendation, and machine learning techniques.

Content-based recommender systems try to recommend items similar to those liked by the user in the past [190,273,286]. Systems implementing this approach try to describe the attributes or characteristics of the items previously rated by the user to build a model or profile of user interests [190]. Once it is built, the recommendation process consists in matching up the attributes of the user profile with the attributes of a new item that has not been previously rated by the user to estimate the user's probable level of interest in that item.

Content-based recommender systems have some advantages over collaborative filtering: *user independence* (the recommendation can be processed without requiring information from other users), *transparency* (it is possible to explain how the recommender works by examining the attributes in the user profile), and *possibility of evaluating new items* (it is possible to estimate the ratings for a new item, which has never been rated by any user, provided that the set of attributes for the item is available) [190]. On the other hand, the drawbacks of this approach are: *analysis is limited to the context* (i.e., the recommender's power is limited to the amount of information about each item that is available), *over-specialization* (because the recommender only suggests items that are similar to those previously rated by the user, it is difficult to suggest novel items that the user might also enjoy), and *difficulty to make recommendations for a new user* (enough ratings need to be collected before a content-based system can make a useful suggestion to a new user) [190].

Collaborative (or social) filtering approaches recommend items that are also liked by similar users [69,168,286,301], unlike content-based approaches. In other words, the ranking for a new item *i* for a user *u* is likely to be similar to that of another user *v*, provided that *u* and *v* have rated other items in a similar way [69]. Therefore, there is no need for exogenous information about either items or users [168]. Collaborative filtering methods can be grouped into two classes: *neighbourhood-based* and *model-based* methods.

In neighbourhood-based collaborative filtering, the user-item ratings stored in the system are directly used to predict ratings for new items [69]. This can be done in two ways: in *user-based recommendation*, the interest of a user *u* for an item *i* is evaluated by using the ratings of this item by other users, called neighbours, that have similar rating patterns than *u*; in *item-based recommendation*, the rating of a user *u* for an item *i* is based on the ratings of *u* for items similar to *i* (i.e., items that were rated similarly by different users) [69].

In (latent factor) model-based recommendation, the user-rating ratings are used to learn a predictive model [69]. These methods use matrix factorization [67] to transform both users and items to the same latent factor space, which tries to explain ratings by characterizing both users and items in factors automatically inferred from user feedback [168].

The advantages of collaborative filtering methods are: *simplicity* (they are intuitive and relatively simple to implement), *justifiability* (the list of neighbours and ratings can be used to justify the recommendation), *efficiency* (they require no costly training phases nor a detailed characterization of users and items), and *stability* (they are not affected by the addition of new users and items) [69]. On the other hand, collaborative filtering suffers from problems of *data sparsity* (lack of initial ratings), *limited coverage* (lack of identifiable neighbours), and *difficulty to make recommendations for new items* (the system cannot recommend items that have no ratings yet) [286].

Hybrid recommendation systems are based on the combination of the above-mentioned techniques. They try to use the strengths of one technique to counterbalance the weaknesses of the other technique [43,286].

Several strategies have been employed to combine different approaches into hybrid systems, such as: *weighted* (the scores of different recommenders are combined numerically), *switching* (the system chooses one among the available recommenders), *mixed* (different recommendations are presented together), *feature combination* (features from different sources are combined together into a single recommendation algorithm), *feature augmentation* (one recommender is used to compute an initial recommendation, which is then used as input to the next method), *cascade* (lower priority recommenders are used to break ties in the scoring of higher ones), and *meta-level* (one recommendation technique is used to produce a model, which is then used as input by the next technique) [43].

In **context-aware recommender systems** (CARS; [5]), the recommendations are not only dependent on the users and items, but also on a third input category: the context in which the recommendation occurs, such as location or time of day. In other words, a CARS extends the rating function *R* by including contextual information as a third input dimension: $R: User \times Item \times Context \rightarrow Rating.$

A context-aware recommendation process can take three different forms, depending on which phase the contextual information is used: contextual pre-filtering, contextual post-filtering, and contextual modelling [5]. In *contextual pre-filtering*, contextual information is used to select data for the specific context, i.e., to select the relevant set of records. Then, any traditional RS can be used on the selected data to predict new ratings. In *contextual post-filtering*, contextual information is initially ignored, and ratings are predicted using any traditional RS on the entire data. Then, the resulting set of recommendations is adjusted (contextualized) for each user. On the other hand, in *contextual modelling*, contextual information is used directly in the modelling technique as part of the rating estimation. Thus, contextual modelling approaches require the use of a truly multidimensional rating function. Several recommending algorithms are available, based either on heuristics or on predictive modelling techniques (see [5] for a more in-depth review).

A recent extension to CARS is the Dynamic Risk-Aware Recommender System (DRARS; [39]). In this approach, the system considers not only the context, but also the specific situation the user is in, and the risk of disturbing the user in this situation (e.g., when the user is driving or operating a heavy machine).

Machine learning techniques can also be used to learn models to predict item ratings and are generally employed to improve the precedent techniques [39]. Some of the commonly used machine learning techniques include *naive Bayes classifier* (a probabilistic approach to classify items into categories), *case-based reasoning* (CBR, an artificial intelligence technique that attempts to solve new problems by analyzing the solutions to previous, similar problems), and *artificial neural network* (ANN, an artificial intelligence technique used for pattern recognition).

2.3.2. Personalized Persuasive Systems

Several theoretical and empirical studies have investigated different factors for persuasive technology personalization, such as [255,262]: personality types [6,16,115], age [258], gender [258,261,264], gamer type [260,269], culture [156,254,257], and individual susceptibility to persuasive attempts [151,154,260]. Moreover, Kaptein et al. [152] introduced the concept of *profiling* as a method to estimate which influence principles will be the most effective for each individual user. Thus, a persuasion profile is a collection of estimates of the expected effects of different influence strategies for an individual, which indicate which of the strategies are expected to be the most effective. Kaptein et al. have also explored the differences between building personalization profiles by collecting information from the user either explicitly or implicitly. Explicit profiling occurs when meta-judgmental measures are obtained using questionnaires in which users reflect upon their own traits (such as the Hexad scale introduced in Section 2.2.2.1). On the other hand, implicit profiling uses operative measures to estimate the user's susceptibility to different persuasion strategies. In this case, the actual response to persuasion attempts are used to personalize future attempts. Persuasion profiles can be based on both explicit and implicit measures [152].

Oinas-Kukkonen and Harjumaa [123] built on Fogg's [92] seven original persuasive strategies to further develop 28 persuasive systems design principles; one of these principles is personalization, described as the system's capability to offer personalized instead of random content. Nevertheless, one of the most widely employed set of persuasive strategies in technology are Cialdini's set of six strategies [56]: (1) *reciprocity* (people by nature feel obliged to return a favour they received from others), (2) *scarcity* (people tend to place more value in things that are in short supply), (3) *authority* (people tend to comply to a request when it is made by a person they perceive with knowledge or power), (4) *commitment and consistency* (people by nature tend to be consistent with previous behaviours), (5) *liking* (people can be more easily influenced by other people they like), and (6) *consensus* (people tend to imitate a behaviour when they observed it being done by several others). Several studies have investigated the use of Cialdini's strategies in persuasive technologies and collected empirical evidence of significant differences in how different users are influenced by each strategy [154,258].

Personalization in persuasive technologies (excluding persuasive games and gameful systems, which we address in the next two subsections) have been explored in diverse application domains. For example, in the domain of health, Jalil and Orji [138] identified personalization factors for digital dietary recommendations for type 2 diabetes patients; Kırcı and Ünal [162] proposed the personalization of mobile health applications for remote health monitoring; Rutjes et al. [294,295] are developing personalized digital health coaches, which combine the features of technology with the presence of human coaches; and Azevedo et al. [19] introduced a platform that allows older adults and their caregivers to tailor the behaviour of their Web applications and persuade older adults to adopt healthy behaviours. (Additionally, please see Orji and Moffaatt [262] for a systematic review of persuasive technologies for health and wellbeing.) Also related to health, but with a different goal, Ikwunne and Orji [136] developed a messaging system that helps reduce the perception of the waiting time needed before a patient can see a doctor. Baez et al. [20] suggested an approach to design personalized technology for stimulating social interactions among and with older adults in nursing homes. In the domain of e-commerce, Adaji and Vassileva [2,3] applied the framework for e-commerce personalization [153] and the persuasive systems design model [251] to identify the personalization strategies practiced by Amazon, which they classified into four categories: providing primary task support, dialogue support, system credibility support and social support; Adaji et al. [1] studied the differences on diverse types of shoppers susceptibility to Cialdini's six persuasive strategies [56]; and Nkwo et al. [246] compared the personalized persuasion strategies of two of the largest African e-commerce platforms (Jumia and Konga). In education, Orji et al. [252] developed a personalized persuasive platform that selected one out of three social influence strategies (social comparison, competition, or social learning) according to the students' preferences (which were based on their answers to a questionnaire) to motivate them to engage more in learning activities.

It is worth noting that many of the works cited on the previous paragraph were published on one of the editions of the International Workshop on Personalization in Persuasive Technologies rather than more established conferences or journals and reported works in their initial stages rather than completed research. This shows the recent increase in the interest for the topic, but also that the studies need to mature more before conclusive results can be published.

2.3.3. Personalized Games

Bakkes et al. [21] define a *personalized game* as "a game that utilises player models for the purpose of tailoring the game experience to the individual player". They suggest four different approaches for modelling the player: (1) modelling actions, (2) modelling tactics, (3) modelling strategies, and (4) profiling a player, using for example personality traits or player type models.

Regarding personality traits, several studies have shown evidence of different gaming preferences or playing style related to each of the traits of the five factor model (FFM; [64,107]): openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. For example, Johnson and Gardner [143] have studied the relationship between the FFM personality traits and the fulfillment of psychological needs in video games. They found positive correlations between agreeableness and competence; and openness to experience and autonomy; as well as a negative correlation between emotional stability and presence. Follow-up studies by Johnson et al. [144] and Peever et al. [274] also found evidence of correlations between personality traits and game gender preferences. Yee et al. [348] studied how personality traits affect player behaviour in World of Warcraft [32]. They related extraversion with the preference for group activities, agreeableness with more frequent use of emotes and preference for non-combat activities, conscientiousness with the enjoyment of disciplined collections in non-combat settings, neuroticism with a preference for Player vs. Player activities, and openness with curiosity-driven gameplay, such as creating new characters or exploring the game world.

Despite the evidence of some relation between personality factors and gaming preferences, it seems personality can only partly explain the full range of different preferences. Therefore, researchers have also explored the use of player type models (already introduced in Section 2.2.1) to better explain player preferences for game personalization. In particular, the BrainHex [234] has received significant attention. For example, Orji et al. [260,269] developed tailored persuasive health games based on the player's BrainHex type and Birk et al. [30] studied how the player styles from BrainHex moderate the player's motivation with a social network game.

Because a significant part of the research on personalized games has focused on persuasive games, there is significant overlap between research in personalized games and personalized persuasive technologies. Thus, similarly to personalized persuasive systems, other factors might also be useful for personalizing games, such as age and gender [31,261,305,341], culture [337], and susceptibility to specific persuasive strategies [262]. Nevertheless, Mattheiss et al. [209] argue for the need of further investigating the balance between personalization costs and benefits because at some point the addition of more personalization factors will result in little benefits.

Besides personalization factors, it is also necessary to consider which components of games can be tailored to users or groups of users. Bakkes et al. [21] suggest seven different components that could potentially be tailored: (1) space adaptation, (2) mission or task adaptation, (3) character adaptation, (4) game mechanics adaptation, (5) narrative adaptation, (6) music or sound adaptation, (7) player matching (multiplayer), and (8) difficulty scaling. Difficulty adjustment in particular is a topic that receives great attention in gaming. Traditionally, many games offer a configuration for players to customize their experience by changing the difficulty (or other parameters of gameplay that make the game easier or more difficult). In addition, dynamic difficulty adaptation (DDA) has been the topic of several recent studies (e.g., [10,94,95,163]), which investigated how to do it and what are the effects on the player's experience.

Empirical studies have explored factors related to personalized persuasive games in several application domains. For example, in health, Orji et al. [253,260,269] developed personalized strategies for games aimed at fostering healthy eating; Van Dooren et al. [81] developed a personalized design process for games to support therapies for youth addiction; Geuens et al. [104] studied how personalization can increase adherence to physical therapy; and Ndulue and Orji [237] designed a persuasive game to encourage players to avoid risky sexual behaviour that was personalized to the culture of African youth. In the domain of exergames, Caro et al. [49] explored personalization factors to design exergames to support visual-motor coordination of children with autism and Yoo et al. [349] designed a virtual reality exergame with dynamic difficulty adjustment to deliver personalized activity levels and experiences. For wellbeing, Ciocarlan et al. [57] investigated what individual characteristics need to be considered and what personalization approaches could be applied in a persuasive game to improve subjective wellbeing in a student population. Regarding educational games, Khanana [157,158] developed a set of design heuristics for digital educational games for school children of 7 to 11 years old. Finally, in the domain of advergames, Wanick [337] studied how culture influences the design of games for advertisement.

2.3.4. Personalized Gamification

Personalization can be used in gameful design to tailor interaction mechanics to the user. Nonetheless, research on personalized gamification is still in the initial stages and several of the existing publications focus on developing models of user preferences, classifying gameful design elements, or understanding the effects of different personalization approaches in the user experience or the instrumental results. However, a few practical approaches to personalized gamification are now beginning to appear in the literature, which are being developed simultaneously to our work in this thesis.

2.3.4.1. Models of Individual Preferences

Several researchers have been documenting models of personal preferences to different game design elements or gamification in general, with respect to age, gender, personality traits, or user types. For example, Koivisto and Hamari [167] studied the effects of age, gender, and time using the service for the gameful experience in the context of a fitness community. They found out that age did not affect the benefits significantly, but the ease of use diminished with age. Regarding gender, their results indicated that women perceived the social benefits more than men did. Finally, their results also showed that perceived usefulness, enjoyment, and playfulness tended to diminish with time using the service, suggesting that gamification might cause a novelty value that does not last. Furthermore, the novelty effect was stronger for younger users, showing that younger people might get bored more quickly than more mature users.

Moreover, Kappen [147,148] studied individual preferences in gameful applications for physical activity. He suggests that for younger people (ages 18–29), it is more effective to combine intrinsic motivators such as goals and progression with extrinsic ones like badges and rewards; for ages 30–49, it is better to incorporate feedback elements like calories and distance travelled, daily progression, and comparisons with a social circle; for ages 50–64, it is also better to incorporate feedback elements like calories and distance travelled, but providing the opportunity for goal setting with weekly progression elements; and for older adults (ages 65+), it is better to provide monitoring and encourage walking with feedback elements such as step counters and distance metrics, while also indicating progress and improvement in a positive way. This framework was applied to an eight-week study of gamification of older adults' physical activity [147,149], with positive results and the development of further design guidelines targeted for this age group. Similarly, Altmeyer and Lessel [8] also investigated game preferences for older adults (ages 75+). They found out that socializing is a core motivator for seniors, who play more to communicate and maintain social contacts than to win the game. The seniors were also more interested in helping each other, to promote positive relations for wellbeing, rather than competing. Thus, Altmeyer and Lessel suggested that collaborative game elements should be used over competitive ones for systems designed for older users.

Regarding user preferences by personality traits, Ferro et al. [87] studied several models of personality and player types, aiming to find the similarities between them as well as to relate them to different game design elements. Their work grouped personality traits, player types, and game elements in five player categories: 'Dominant', 'Objectivist', 'Humanist', 'Inquisitive', and 'Creative'. Furthermore, Jia et al. [140] studied the relation between the five-factor model (FFM) personality traits (see Section 2.1.4.2) and individual gamification elements for habit tracking applications and found several significant correlations. They noted that people who are more extraverted are more likely to prefer points, levels, and leaderboards. In addition, emotional stability was negatively correlated with all elements, and significantly so with points, badges, progress, and rewards. The other personality traits were less significant in determining preferences.

Ašeriškis and Damaševičius [17] studied user preferences for two different types of leaderboards, based on the Hexad framework. They found out that an enhanced leaderboard, which included information about winning streak, biggest win, and biggest loss (in addition to the position and score, which were also available in the standard leaderboard) was effective in motivating people with high scores for the Free Spirit, Disruptor, and Player types to play longer, but it was not effective for Socialiser, Philanthropists, and Achievers. Furthermore, they developed a mathematical model to simulate user motivation in gameful systems by user types [18]. They concluded that motivation in gameful systems might be predictable if the impact of each element on each user type is previously known. Both studies were conducted in the context of a market simulation game.

Codish and Ravid [58,59,61] also studied user preferences in gamification based on personality traits and gender, in an educational context. In their experiments, they observed that students with high extraversion enjoyed badges more when they were given in front of the class (thus, allowing them to immediately show their achievement to others), whereas students with high introversion preferred badges when they were given automatically and tied to progress on a leaderboard. On the other hand, although all students enjoyed being in the top of the leaderboard, this gameful element was perceived as more playful by introverts. Codish and Ravid argue that this probably happened because the leaderboards were enjoyed individually, so extroverts were not able to brag about their performance in real time. Regarding gender, in another study of a gameful learning system that used badges and leaderboards [61], both genders showed the same perception of playfulness at the beginning of the term, but at the end of the course, female students maintained a significantly higher perception of playfulness than the male students.

With a main focus on persuasive gameful systems, Orji et al. [263] studied the relation between the five-factor model personality traits and several persuasive strategies used in gamification, and later [268] between the Hexad user types and the same persuasive strategies, in the context of risky health behaviour change, and found significant correlations. They noted that extraversion, agreeableness, and openness are the three personality traits that predict most of the variance in the effectiveness of different persuasive strategies. Regarding the user types, the preferred persuasive strategies for people high in their philanthropist score was simulation; for free spirits, it was personalization; for disruptors, customization and competition; and socialisers and players were positively associated with most of the persuasive strategies; while achievers did not show a specific preference for any strategy.

Also related to user preferences for different gamification elements, we already mentioned that Marczewski [199,202] has been maintaining a suggested list of elements that can be more appealing for each Hexad user type, which he updates over the years. However, the categorization is more based on personal practical experience, rather than systematic empirical studies. On the other hand, Tondello et al. [329] conducted a survey-based study to evaluate these relationships statistically, and found significant correlations between the Hexad user types and 32 of the gameful design elements listed by Marczewski (see Section 2.2.2 and Table 2-4 for details). Similarly, Gil et al. [105] sought to validate the expected relationships between gamification elements and Hexad user types, by tracking real experiences of users in an e-learning context. They noted that most of the expected relationships could be confirmed, except those for the Free Spirit type. However, it is important to note that their study (which was published in 2015) employed preliminary versions of the Hexad user types and the game element recommendations, dated of 2013.

Regarding student preferences in gameful learning applications, Barata et al. [22,23] studied student performance and gaming preferences from a gamified university level engineering course and identified four student types related to different gaming preferences: Achievers (those that put in the effort to achieve high scores and complete all tasks), Regular Students (those that keep a good pace in the course, but below the line of the Achievers), Half-hearted Students (those that complete a few tasks, but perform below the regular students), and Underachievers (those that barely complete any task and end up with a very low score). The authors suggest this framework may be used in future gamified education projects to tailor the course to the different characteristics of the students. Knutas et al. [165] also studied student behaviours, but in collaborative learning environments, to understand different ways that students collaborate in a group task. They classified students into four profiles regarding collaboration behaviour: cooperative workers (who concentrated mostly on professional communications, related to the tasks at hand), social team members (who socialize beyond the more directly productive activities of reporting and organizing), achievement-oriented leaders (people who like to get things done, take the initiative to lead others, and listen less to feedback), and task-oriented workers (who concentrated mostly on professional communications, like the cooperative workers, but different from them, they limited their communications within their own team, instead of also collaborating with other teams). Knutas et al. also discuss potential ways that these profiles can be used for adaptive gamification, but no specific methodology is provided yet.

2.3.4.2. Classifications of Gameful Design Elements

On the topic of gameful design elements, some authors have proposed taxonomies or classifications based on specific criteria. Phillips [276,277] suggested a taxonomy of videogame rewards based on prior literature and focus group studies. The taxonomy included the following reward types: access (granting the player access to new environments, objects, or models), facility (increasing the effectiveness of the player within the game), sustenance (mitigate the burden or the difficulty of the game), glory (which are generally quantifiable through points, achievements, badges, and definitive victory conditions), praise (which is communicated from the game system to the player), and sensory feedback (which is not a reward type per se, but represent the degree to which rewards provide the user with visible or tactile feedback, with the goal of promoting positive affect). Rapp [284,285] also discussed the classification of videogame rewards and social interactions, based on an ethnographic study of *World of Warcraft* (WoW; [32]), and discussed potential applications of his model to gameful design. First [284], he observed that rewards in WoW fall into one of three categories: enabling rewards (which increase the player's power within the game, such as weapons and armour), exchanging rewards (which can be traded in the game for other virtual goods, such as coins or crafting materials), or flexible rewards (which can be valued differently by each player, such as mounts and pets). Next [285], he classified social interactions in WoW into three types: artificial relationships (implemented by non-player characters, who give the player a first feeling of social interaction without needing to play with real people), temporary associations (which allow players to briefly work together to complete a mission), and liquid organizations (the guilds, which in WoW are organizations with a hierarchical structure that players join for an extended period of time to work together towards the most difficult objectives in the game). Rapp argues that designing these different types of rewards and social interactions for gameful systems would diversify the type of gamification elements and mechanics and potentially afford more positive experiences. While these models provide valuable information that can inform the design of rewards systems in gamification, they are each limited to a specific design element.

With a different approach, Exton and Murray [85] suggested a taxonomy of gameful design elements based on a theoretical evaluation of their motivational properties. Each element was classified according to their envisioned potential to afford either type of motivation descried by self-determination theory [296]: competence, autonomy, or relatedness. Furthermore, Robinson and Bellotti [290] proposed a preliminary taxonomy of gamification elements based on how much anticipated commitment was expected from the user (low, medium, high, or variable commitment). However, none of these taxonomies consider different user preferences as we do in this work.

2.3.4.3. Personalized Gameful Design Methods

It is also noteworthy that despite the existing literature on user preferences in gamification and games, most gameful design methods only superficially take user preference in consideration as part of their process, if at all [225,230]. One explanation for the lack of consideration for user preferences in design methods might be the difficulty of translating the existing models directly into design guidance. For example, Werbach and Hunter's Six Steps to Gamification (see Section 2.1.6.1) suggests segmenting the users based on player types, but no specific guidance is offered as to how this should be operationalized, and how the design should be modified for each user segment. Similarly, Kappen and Nacke's Kaleidoscope of Effective Gamification (see Section 2.1.6.3) proposes considering the users' intrinsic motivations and Burke's Gamify (see Section 2.1.6.4) suggests writing user personas to better understand the target audience, but it is not clear how this information should be used to personalize the design for each user. Nicholson's RECIPE (see Section 2.1.6.6) and Deterding's Lens of Intrinsic Skill Atoms (see Section 2.1.6.7) are strongly user-centred methods, which base the design decisions on specific research about the user needs and motivations. However, they do not clarify how to design personalized systems to different users instead of averaging the research data into one-size-fits-all designs.

Considering the gameful design methods in the industry, Marczewski's Gamification Framework (see Section 2.1.6.2) and Chou's Octalysis Framework (see Section 2.1.6.8) are the methods that more directly address the issue of personalization for different users. Marczewski's Gamification Framework is based on the Hexad user types and includes a list that classifies gameful design elements according to the user types that they are more likely to appeal to; therefore, designers have specific guidance on selecting elements appropriate for each user type. Similarly, Chou's Octalysis Framework offers two types of guidance for personalized design: the Core Drives, which helps the designers in classifying different types of user motivation and selecting appropriate gameful design elements, and the inclusion of player types in the third level of analysis, with specific guidance on how to adapt the resulting design for each user segment.

Also from the gamification industry, Gadiyar [97] argues for the need of evolving gamification practice toward personalized experiences and Paharia [271] suggests using gamification and big data analytics to build loyalty programs. Nevertheless, neither propose an actionable method to implement personalized gamification.

In academic research, a few design methods have been in development at the same time than our work, which are strongly focused on building personalized gameful systems. For example, Ferro [88,89] has recently developed *Gamicards* (see also Section 2.1.6.5), a methodology that helps designers create gameful experiences by selecting game elements and mechanics tailored to the users and context of the application. *Gamicards* is based on the GEM (Game Elements and Mechanics) framework. In the GEM framework, game elements are defined as the components of games that contribute to the experience and classified as 'adventure', 'quantifiable', or 'dexterity/skill'; whereas game mechanics are the actions that the player carries out to obtain the elements and are classified as 'efficacy', 'activism', 'social', and 'organizational'. Since several studies have shown that user preferences can significantly affect the effectiveness of instrumental game systems (e.g., [259,260,269]), it can be expected that this will also happen in gameful systems. Therefore, *Gamicards* can contribute to the improvement of design methods by providing a classification of gameful design elements that will help designers better understand user preferences and translate this information into design guidance.

Furthermore, Mora's Framework for Agile Gamification of Learning Experiences (FRAGGLE; [227,228]) introduces a design process for educational gamification that integrates the consideration of user (student) preferences based on the Hexad framework (see Section 2.1.6.10). Mora studied how different designs of the same gamification element can be more or less appealing to different user types (see Table 2-2). This classification was done for leaderboards, teams, challenges, voting, gifting, and exploration. Therefore, FRAGGLE's design process in the Creation stage recommends matching the chosen gamification components to the user type scores of the students, so that each student will be assigned to experiences that they are more likely to enjoy, thus leading to increased motivation.

Böckle et al. [35] also devised a design framework for adaptive gamification, which was based on a literature review they conducted aimed at identifying common practices in adapting gameful systems to different users [36]. Their framework is composed of four elements, which can be applied to the design process in a variety of orders. The first element is the purpose of adaptivity, which consists in determining in the context of the adaptation if and how it is necessary to change the state of the user, support learning, support participation, or create a meaning between end user and activity. The second element is the adaptivity criteria, which are the parameters used to model the users and can be based on things such as player or personality types, user data, usage data, status, or reputation. The third element are the adaptive game mechanics and dynamics, which consist in defining different levels or types of feedback, points, difficulty, and customized challenges according to the different types of users determined by the adaptivity criteria. The fourth and final element are the adaptive interventions, which are the suggestions and recommendations of things that the user can do, or the implementation of personalized content, adaptive paths, or adaptive user interfaces.

On the other hand, Lessel et al. [181–183] propose the different approach of *Bottom-up Gamification*, which consists on giving choices and allowing users to build their own gameful experience. In their first study [182], they asked participants to select the game elements they would like to use for a task management app, such as receiving points, receiving badges, seeing a progress bar, adding a narrative, or competing against others. They observed that participants were able to design experiences that they believed would motivate them and enjoyed doing so. In the second study [183], they implemented a microtask platform that included several game elements (points, badges, leaderboards, cooperation, and time pressure) and compared different conditions of "top-down" design (where the designer created the combination of game elements to be used) and "bottom-up" design (where participants were given freedom to combine the game elements as they wanted). The results showed that the participants in the bottom-up condition performed better (solved more tasks) than in the top-down condition. In the third study [181], Lessel et al. asked participants to design a gameful experience for four different fictional scenarios, but this time, they let participants choose any game element that they wanted, without limiting them with a pre-selected list of authorized elements. Once more, participants were able to design experiences that they felt they would enjoy and did not feel hindered by the possibility of choosing elements. However, the design exercise was only conceptual, so the resulting designs were not implemented to see how they would work in practice. Moreover, the researchers compared participants' design choices with their Hexad user type scores and personality trait scores but found no relationship between them. In general, Lessel et al. argue that bottom-up gamification can help increase the user's perceived voluntary participation because they are being allowed to design their own experience, instead of being forced to comply with rules that someone else imposed on them.

2.3.4.4. Studies of the Effects of Personalized Gameful Systems

Regarding the effect of personalization on user performance, Mora et al. [226,228] evaluated the use of personalized gamification in the classroom. They compared students' engagement with two different versions of the same undergraduate computer network design course. Both were designed using the FRAGGLE methodology (see Section 2.1.6.10); however, the control condition implemented a one-size-fits all approach (all students interact with the same gamification elements), whereas the experiment condition implemented a personalized approach, in which students were split into four groups according to their Hexad user type scores and the gamification elements were tailored in each group to the corresponding user types. The results showed that mean behavioural and emotional engagement scores were higher for the personalized condition than the control condition; however, the standard deviations were high, and the differences were not significant.

Moreover, as we mentioned in the previous subsection, Lessel et al. [183] compared different versions of personalized and non-personalized gameful design approaches for a microtask platform. In their "top-down" condition, users had to interact with all available game elements with a standard configuration and no way to customize it (non-personalized condition); in the "selective top-down condition", users were allowed to select one among a few pre-configured combinations of game elements; in the "selective bottom-up" condition, participants could also select pre-configured combinations, but they could further customize them (e.g., change the amount of points given); and in the "bottom-up" condition, participants could freely combine and configure the available game elements as they wanted. The results showed that participants in all the personalized conditions performed better than the top-down condition, as they solved more tasks faster and without a decrease in correctness.

Böckle et al. [35] also evaluated the effects of adding personalization to a gameful application. In their case, they had an existing application for knowledge exchange in post-graduate medical training, which was lacking participation. After using their design framework for adaptive gamification to add adaptive feedback mechanics, recommendations, and suggestions, they saw a significant increase in overall system activity.

2.3.4.5. Recommendation-based Personalization

Considering the approach of recommendation-based personalization, a few works discuss promising ideas. For example, Meder and Jain [218] studied the recommendation of game elements that would maximize each user's contribution in gameful systems using matrix factorization (a collaborative filtering technique). Geiger and Schader [103] reviewed the state of the art on personalized task recommendation in crowdsourcing information systems. Some crowdsourcing systems use gamification to motivate their users. Yet, crowdsourcing is one of the possible application domains for gamification, and not every crowdsourcing systems use gamification. Moreover, Codish and Ravid [60] proposed an approach for adaptive gamification which is based on tracking individual user behaviours and engagement levels, then using online analytics to fine tune the system's rules to personalize the experience for each user. However, their work so far has been conceptual, and no reports of an actual implementation are available yet.

On the other hand, Knutas et al. [166] devised a concrete process for designing algorithm-based personalized gamification. They extended Deterding's Lens of Intrinsic Skill Atoms gameful design method (see Section 2.1.6.7) with two additional steps: select personalization strategies (where the designers should decide which models will be used for personalization) and distill rules into an algorithm (where the designed gamification elements and rules for each user segments are implemented as supervised machine learning algorithms). They also suggested that the synthesis and ideation steps should consider the personalization models to design different gameful interactions for each user segment, which could later be implemented by the machine learning algorithm.

As a demonstration of their method, Knutas et al. [166] implemented a personalized gameful computer-supported collaborative learning environment. They used the Gamification User Types Hexad as the personalization strategy and designed different types of tasks that were adequate to the characteristics of each user type. Then, 69 human-defined rules were written to select specific activities to suggest to the user based on their user type and other parameters (such as activity levels and challenge levels). Finally, these rules were synthesized into 59 rules and implemented using a machine learning classifier. Therefore, during their interaction with the online platform, users would receive personalized suggestions of activities to do next based on their Hexad user type scores and their current status in the system. In summary, so far, Knutas et al.'s work presents the only recommendation-based personalized gamification framework that includes a concrete implementation that we are aware of.

2.4 Heuristic Evaluation

Part of the design process for any digital interactive system involves evaluating and refining the design ideas. For usability evaluation, two standard approaches exist. First, the gold standard is a usability test, where user experience (UX) researchers can either run a formative test (where they usually sit close to the participant and observe their behaviour) or a summative test (where they are often present locally or virtually, but the participant is working through an assigned task or scenario while some outcome measures are recorded). However, second, it can be advisable to run a usability inspection also known as heuristic evaluation before planning an expensive usability test. These inspections allow experts to evaluate a design based on a set of principles or guidelines (i.e., heuristics). They are fast and inexpensive tools that can be used to identify and address design issues.

In usability engineering, heuristics are general principles or broad usability guidelines that are used to design and evaluate interactive systems [243]. Heuristic evaluation is the use of said principles as a usability inspection method by experts to identify usability problems in an existing design as part of an iterative design process [240,242]. These inspections are usually done early in the design process to catch the most discernible application errors before scheduling user tests.

These expert guidelines date back to the early days of software design (e.g., Smith and Mosier [313]) and have over the last decades improved how we develop software and interactive applications. In the established areas of UX, heuristic evaluation or inspection methods [240,242] are commonly used as evaluation tools during the project design and implementation phases. They are not meant to replace user testing, but rather add to the set of evaluation tools.

2.4.1. Heuristic Evaluation of Games

Several authors have suggested heuristic evaluation models for games. These models vary both in their goals and their addressed dimensions: while some are more general, aimed at evaluating any game genre or type, others are more focused for example in networked or mobile games. The most relevant heuristic evaluation models for game design are shown in Table 2-5.

However, despite the availability of these heuristic evaluation models for games, their usage does not seem to be widespread among game companies. In a study recently published by Rajanen and Rajanen [282] with 331 North European and 802 North American companies, only 24% of them use heuristic evaluation regularly in game development. Among the reasons given for the companies that do not use them were lack of knowledge of their availability or how to use them, cost or lack of personnel to use them, or that the existing heuristics were not suitable for their games. On the other hand, the companies that do heuristic evaluation regularly stated that it is an effective way to find problems, it is easy, cheap, and not time consuming. But most of them developed their own heuristic list or used an adapted Nielsen's [241] list. Moreover, many respondents considered that specific lists should exist for specific games or genres.

Table 2-5. Existing heuristic evaluation models for games. Adapted from [321].

Model Name	**Description**
Heuristic Evaluation for Playability (HEP) [70]	A set of heuristics for playability comprised of four categories: gameplay, game story, game mechanics, and game usability.
Heuristics for Social Games [270]	A set of heuristics created from a critical review of prior video game evaluation heuristics.
GameFlow [316,317]	A comprehensive heuristic set designed as a tool to evaluate player enjoyment in eight dimensions: concentration, challenge, player skills, control, clear goals, feedback, immersion, and social interaction.
Game Approachability Principles (GAP) [72]	A set of guidelines to create better tutorials or experiences for new players.
Games Usability Heuristics (PLAY) [71]	A set of 48 principles aimed to evaluate action-adventure, RTS, and FPS games. The heuristics are organized in three categories: game play, coolness / entertainment / humor / emotional immersion, and usability & game mechanics.
Networked Game Heuristics (NGH) [278]	A set of heuristics that consider specific issues related with group play over a network.
Playability Heuristics for Mobile Games [169]	A set of heuristics for mobile games comprised of three categories: game usability, mobility, and gameplay.
Wearable Augmented Reality Heuristics [98]	A set of heuristics for wearable devices in playful applications organized in four categories: game usability, mobility, gameplay, and wearable technology.

2.4.2. Heuristic Evaluation of Gameful Systems

While it has become more common to run user tests with gamified applications, the domain is still lacking inspection tools for evaluating gameful designs. Some heuristics for evaluating games or playability could also be applied to gameful applications. Some of the dimensions addressed by most game design heuristics are of concern to gameful design, such as goals, challenge, feedback, and social interaction. However, heuristics for games include several dimensions that are not applicable to most gameful applications, such as control and concentration.

Additionally, some of the game heuristics cover issues that can be addressed in gameful applications using general UX principles, such as screen layout or navigation. These special heuristics might be necessary when evaluating games because games often use their own user interface principles, which can be different from traditional application interfaces. However, most gameful applications have user interfaces that follow current design standards; thus, general UX evaluation methods can be easily applied to gameful applications to address issues such as usability or ergonomics.

Furthermore, game design heuristics do not cover the full range of common motivational affordances used in gamification. For example, meaning, rewards, and scarcity are dimensions of motivational affordances often used in gameful design that are not covered by the existing game heuristics. This makes using game design heuristics to evaluate gameful applications difficult. The evaluator would have to decide first which dimensions from the game heuristics should be used and which should not; next, they would also have to be concerned with motivational issues that are not currently covered by game heuristics. Consequently, we conclude that an evaluation method better suited to evaluate gameful applications is needed, which we introduce in Chapter 6.

Chapter 3 Personalized Gameful Design Method

As reported in the previous chapter, scholars and practitioners are very interested in the personalization of gameful systems. However, there is still no widely agreed upon methodology for personalized gameful design. This chapter addresses this gap by proposing a new method for personalized gameful design, which consists on three sequential steps: modeling user preferences, selecting the gameful design elements that are more likely enjoyable for each user, and evaluating the motivational potential of the design. These steps can be integrated into many of the existing gameful design methods to augment them with personalization.

For the development of this thesis, we adopt the definition of personalization as summarized by Adomavicius and Tuzhilin [4] (see also Section 2.3). Therefore, we consider that personalization is the tailoring of certain offerings by providers to consumers based on knowledge about them, with certain goals in mind. In gamification, the offerings that are being tailored are the gameful design elements integrated into the gameful system; the providers are the people or organization behind the gameful system, who decide on which content will be offered; the consumers are the users of the gameful system; the knowledge about the consumers are the models of the user and their preferences; and the goals in mind are the goals of the gameful system being designed, which vary greatly from system to system (e.g., increasing user engagement or interactions with the system, promoting behaviour change, promoting adherence to a specific practice, fostering a community, increasing learning, among others). In the context of this thesis, we can rewrite that:

Personalization of gameful systems is the tailoring of the gameful design elements by the providers to the users based on knowledge about them, to boost the achievement of the goals of the gameful system.

Additionally, we present a generic method that can be used to design and implement system-initiated personalization or user-initiated personalization (customization). Our proposed method allows designers to select the gameful design elements that are more likely to help achieve the goals for each user. This knowledge can then be applied into system-initiated personalization, in which a recommender system or similar mechanism can automatically suggest the best elements for each user (or even automatically select elements without the user intervention), or into user-initiated personalization, in which the system will include features that will allow the user to select which elements they want to use. These personalization strategies are *dynamic* because the gameful design elements are tailored for each user at run time, not at design time. Section 3.2 provides more details about how dynamic personalization is achieved by following our approach.

In the following sections, we first review the kinds of items that can be personalized in gameful design and justify our focus on personalizing gameful design elements. Next, we present the general structure of the method and the steps involved in personalized gameful design. Finally, we explain and exemplify how these steps can be integrated into the existing gameful design methods to augment them with personalization.

3.1 Deciding What to Personalize

There are many different types of offerings that could be personalized in a gameful application. However, as Mattheiss et al. [209] noted, a set of offering types that will achieve a balance between personalization costs and returns needs to be chosen. But this selection is not trivial because there is not enough empirical evidence regarding the costs and the benefits of each type of personalization. Therefore, after examining the literature reviewed in the previous chapter, and considering the issue of personalized gamification, we believe that the main kinds of offerings that can be personalized in gameful systems are the activities, game elements, persuasive strategies, rewards, and difficulty. Although this list might need to be further revised in the future, as additional evidence of the costs and benefits of these types of personalization become available, these are the types of adaptation that we believe carry the highest potential to improve the user experience.

Activities: The activities of a user in a gameful application depend on the domain. For example, in an e-commerce application, they could be browsing, visiting, and buying products; in a fitness application, they could be a variety of types of physical exercise; in a health application, they could be dieting or exercising, among others; and in a learning application, they could be reading lessons, watching videos, taking quizzes, or completing challenges. The gameful system would need to rely on knowledge gathered from the application domain to analyze user preferences for different activities and select those that the user would be more likely to enjoy. For example, personalization in e-commerce applications have already been extensively studied [113,155] and this knowledge could be used to inform personalized gameful e-commerce systems. Similarly, there is literature investigating the types of healthy activities more suited to each person, or the differences between individual learning preferences and distinct learning activities that would be more effective for each person. Gameful systems can take advantage of this knowledge to recommend tailored activities according to predicted user preferences instead of suggesting the same activities to all users.

Game elements: As we reviewed in Chapter 2, there is evidence that users tend to enjoy some game elements more than others and that it is possible to assess these preferences with a user type survey (see Sections 2.2, 2.3.3, and 2.3.4). Thus, a gameful system could select different types of gaming activities to satisfy the user's preferences. For example, after the system identified that the user might enjoy carrying out a particular exercise type (e.g., walking, running, or hiking), or a particular learning activity (e.g., watching a video or taking a quiz), it might combine them with a particular type of gaming activity that the user would be likely to enjoy, such as solving a challenge, completing a quest, competing with others, collaborating with others, or exploring different ways of completing a task.

Persuasive strategies: In persuasive gameful systems, the persuasive strategies used to communicate with the user can be tailored (see Section 2.3.2). For example, using Cialdini's strategies [56], if the system finds out the user is more susceptible to scarcity, it can suggest limited opportunities to complete a task; if the user seems more susceptible to authority, the system can show expert comments for each activity; and if the user is more susceptible to consensus, the system may show that a large quantity of people are already carrying out an activity.

Rewards: As we reviewed in Section 2.3.4.2, there are taxonomies of rewards in games and gamification, which identified the different types of rewards, how they might be related to different user preferences, and what effects they might afford when earned by the user. For example, referring to Phillips's taxonomy [276,277], rewards of facility or sustenance could be offered to users who are struggling to move forward in their journey to decrease the difficulties they are facing; rewards of glory could be given to users who seek achievement or recognition, so they can feel competent for their accomplishments; rewards of praise are useful to encourage users to keep engaged and interacting with the systems; and rewards of access could be given to users who have completed the existing challenges and are interested in tackling different objectives or exploring new types of activities.

Difficulty: We noted in Section 2.3.3 that dynamic difficulty adjustment is a common practice in commercial games, which has also been often studied. However, this practice has not been thoroughly explored in gamification, although Marczewski [207] briefly talked about balancing difficulty between users in gamified systems and other authors have even more briefly touched the topic of difficulty balance. For example, according to Marczewski [207], gameful systems can be balanced by dividing the users so competition only occurs between users with similar skill levels, handicapping or powering up scores so users with different skills have similar chances of winning, working with levels so the increase in difficulty is gradual, or normalizing scores between teams of different sizes. Another approach, which is more similar to difficulty adjustment in games, is to directly adapt the difficulty of the tasks in the gameful system according to the measured skill of the user. According to our research [327], difficulty adjustment in gameful systems is also supported by goal-setting theory [188,189], which demonstrated that difficult goals tend to increase performance, but just as long as the goal is still perceived as achievable. If the user feels that they are not skilled enough to achieve the goal, they might actually be demotivated.

Looking at the types of adaptations that can be made in games proposed by Bakkes et al. [21] (see also Section 2.3.3), there are still some types that do not fit any of the above, such as space, character, narrative, music, or sound. However, these types of adaptations have been less studied in gamification until now and it is not clear how beneficial they would be to help in achieving the goals of gameful applications. Thus, we have not included them in the list above and we have not considered them for personalized gamification in the current work.

After considering the types of potential adaptations for gameful systems listed above, we have decided to focus this thesis on the personalization of gameful design elements. The principal reason for this choice is that gameful design elements are generally the main factor involved in the affordance of gameful experiences and motivation in gameful systems (see Sections 2.1.1–2.1.3). Moreover, a method for personalization of gameful design elements seems to be what is most needed by the gamification research and practice communities. In comparison, it is not possible to devise a generic method for the personalization of any target activity in gameful systems because, as stated above, gamification is applied to different domain areas. Thus, the designers need to take advantage of the available knowledge of the domain to personalize the activities. For example, the designer of a gameful e-commerce platform needs to understand the knowledge from marketing research to personalize the buying or selling activities, the designer of a gameful system for learning needs to use the knowledge from research on education, and the designer of a health-related gameful system needs to refer to health research to understand which activities are more adequate for each user. On the other hand, research on the personalization of persuasive strategies is already under way in the field of persuasive technologies and can be adapted to persuasive gameful systems.

Frameworks for personalized reward systems and difficulty adjustment in gamification are also important. However, rewards and difficulty adjustment are more limited than the selection of different game design elements because they modify the user experience on specific points, whereas modifying the game elements that the user interacts with can potentially change the experience in a very significant way. Therefore, we consider that the personalization of gameful design elements can potentially lead to the highest impact on user experience, whereas personalizing the rewards and the difficulty can also potentially lead to UX improvements, but in a more limited scale. Thus, we have decided to focus on the personalization of gameful design elements.

3.2 The Steps for Personalized Gameful Design

A gameful interactive system can be personalized at design time or at run time. If the user population is known in advance (for example, the gameful system will be used by a class of students, so the user population is limited to the class list), then the system can be designed specifically for them and include only the gameful design elements that they are likely to enjoy. On the other hand, if the users are not known in advance, then personalization must happen dynamically at run time. Thus, the gameful design elements will be tailored for each user during their interaction with the system. But for this to happen, the system must be designed for personalization. This means that its design must include different types of gameful design elements that can be appealing to different types of users. In addition, it must include features for system- or user-initiated personalization. These features should allow the system to enable the elements that are most appropriate for a user, while disabling those elements that are less appropriate.

To design systems with these features, we define three steps for personalized gameful design (see Figure 3-1): (1) classification of user preferences, (2) classification and selection of gameful design elements, and (2) heuristic evaluation of the design.

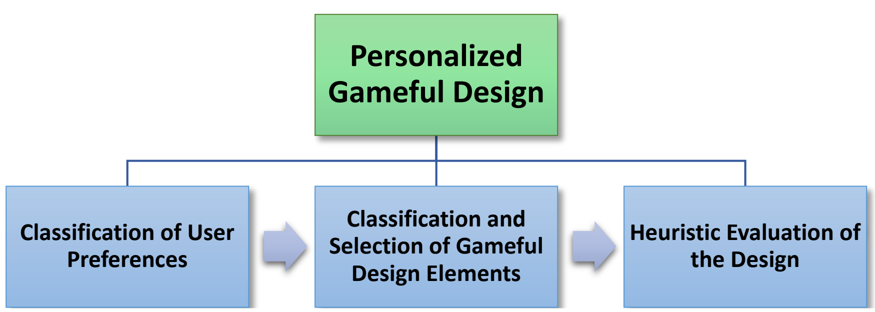


Figure 3-1. The Method for Personalized Gameful Design.

This section describes these steps and the next section explains and exemplifies how they can be integrated into complete gameful design methods. Moreover, the next chapters provide details about how the knowledge for each one of the steps was produced.

3.2.1. Classification of User Preferences

To personalize the user experience, the system needs to keep a user profile with knowledge that can be used to discover the kind of gameful experiences that they are more likely to enjoy. There are several models in the literature that could be used to classify user preferences, such as personality traits, age, gender, and user types (see Section 2.3.4.1). Age and gender data might already be available for the system or might be easy to collect. Additionally, the Gamification User Types Hexad (see Section 2.2.2) was created with the aim of covering a broad range of gameful systems and was already being used by practitioners around the world. Thus, we considered it to be potentially suitable for personalization of gameful systems and thus warranted further research.

Therefore, the personalized gameful system must be able to discover the Hexad user type scores for each user and store this data into the user's profile, so it can be later used to select the appropriate gameful design elements for the user. This can be done either explicitly or implicitly.

Currently, the most well-developed method of scoring an individual in the Hexad user types is explicitly, using the Gamification User Types Hexad Scale (see Section 2.2.2.1). Nevertheless, when I started my Ph.D. research, the Hexad framework was not validated yet, and a standard assessment scale was not available. But the assessment scale was soon developed by researchers from the Austrian Institute of Technology [79] and we collaborated with them to perform an initial validation [329] (see also Section 2.2.2.1). However, a validation of the scale with a larger sample was still needed. Therefore, as part of the development of this thesis, we conducted three studies to validate the proposed scale with a larger participant sample. The details are presented in Chapter 4 and the final version of the scale that can be used for personalization is available in Table 4-24.

As we mentioned before, if the user population is known in advance, the system can be designed specifically for those users. Therefore, they can be asked to fill out the scale before the design process starts. This way, the designer would already have data about the users' Hexad scores to inform the design process. On the other hand, if the users are not known in advance, the scale can be integrated into the design of the system, as part of the registration or onboarding process. Thus, the system should be designed to save each user's Hexad scores into the database. These scores can then be used to select the gameful design elements during the system's execution.

Nevertheless, asking users to fill out the Hexad scale can be an intrusive and long task, particularly if it is part of the registration or onboarding. Thus, implicitly generating the user type scores would be a more practical and less intrusive approach for the user. To achieve this, the system would need to observe the user's interactions with the system and from the data, infer the user's type scores. But despite being theoretically possible, this approach was not developed or tested yet to the best of our knowledge. Therefore, it remains as a possibility that has yet to be explored in future work. Moreover, although this approach is more practical for the user, its disadvantage is that the system needs to log enough of the user's interactions to infer their user type scores and begin selecting gameful design elements. How long that would take is currently unknown as no concrete method for achieving this exists yet. Meanwhile, the user experience would begin without personalization, which would be improved the more data the system can collect about the user with time.

If the data about the user's personality traits can also be known by the system, it can also be used for personalization. Similar to the Hexad user types scores, personality trait scores can be obtained explicitly by asking users to fill out one of the available scales (see Section 2.1.4.2) or implicitly by logging their activity and trying to infer their personality. However, also similar to the user types, automatic inference of personality traits by analysing user behaviour is theoretically possible and is a topic under study by the research community, but some more time is needed until robust methods are developed. Additionally, users might consider personality traits profiling even more invasive than user types profiling. The Gamification User Types Hexad only gives information about how a user interacts with gameful systems, which might be a type of personal information that users might be willing to give out to have the system personalized for them. On the other hand, information about personality traits may allow the provider of the system to make several other assumptions about one's behaviour and preferences. Therefore, we expect that some users might be more cautious before giving away information about their personality. That is one more argument in favour of using user types over personality traits for personalization, although both types of data can be combined and used together if they are available.

3.2.2. Classification and Selection of Gameful Design Elements

The selection of the gameful design elements more appropriate for each user is the core step for personalized gameful design. The adequate tailoring of the elements to the preferences of each user can potentially lead to more enjoyable gameful experiences. By extension, it can be expected that the utilitarian outcomes of the gameful system will also be improved as the gameful experience is improved, since the gameful experience is the mediator for the psychological and behavioural outcomes that are expected from gameful systems (see Sections 2.1.1–2.1.3).

To select gameful design elements for each Hexad user type, Marczewski [199] provided a list that suggests relationships between elements and user types, which was partially validated in our initial study of the Hexad scale [329] (see also Section 2.2.2 and particularly Table 2-4). However, to provide more practical design guidance, we judged it would be better if the gameful design elements were classified and grouped according to user preferences. With this information, designers might be able to better combine elements from the same group to create engaging experiences and relate them with the Hexad user types to afford personalization.

Therefore, we conducted a study to classify gameful design elements according to user preferences, which we describe in detail in Chapter 5. In summary, the results from our study suggest the following categories of gameful design elements and the following relationship with

Hexad user types, personality traits, gender, and age, as shown in Table 3-1 (see also Table 5-1 in Chapter 5 for the description of each gameful design element mentioned here).

Table 3-1. Groups of gameful design elements and their relationship to Hexad user types, gender, and age.

Groups	Elements	Preferred by
INDIVIDUAL MOTIVATIONS This category represents the user's interest in their own experience within the system. Elements in this category had the highest preference scores overall, showing that they might be important motivators to everyone, even though their enjoyable is even higher for some people.		
Immersion	Mystery box Easter eggs Theme Narrative or Story	Women Achievers and Free Spirits
Progression	Levels or progression Meaning or purpose Progress feedback Learning	Achievers and Philanthropists (only slightly)
EXTERNAL MOTIVATIONS This category represents the user's interest in earning external incentives and tailoring the system to them.		
Risk/Reward	Access Lotteries or games of chance Boss battles Challenges	Younger people Achievers Players
Customization	Avatars Customization Points Virtual economy	Younger people Women People who are more open to experiences
Incentive	Badges or certificates Certificates Collections Rewards or prizes Unlockable or rare content Quests	Younger people Players People who score higher on neuroticism
SOCIAL MOTIVATIONS This category represents the user's interest in relatedness and social interactions.		
Socialization	Social comparison or pressure Leaderboards Social competition Social networks Social status Guilds or teams Friend invite Social discovery Trading Scarlet letter	Men Socialisers Extroverts

Assistance	Glowing choice Beginner's luck Signposting Anchor juxtaposition Power-ups or boosters Humanity Hero Personalization Free lunch	Women Extroverts
Altruism	Knowledge sharing Gifting Innovation platforms Development tools Administrative roles Voting mechanisms Exploratory tasks Creativity tools Meaningful choices	Younger people Men Philanthropists and Socialisers

If the Hexad user type scores, age, and gender (and personality traits, if the information was also collected) of the users are known before the design process, then the design can be oriented to the target users. This means that the groups of gameful design elements preferred by the users should receive the focus during the design phase, with the other groups of elements used only as secondary affordances.

For example, if the target users are younger people, with average high scores in the Player and Achiever user types, the system's design should be focused on elements of Risk/Reward (e.g., access, lotteries, boss battlers, challenges) and/or Incentive (e.g., badges, certificates, collections, rewards). On the other hand, if the user population is more composed of women, Immersion elements (e.g., mystery boxes, Easter eggs, theme, story) should be the focus of the experience if they also average high scores in the Achiever and Free Spirit user types, but Customization elements (e.g., avatars, points, virtual economy) should be the focus if instead their personality is more open to experiences.

On the other hand, if the user profiles are not known before the design, then the system must incorporate several different types of experiences, which can be tailored to each user during the system's execution. In this case, we suggest that designers should look at the different groups of gameful design elements and try to incorporate a few elements from each group into their system. This will ensure that the system will have enough types of elements to be later tailored to each user, as it is impossible to offer tailored experiences if the elements are not present in the system. The system should also be designed with some flexibility in mind to allow for personalization. This means that the system must be designed in a way that the user should not be required to interact with all incorporated gameful design elements to achieve their goals. Instead, the system should be able to activate or deactivate the functionality of each gameful design element based on the user profile to afford personalized experiences.

After being designed with a few gameful design elements from all the groups presented in Table 3-1 (e.g., at least two or three elements from each group) and after incorporating a mechanism to collect data or infer the user's Hexad type scores like we explained in the previous section, the system will then be able to select the elements to activate or deactivate to personalize the user experience. This selection can be implemented as a user customization (user-initiated personalization) or as a (semi-)automatic adaptation (system-initiated personalization). Although the processes of customization or adaptation happen at run time, they must be planned and included into the system as part of its design. Therefore, we also describe them here to guide designers into including these features as part of the design of their gameful systems.

3.2.2.1. Customization (user-initiated personalization)

To enable customization, the system should present a list of gameful design elements and let the user select the elements that they wish to use. If the user is just asked to freely choose between the elements without any further assistance from the system, this approach is similar to Lessel et al.'s Bottom-up Gamification [181–183] (see also Section 2.3.4.3). Nevertheless, the system can also help the user by employing the data from Table 3-1 to suggest which elements they are more likely to enjoy. This might help avoid an issue of information overload, or in other words, avoid offering so many choices that we user may feel overloaded and might find it difficult to make a selection. If the system has knowledge about the user's type, gender, and age, and can thus decide which game design elements to suggest, those options can be highlighted in the user interface. Therefore, if the user does not wish to spend time to understand all the options to make a selection, they can more quickly just accept the system's suggestion, which has a good probability of affording an engaging, personalized experience.

3.2.2.2. Automatic or semi-automatic adaptation (system-initiated personalization)

In this approach, the system would take the initiative of selecting the gameful design elements for each user, based on their profile and the data from Table 3-1. If the personalization is fully automatic, then the system would enable the selected gameful design elements and disable those that were not selected without any intervention from the user. This way, the user might not even realize that the adaptation happened. This is the approach that requires less effort from the user; however, if the selection algorithm did not select the most optimal experience for the user, the downside is that the user will not be able to manually adjust the selection. Therefore, a semi-automatic mechanism might be more successful in affording an optimal experience. In this case, the system would pre-select the elements, but display the selection for a final adjustment by the user before applying the changes. Alternatively, the system could also make the adjustment automatically, but offer a user interface where the user can make manual adjustments if they are not totally satisfied with the experience.

Semi-automatic adaptation is similar to customization with suggestions from the system, but there is a subtle difference. In semi-automatic adaptation, the system will initiate personalization even if the user has not requested it and will pre-select the elements that will be used, while still allowing the user to make adjustments. In contrast, customization only happens if it is initiated by the user. Additionally, even if the system offers suggestions for customization, it does not pre-select any element, and the suggestions are only applied if the user explicitly accepts them. The inclusion of one or other mechanism into the system is a design decision.

To accomplish the dynamic selection of gameful design elements, the knowledge from Table 3-1 can be implemented into the system as a set of conditions (e.g., if the user's gender is female and their Achiever of Free Spirit scores are high, then Immersion elements will be suggested, and so on). Alternatively, a recommender system could be implemented to make the selection.

3.2.2.3. Recommender Systems for Personalized Gamification

At the present, there are still no implementations of recommender systems that could be used to operationalize personalized gamification. Thus, to advance future research for building recommender systems for personalized gamification, we propose a general framework that researchers can use to design these systems. We centre this framework on the core elements of a recommender system: inputs, outputs, and process. Figure 3-2 shows how each of these elements contribute to the recommendation process.

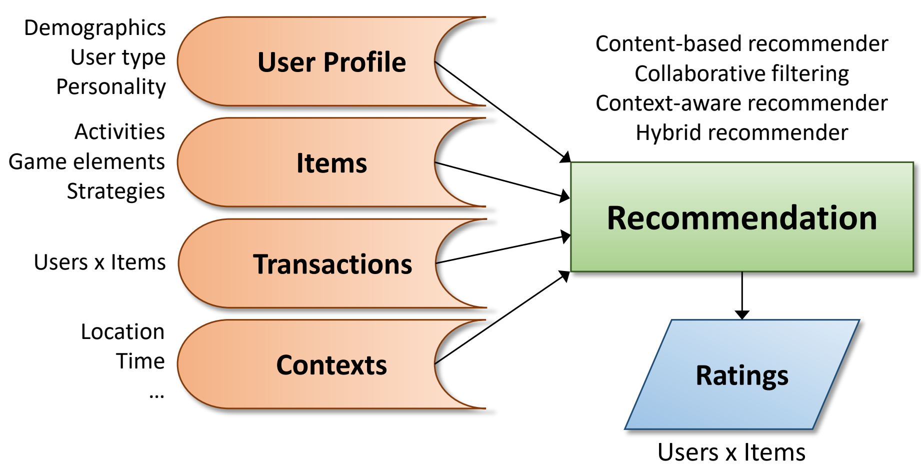


Figure 3-2. Inputs and outputs of the recommendation.

Inputs are the *items* to be rated and recommended by the system, the *user* profiles, the *transactions* between items and users that will be logged and analyzed, and the different types of *context* in which the recommendations can occur. As explained above, the main type of items to be recommended by the system according to our framework is gameful design elements. In a more comprehensive implementation of a recommender system, activities, persuasive strategies, reward types, and difficulty levels could also be recommended. Also as explained above, the main type of information in the user profile is their Hexad user type scores, together with their gender, age, and their personality trait scores if available. The transactions will be the activities actually performed by the user. Each time the user performs an activity, the recommender system can take the opportunity to record the user's rating for that particular activity, game element, persuasive strategy, reward type, difficulty, or combination of them. These ratings can be collected implicitly (i.e., by assuming that the user carrying out an activity indicates they enjoy it, thus increasing the implicit rating for that activity and game element) or explicitly, by asking the user to rate the activity after its completion. It is also possible to use frequency of visit or click at a particular feature or element, or the time spend on a task or using a particular element, to determine the user's preference. Finally, the different types of context that need to be considered by the recommender system depend on the domain. Thus, it is also possible to learn from knowledge already documented in each specific domain to inform the recommender system. For example, in a health or fitness application, the season, time, or location might limit the kind of activities that the user can perform; or in an e-commerce application, the location or seasonal factors may also limit the availability or cost of some products.

Outputs are the ratings that the recommender system will predict. They correspond to the predicted likelihood that the user will enjoy each item not previously rated for that user. The complexity of a recommender system for gamification is that there might be up to five different types of items to analyze and recommend as stated above: activities, game elements, persuasive strategies, reward types, and difficulty levels. In the simpler approach, the recommender system would receive input data about transactions and ratings for each of these types of items and would attempt to predict new ratings for them separately. This approach would simplify the implementation; but it would defer the decision on how to combine these different types of items to another application component before making the recommendation to the user. Thus, the complexity is only being transferred to another subsystem, which might not have the capability to assess the user's preferences when performing the combinations. A more comprehensive approach would be to have the recommender system receive ratings for each different item type separately, as well as for the specific combinations of items, then try to predict the ratings for complex combinations based on the input data. This approach would increase the complexity of the recommender system. However, it would enable the system to provide more accurate and useful recommendations because all the combinations will be rated according to the user preferences analyzed from the input data.

Processes are the *recommendation methods* of the system. The choice of the recommendation method to use will depend on the application domain and the resources available.

- *Content-based recommender*: A content-based recommender can take advantage of knowledge from the application domain, if available, based on the user profile and information about the items, as well as the information from Table 3-1. The advantage of this approach is that it does not suffer from the problems of cold start or lack of coverage. However, it depends on having enough information about the user's type and the game elements themselves. Thus, this approach might not work if the user is not willing to fill out the user types survey.
- *Collaborative filtering* can overcome the lack of knowledge about the user or the game elements necessary to build a content-based recommender. It only depends on the ratings collected explicitly or implicitly from user transactions. Yet, collaborative filtering suffers from cold start and coverage problems, meaning that the system cannot make

recommendations for new users or items because at that moment they will have no ratings to base the recommendation on. Thus, a recommender algorithm will be less likely to provide good recommendations for new users or new items without enough initial ratings.

- *Context-aware recommender*: Contextual information allows the system to filter the recommended items within limitations of an application domain. The decision to use a context-aware recommender will depend on the application domain and the existing knowledge about contextual information. For example, in a learning system, proximity to the date of a scheduled exam could constitute a kind of contextual information that may be used to adapt the personalized gameful design elements. As the exam date approaches, the system could activate elements to motivate the user to prepare for the exam, such as challenges that invite the student to review specific material. This approach could be used together with either a content-based or a collaborative recommender system.
- *Hybrid recommender*: A hybrid recommender could take advantage of the best characteristics of each of the above methods. For example, a content-based recommendation algorithm can be used to provide initial recommendations based on theoretical and empirical models while a transaction history is not yet available to feed a collaborative filter. After that, the collaborative filtering algorithm might be used to improve or completely replace the content-based recommendations. Contextual information can further be used to improve or filter the recommendations based on the limitations of the application domain.

3.2.3. Heuristic Evaluation of the Design

After a gameful system has been designed following the instructions detailed in the previous section together with a gameful design method, it needs to be iteratively evaluated and improved until the user experience is adequate and the users are achieving the instrumental goals intended by the system. While most gameful design methods suggest a phase or step where a prototype is implemented for playtesting, an initial evaluation of the design ideas or prototype by a quality control team might be a good alternative. A useful type of methodology to achieve this is heuristic evaluation (see Section 2.4). Heuristic evaluation can be quickly carried out by three to five HCI, UX, or gamification experts, if we follow the same guidelines employed for usability evaluation [240,244,245]. This can be done even before implementing a prototype, and it can help identify the most obvious issues with the system with a lower cost than playtesting. A heuristic evaluation will not eliminate the need for playtesting, but if it can help the team find and eliminate some of the issues before playtesting, the cost and time to deliver the solution might be greatly reduced.

As we reviewed in Section 2.4, several heuristic models are available for usability and games. However, a specific method was not available for gameful design. Therefore, we developed the Gameful Design Heuristics, which consists of 28 heuristics organized in 12 motivational dimensions. By using our heuristics to evaluate a gameful system's design, the team can have a good idea if the design includes affordances for all the different categories of motivations or if some of them are missing. As we mentioned in the previous section, a specific type of motivation cannot be selected in a personalized gameful system to appeal to specific user preferences if it is not present in the design. Thus, using the heuristics is important to identify any omission that can be solved during the design phase.

Chapter 6 presents the development of the Gameful Design Heuristics and the instructions to use them. Furthermore, Appendix A presents the full set of heuristics, together with the guiding questions that can help designers conduct the heuristic evaluation for any gameful system.

3.3 Integrating Personalization into Other Gameful Design Methods

Our goal is not to replace existing gameful design methods, but to specify a set of steps that can be integrated into existing methods to augment them with personalization. In this section, we exemplify how this can be done for some of the design methods reviewed in Section 2.1.6.

3.3.1. Six Steps to Gamification

The Six Steps to Gamification process [338,339] already contains its own steps where the steps described in the previous section can be introduced. The classification of user preferences can be integrated into step 3 ("describe the players"). The classification and selection of gameful design elements can be integrated into step 4 ("devise activity cycles"). And finally, the heuristic evaluation can be integrated into step 5 ("don't forget the fun"). Therefore, the Six Steps to Gamification augmented with personalization would look like this:

1. **Define the business objectives**: unchanged from the original method;
2. **Delineate target behaviours**: unchanged from the original method;
3. **Describe the players**: the players should be described based on their Hexad user types, gender, and age, as well as personality traits if possible;
4. **Devise activity cycles**: while designing the engagement loops and progression stairs, the designer must consider our proposed framework to select the gameful design elements that will be more engaging according to the characteristics of the players;
5. **Don't forget the fun**: in addition to the other processes that would already be used to test the design, the Gameful Design Heuristics can also be employed at this stage to check for any issues regarding motivational design;
6. **Deploy the appropriate tools**: again, the framework for selection of gameful design elements would be used in this step to select personalized elements. If dynamic mechanisms are necessary (for user- or system-initiated personalization during execution), these need to be implemented into the system during this step.

3.3.2. Marczewski's Gamification Framework

Marczewski's Gamification Framework [200,205] is one of the gameful design methods that already considers the Hexad user types as part of the design process. In fact, the Hexad user types were developed by Marczewski together with the other parts of the framework. In addition, Marczewski also collaborated with the team that developed the Hexad scale and with our team when we conducted the large-scale validation studies of the scale (see Chapter 4). Therefore, the Hexad scale is also already incorporated into his Gamification Framework. Nonetheless, the classification and selection of gameful design elements that we proposed can be integrated into the "Design/Build" phase of Marczewski's framework, as well as the heuristic evaluation. The framework augmented with the new processes would look like this:

1. **Define**: unchanged from the original method;
2. **Design/Build**: the Hexad user types are already included in the framework as part of this phase. Additionally, the classification of gameful design elements introduced in the previous section is used to help the designer choose the gameful design elements more appropriate for each user and the Gameful Design Heuristics are used to evaluate and improve the design;
3. **Refine**: since this phase involves a repetition of the processes from the design/build, with the goal of iteratively improving the product, all the personalized design processes will also be used here to help select new gameful design elements and evaluate the new designs.

3.3.3. The Lens of Intrinsic Skill Atoms

The Lens of Intrinsic Skill Atoms [75] also already contains its own steps where the personalized gameful design steps can be integrated. The classification of user preferences can be integrated into step 2 (research) and step 3 (synthesis). The classification and selection of gameful design elements can be integrated into step 4 (ideation). Finally, the heuristic evaluation can be carried out within step 5 (iterative prototyping). The Lens of Intrinsic Skill Atoms augmented with personalized gameful design looks like this:

1. **Strategy**: unchanged from the original method;
2. **Research**: while modeling the characteristics, needs, and motivations of the users, the UX researchers should also seek to map the user types, gender, and age of the potential users.
3. **Synthesis**: when identifying the skill atoms composed of activity, challenge, and motivation, the designers should consider the motivations of different users, according to their user types. Therefore, different skill atom triplets might be identified for different user segments;
4. **Ideation**: the brainstorming, prioritization, and selection of gameful design elements should consider the classification that we presented in our framework. Therefore, different gameful design elements should be selected for different user segments;
5. **Iterative Prototyping**: before playtesting with users, the design can be evaluated using our Gameful Design Heuristics.

3.3.4. Actionable Gamification – Octalysis Framework

The Octalysis Framework [53] is another gameful design method that already considers personalization to some extent. This is achieved in the third level of the framework, when player or user type models are employed to consider different user motivations and journeys. However, guidance on how to adapt the design to different user types is scarce in the literature, with additional training being provided only in specific courses and to members of the Octalysis Prime community[2]. Therefore, our classification of gameful design elements can be further integrated into the method, after the user journey and motivations are analyzed and classified using the Hexad user types, to help the designer select the best gameful design elements for each user type. Moreover, the Gameful Design Heuristics can be used after the design is completed or after a first prototype is built to evaluate it and suggest improvements before beginning to playtest the product. Therefore, the Octalysis strategy dashboard looks like this after being augmented with our steps for personalized gameful design:

1. **Business metrics**: unchanged from the original method;
2. **Users**: the user journey and motivations should be classified based on the Hexad user types;
3. **Desired actions**: the classification of gameful design elements can be used to select specific elements to create actions personalized to each user type;
4. **Feedback mechanics**: the classification of gameful design elements can also be used to select specific feedback mechanics for each user type;
5. **Incentives**: our framework does not provide direct guidance to personalize the incentives to different user types. However, we note that one of the existing reward taxonomies (see Section 2.3.4.2) can be used to aid the designer choose personalized incentives.

3.3.5. How to gamify

The gamification process by Morschheuser et al. [230] is another method that does not originally incorporates personalized design, but already includes steps where the personalization steps can be introduced. The classification of user preferences can be incorporated into step 2 (analysis). The classification and selection of gameful design elements can be incorporated into step 3 (ideation). And the heuristic evaluation can be carried out as part of step 4 (design of prototypes). The Gamify process augmented with personalized gameful design looks like this:

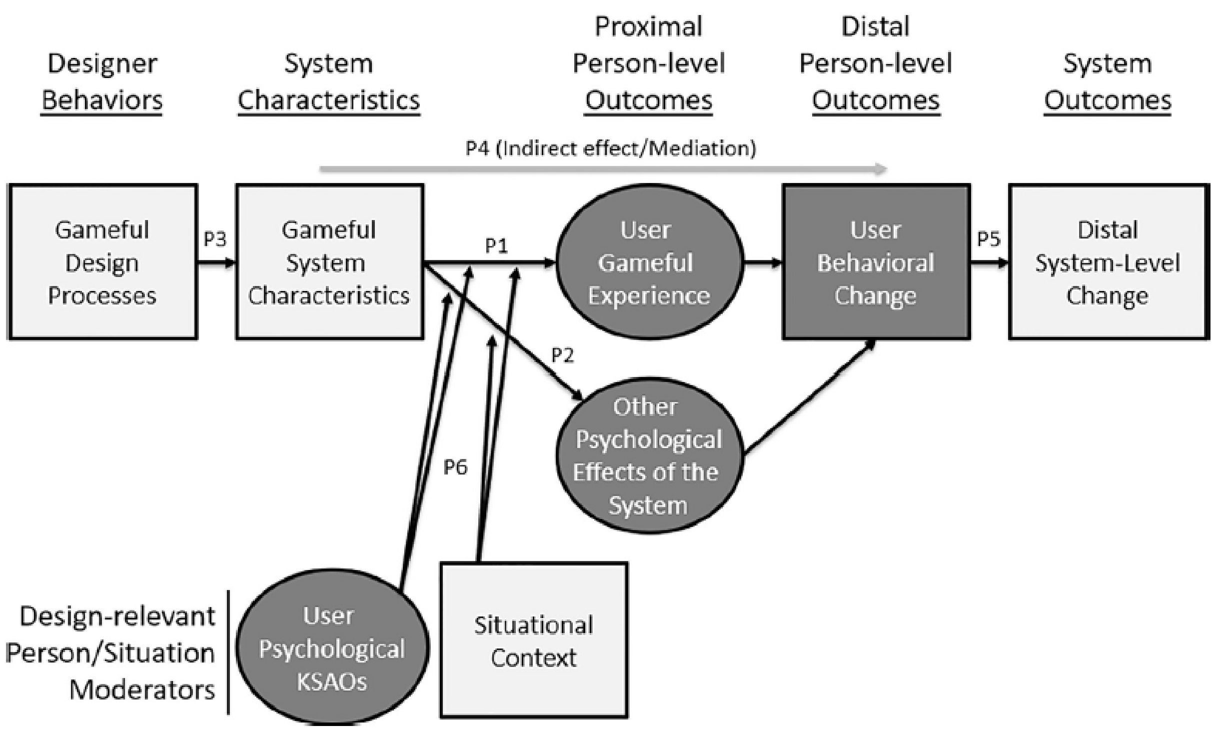
1. **Project preparation**: unchanged from the original method;
2. **Analysis**: while studying the target users, it is important to consider their different preferences based on user types, gender, and age;
3. **Ideation**: during the iterative brainstorming activities and the consolidation of ideas, the classification and selection of gameful design elements that we proposed should be applied;
4. **Design of prototypes**: before playtesting with real users, the Gameful Design Heuristics can be used for an initial evaluation and improvement of the prototypes;

[2] https://octalysisprime.com

5. **Implementation**: if dynamic personalization features should be incorporated into the system (for user- of system-initiated personalization), they must now be implemented;
6. **Evaluation**: unchanged from the original method;
7. **Monitoring**: when the system is iteratively improved over time the selection of gameful design elements and the heuristic evaluation can also be used again.

3.4 Benefits of Personalized Gameful Systems

To understand the potential benefits of personalized gameful systems, it is useful to consider the theory of gameful systems and experiences proposed by Landers et al. [179] and depicted in Figure 3-3.



Notes. Shapes containing black text and light grey background represent system-level characteristics; shapes containing white text and dark grey backgrounds represent person-level observations or constructs. Rectangles indicate observable characteristics; ovals indicate unobservable constructs. Lines pointing from shapes to other shapes indicate causal direct effects of one variable on another; lines pointing from shapes to other lines indicate causal moderation. "P#" indicates a theoretical proposition as numbered in text; the numbers themselves have no additional meaning.

Figure 3-3. A theoretical model of gameful experiences. [179]

According to this theory, the characteristics of a gameful system afford a gameful experience (P1) and other psychological effects (P2) for the user. The system is imbued with these gameful characteristics through a gameful design process (P3). Mediated by the gameful experience and other psychological effects, the interaction of the user with the gameful system leads to behavioural changes (P4). In turn, these behavioural changes lead to distal system-level outcomes (P5). Moreover, the gameful experience and other psychological effects afforded by the system are moderated by the psychological characteristics of the user (such as knowledge, skills, abilities, and other characteristics) and the situational context (P6).

Considering this theory, a personalized gameful design method is a process that imbues a system with characteristics that afford gameful experiences (P3). However, in contrast with other general design methods, personalized gameful design also takes into consideration how the characteristics of the user affect the gameful experience (P6). Therefore, the goal of personalized design is to promote a better gameful experience by improving the moderating effect of the psychological characteristics of the user, which is achieved by designing the system in a way that it can be tailored to different users. Then, according to P4, a better gameful experience should mediate better distal person-level outcomes (behavioural changes), which in turn will lead to better distal system-level outcomes (P5).

The types of person-level and system-level outcomes of gameful systems vary greatly according to the application domain. For example, in a gameful learning system, the person-level behaviour changes resulting from gameful experiences could be learners studying a larger portion of the course material, completing more learning tasks, interacting with additional learning materials, among others. Mora et al. [226,228] described an example of how personalization can affect the behavioural and emotional outcomes of a gameful learning system more than a generic version. In turn, these behavioural outcomes can lead to broader system-level outcomes, such as improved average course grades or learning rates. In the domain of health, Orji et al. [268] showed that personalized systems can better persuade users to adopt safer drinking behaviours (person-level outcomes), which can potentially lead to broad public health improvements (system-level outcomes). Similarly, personalized gameful systems can be more effective in promoting person- and system-level outcomes in a variety of other application domains.

3.5 Conclusion

In this chapter, we introduced a method with three steps to personalize the design of gameful interactive systems: classification of user preferences, classification and selection of gameful design elements, and heuristic evaluation of the design. Moreover, we showed how these steps can be integrated into existing gameful design methods. A similar procedure can be employed to also integrate this method into any other gameful design method that we did not explicitly mention.

Gamification researchers and practitioners have often mentioned the importance of considering the users and personalizing the design, but so far, they only had vague references about how to adapt the design for each user. Our process presents clear guidelines and specific categories of gameful design elements that are more likely to be enjoyable by each type of user. Therefore, designers will now be able to effectively build personalized gameful systems.

In the next three chapters, we provide more details about the scientific development of each one of the three steps that we briefly described in this chapter. Then, in Chapter 7, we describe an example of the application of this method to design and implement a platform for the study of personalized gamification.

Chapter 4 Evaluation of the Gamification User Types Hexad Scale

To evaluate the Gamification User Types Hexad Scale, we conducted three large-scale empirical validation studies. The first study used data from our online survey of 556 participants and interrogated about personalized gameful design. The second study also collected data via an online survey, in which we distributed a tool that allowed individuals to find out their own Hexad user types scores. This study analyzed data from 1,328 participants. Using data from both studies, we investigated the reliability and internal consistency of the scale in both English and Spanish. The results demonstrate the scale's structural validity in both languages. However, there remains scope for improving a few subscales. Therefore, we conducted a third study with 152 participants with the goal of investigating potential improvements to the Achiever and Free Spirit subscales that could solve some of the issues identified in the first two studies. Additionally, we present an account of the user types distribution in the sample and demonstrate that gender and age are correlated to the participant's user types scores.

The three studies presented here repeated the validation techniques employed by Tondello et al. [329] (internal reliability analysis and factor analysis) using the same 24-item Hexad User Types Scale (see Section 2.2.2.1 for details), but with larger and broader datasets, in addition to also carrying out a confirmatory factor analysis. Therefore, we provide empirical evidence that increases our confidence in the structural validity of the scale as a protocol to measure an individual's relatedness to each one of the six user types. In the following sections, we first present the results of each study and then discuss them all together.

4.1 First Study

In the first study, we analyzed data collected during September and October 2016 from an online survey on personalized gamification.

4.1.1. Procedure

The survey was deployed as an online instrument using the LimeSurvey software (LimeSurvey, 2016). Participants were asked to complete a 15-minute survey composed of questions focused on their preferences while using digital gameful applications. The survey consisted of five sections with a total of 67 questions grouped as follows: demographics (age, gender, country, and native language), gaming habits, Hexad user types, examples of games participants enjoy, and participant's experiences with different game design elements. The Hexad user types section employed the 24 items suggested by Tondello et al. [329], with the corresponding translations to the additional languages available in the survey (see Table 4-1).

The survey could be completed anonymously and allowed participants to skip any of the proposed questions or abandon the survey at any time. Prior to the decision to participate, participants were presented with an online informed consent form. In appreciation of the effort and time invested by respondents, they could participate in a draw, which only required the submission of a valid e-mail address after completion of the survey.

The survey could be completed by participants in English, Spanish, Catalan, or Portuguese. Two independent native speakers separately translated all the statements and descriptions into each language from the original version (which was in English for the Hexad user types survey; in Spanish for the remainder of the survey). Finally, each translated version was compared and assessed by an independent third native speaker during the design cycle before the survey activation in a continuous and discursive improvement process.

Table 4-1. The Gamification User Types Scale used in the study.

User Types	#	English Items	Spanish Items
Philanthropist	**P1**	It makes me happy if I am able to help others.	Me hace feliz ser capaz de ayudar a los demás.
	P2	I like helping others to orient themselves in new situations.	Me gusta guiar a los demás en las situaciones nuevas.
	P3	I like sharing my knowledge.	Me gusta compartir mi conocimiento con los demás.
	P4	The wellbeing of others is important to me.	El bienestar de los demás es importante para mí.
Socialiser	**S1**	Interacting with others is important to me.	Interactuar con los demás es importante para mí.
	S2	I like being part of a team.	Me gusta formar parte de un equipo.
	S3	It is important to me to feel like I am part of a community.	Sentir que formo parte de una comunidad es importante para mí.
	S4	I enjoy group activities.	Disfruto con las actividades grupales.
Free Spirit	**F1**	It is important to me to follow my own path.	Seguir mi propio camino es importante para mí.
	F2	I often let my curiosity guide me.	A menudo me dejo guiar por la curiosidad.
	F3	I like to try new things.	Me gusta probar cosas nuevas.
	F4	Being independent is important to me.	Ser independiente es importante para mí.
Achiever	**A1**	I like defeating obstacles.	Me gusta superar las dificultades.
	A2	It is important to me to always carry out my tasks completely.	Realizar siempre por completo mis tareas es importante para mí.
	A3	It is difficult for me to let go of a problem before I have found a solution.	Me resulta difícil abandonar un problema antes de encontrarle una solución.
	A4	I like mastering difficult tasks.	Me gusta dominar tareas difíciles.

Player	**R1**	I like competitions where a prize can be won.	Me gustan las competiciones en las que se pueda ganar un premio.
	R2	Rewards are a great way to motivate me.	Los premios son una buena manera de motivarme.
	R3	Return of investment is important to me.	Recuperar lo invertido es importante para mí.
	R4	If the reward is sufficient I will put in the effort.	Si el premio es adecuado, voy a hacer un esfuerzo.
Disruptor	**D1**	I like to provoke.	Me gusta provocar.
	D2	I like to question the status quo.	Me gusta cuestionar el estado de las cosas.
	D3	I see myself as a rebel.	Me describo a mí mismo como un rebelde.
	D4	I dislike following rules.	No me gusta seguir las reglas.

User Types	#	Catalan Items	Portuguese Items
Philanthropist	**P1**	Em fa feliç ser capaç d'ajudar els altres.	Sinto-me feliz se sou capaz de ajudar os outros.
	P2	M'agrada ajudar els altres a orientar-se en situacions noves.	Gosto de ajudar os outros a se orientarem em situações novas.
	P3	M'agrada compartir els meus coneixements amb els altres.	Gosto de compartilhar meu conhecimento com os outros.
	P4	El benestar dels altres és important per a mi.	O bem-estar dos demais é importante para mim.
Socialiser	**S1**	Interactuar amb els altres és important pera mi.	Interagir com os demais é importante para mim.
	S2	M'agrada ser part d'un equip.	Gosto de fazer parte de uma equipe.
	S3	És important per a mi sentir que sóc part d'una comunitat.	É importante para mim sentir que faço parte de uma comunidade.
	S4	M'agraden les activitats de grup.	Gosto de atividades em grupo.
Free Spirit	**F1**	És important per a mi poder seguir el meu propi camí.	É importante para mim seguir meu próprio caminho.
	F2	Sovint em deixo guiar per la meva curiositat.	Frequentemente deixo-me guiar pela curiosidade.
	F3	M'agrada provar coses noves.	Gosto de tentar coisas novas.
	F4	Ser independent és important per a mi.	Ser independente é importante para mim.
Achiever	**A1**	M'agrada haver de superar obstacles.	Gosto de superar obstáculos.
	A2	És important per a mi completar absolutament totes les meves tasques.	É importante para mim sempre realizar por completo minhas tarefas.
	A3	És difícil per a mi deixar de banda un problema abans que hi hagi trobat una solució.	É difícil para mim abandonar um problema antes de haver encontrado uma solução.
	A4	M'agrada arribar al domini de tasques difícils.	Gosto de dominar tarefas difíceis.

Player	**R1**	M'agraden les competicions on un premi està en joc.	Gosto de competições em que possa ganhar prêmios.
	R2	Les recompenses són una gran manera de motivar.	Recompensas são uma ótima forma de me motivar.
	R3	El retorn de la inversió és important per a mi.	Retorno de investimento é importante para mim.
	R4	Si la recompensa és suficient, hi posaré l'esforç.	Se a recompensa for suficiente, farei o esforço.
Disruptor	**D1**	M'agrada provocar.	Gosto de provocar.
	D2	M'agrada qüestionar l'estatus quo.	Gosto de questionar o status quo.
	D3	Em veig com un rebel.	Vejo-me como um rebelde.
	D4	No m'agraden regles.	Não gosto de seguir regras.

4.1.2. Participants

We recruited participants by e-mail (in both academic and non-academic environments), as well as via social networks (Facebook, LinkedIn, Twitter, and Reddit), game events (Barcelona World Games), and Learning Management Systems from the participating institutions (Universitat Oberta de Catalunya, Universidad de La Laguna, and University of Waterloo). The study was approved by the ethics committees of the participating institutions. Participants were required to be at least 18 years old to participate and were not offered direct remuneration, but they were offered an opportunity to enter a draw to win one of two € 50 prizes.

The total number of participants who answered the survey was 925. However, we discarded 257 participants who did not answer all the questions related to the Hexad user types survey, a necessary condition to allow accurate evaluation. Of the remaining 668 responses, the languages used to answer the survey were distributed as follows: Spanish (53.9%), English (29.3%), Catalan (11.4%), and Portuguese (5.4%). After looking at the language distribution, we concluded that we did not have a large enough sample to validate the Catalan and Portuguese translations of the scale. Therefore, we decided to discard these responses and validate only the English and Spanish versions.

Thus, the final dataset contained 556 responses: 360 in Spanish and 196 in English. The participants were 323 men, 224 women, and 9 did not inform. Participants' ages ranged from 18 to 65 years (M = 30.37, SD = 10.07) and were skewed towards younger participants (with 60% of participants under 30), possibly due to a dissemination focused on higher education institutions and the topic of the survey (gamification) being more appealing to a younger audience. The participants' native languages were distributed as follows: Spanish (62.4%), English (22.1%), and other (15.5%). Most participants answered the survey in their native language. The majority of participants whose native language was not available answered the survey in English. Participants were from 46 different countries, but with an irregular distribution, with a higher number of respondents from those countries where the survey was better advertised (see Table 4-2).

Table 4-2. Participant distribution per country of residence.

Country	Frequency	Percent
Argentina	19	3.4%
Canada	92	16.5%
China	8	1.4%
Colombia	14	2.5%
Germany	10	1.8%
Mexico	30	5.4%
Spain	281	50.5%
United Kingdom	9	1.6%
United States of America	21	3.8%
Venezuela	8	1.4%
Other (< 1% each)	62	11.3%
N/A	2	0.4%

4.1.3. Results

We analyzed the dataset by conducting the following procedures: internal reliability analysis, correlation between user types, and factor analysis. Because our aim was to assess the validity of the model, a confirmatory factor analysis (CFA) represented a more appropriate procedure than an exploratory factor analysis (EFA) [184]. However, this raised the issue of comparability, since Tondello et al. [329] have only reported an EFA. Therefore, to provide both a means of comparison with their prior work and a more reliable validity assessment, we conducted both an EFA and a CFA for this study. Additionally, we also provide a description of the user types' distribution and an analysis of the correlations of gender and age with the user types scores in this distribution.

4.1.3.1. Internal Reliability and Correlations

Table 4-3 presents the internal reliability analyses (Cronbach's α) for each subscale corresponding to each of the Hexad user types in the survey. We present both the overall scores (considering the whole sample) and the scores per survey language, to evaluate if the translations or cultural factors could have influenced the survey's reliability. Overall, the reliability scores are acceptable ($\alpha > .70$), except for those relating to the Free Spirit category in the English-language version of the survey, which are slightly below this level (.629).

Table 4-3. Internal reliability scores for each Hexad user type (overall and per language).

User Types	α (overall)	α (en)	α (sp)
Philanthropist	.799	.748	.814
Socialiser	.823	.825	.826
Free Spirit	.699	.629	.727
Achiever	.787	.730	.808
Player	.864	.843	.874
Disruptor	.759	.788	.746

Table 4-4 presents the bivariate correlation coefficients and significance levels between each Hexad type and all the others. We employed Kendall's τ instead of the more common Pearson's r because the user type scores were non-parametric. As in previous work, we found some partial overlapping between the user types, but some of the observed significant correlations differ from those previously reported by Tondello et al. [329].

Table 4-4. Bivariate correlation coefficients (Kendall's τ) and significance between each Hexad user type and all others.

User Type	Philanthropist	Socialiser	Free Spirit	Achiever	Player
Socialiser	.386 **				
Free Spirit	.304 **	.209 **			
Achiever	.208 **	.129 **	.281 **		
Player	-.045	.065 *	.030	.103 **	
Disruptor	.021	.020	.189 **	.084 **	.097 **

$^{*}p < .05$. $^{**}p < .01$.

4.1.3.2. Exploratory Factor Analysis

To enable a comparison with Tondello et al.'s results and to provide a richer set of evidences of the scale's structural validity, we first provide results from an exploratory factor analysis. The Kolmogorov–Smirnov test showed that the distributions of the Likert responses for all variables were significantly not normal, and several variables had skewness and/or kurtosis values above 1.0. Therefore, we followed the recommendation for conducting the factor analysis using polychoric correlations instead of the more traditional Pearson's correlations [231]. The correlation matrices were adequate for the analysis, with a KMO (Kaiser-Meyer-Olkin test) = .746 for the English sample and KMO = .844 for the Spanish sample; and Bartlett's test of sphericity was significant for both samples ($\chi^2_{(276)} = 1782.1$, p < .001 for the English sample; $\chi^2_{(276)} = 3771.9$, p < .001 for the Spanish sample). We used the software FACTOR 10.8.03 [191] employing the Unweighted Least Squares method for factor extraction and a normalized direct oblimin rotation (because we expected the factors to partly overlap). Since our intention was to validate the existing Hexad model, we forced an analysis with six factors.

We present the results separately for the English and Spanish scales in Table 4-5 and Table 4-6. In the EFA overall, the factor loads are higher for the combinations of item and factor that we were expecting, except for items P4, F2, and F3 in Spanish, which do not seem to be a good fit for the Philanthropist or Free Spirit factor as intended. Moreover, there is some partial overlapping between factors (represented by the items that score on more than one factor), which was expected since we found significant correlations between the user types. However, this demonstrates that the survey items might not be capable of uniquely measuring each user type. This overlapping was more prominent in the Spanish survey.

The Goodness of Fit Index (GFI) = .984 for the English sample and GFI = .993 for the Spanish sample. Moreover, the Root Mean Square of Residuals (RMSR) = .0404 for the English sample, with an expected mean value of RMSR for an acceptable model ≤ .0716 as calculated by FACTOR; and the RMSR = .0295 for the Spanish sample, with an expected mean value of RMSR for an acceptable model calculated by FACTOR ≤ .0528. Therefore, both indices support the goodness of fit of the model to the data.

Table 4-5. Rotated factor loads for each of the Hexad survey items in English.

User Types	Item	Rotated Factor Loads 1 (A)	2 (D)	3 (F)	4 (P)	5 (R)	6 (S)
Philanthropist (P)	**P1**				**.667**		
	P2			.312	**.616**		
	P3				**.605**		
	P4				**.703**		
Socializer (S)	**S1**						**.670**
	S2						**.728**
	S3						**.583**
	S4						**.853**
Free Spirit (F)	**F1**			**.554**			
	F2			**.542**			
	F3			**.507**			
	F4			**.503**			
Achiever (A)	**A1**	**.419**		.337			
	A2	**.787**					
	A3	**.748**					
	A4	**.586**					
Player (R)	**R1**					**.690**	
	R2					**.854**	
	R3					**.753**	
	R4					**.842**	
Disruptor (D)	**D1**		**.723**				
	D2		**.764**				
	D3		**.791**				
	D4		**.566**				
Eigenvalues		5.04	3.48	2.69	2.14	1.50	1.16
% of variance		20.98	14.51	11.21	9.91	6.26	4.82

Note. Exploratory factor analysis based on the polychoric correlations between items with an Unweighted Least Squares method and a normalized direct oblimin rotation. For improved readability, only the factor loads ≥ 0.30 are shown. The coefficients in bold type correspond to the item loads in the factor where they were expected to load higher.

Table 4-6. Rotated factor loads for each of the Hexad survey items in Spanish.

User Types	Item	Rotated Factor Loads 1 (A)	2 (D)	3 (F)	4 (S)	5 (P)	6 (R)
Philanthropist (P)	**P1**					**.453**	
	P2					**.412**	
	P3					**.620**	
	P4			.321	.309		

Socializer (S)	**S1**				**.779**		
	S2				**.773**		
	S3				**.701**		
	S4				**.755**		
Free Spirit (F)	**F1**			**.662**			
	F2					.400	
	F3					.345	
	F4			**.847**			
Achiever (A)	**A1**	**.634**					
	A2	**.815**					
	A3	**.813**					
	A4	**.669**					
Player (R)	**R1**						**.869**
	R2						**.959**
	R3						**.711**
	R4						**.842**
Disruptor (D)	**D1**		**.729**				
	D2		**.547**				
	D3		**.809**				
	D4		**.608**				
Eigenvalues		6.46	3.52	2.27	2.15	1.18	1.00
% of variance		26.91	14.63	9.47	8.97	4.95	4.16

Note. Exploratory factor analysis based on the polychoric correlations between items with an Unweighted Least Squares method and a normalized direct oblimin rotation. For improved readability, only the factor loads ≥ 0.30 are shown. The coefficients in bold type correspond to the item loads in the factor where they were expected to load higher.

4.1.3.3. Confirmatory Factor Analysis

To evaluate further the goodness of the Hexad survey scale's fit to the theoretical model, we conducted a confirmatory factor analysis, using structural equation modeling in SPSS Amos 24 (IBM, 2016) with a maximum likelihood method. The six Hexad user types were modeled as latent variables, the 24 survey items were modeled as observed variables, and the four items associated with each user type were modeled as reflections of the respective latent variable (see Figure 4-1). We only used the measurement model for the goals of our study. All parameters were left free to be estimated. Following Kline's suggestion, we report the results of the chi-squared test (χ^2) and the root mean square error of approximation (RMSEA) to evaluate the goodness of fit of the model [164]. Table 4-7 further details the standardized (β) and unstandardized (B) regression weights, as well as the standard errors (SE) and critical ratios (CR) for each of the scale's items.

In the scale in English, the chi-squared test did not support the evidence for a good model fit ($\chi^2_{237} = 498.861$, $p < .001$). However, the test is known to inflate the statistical values for large sample sizes; therefore, the RMSEA should be a more reliable measure of fit for our study [303]. The calculated RMSEA = .075 (90% CI = [.066, .084]), which is above the recommended cut for a well-fitted model (.06 according to Schmitt [303]). Therefore, the CFA results demonstrate that the measurement model is close to an acceptable fit, but that it has room for improvement. Particularly, the individual regression weights per item showed that items F2, F3, and F4 were a weaker fit to the Free Spirit subscale.

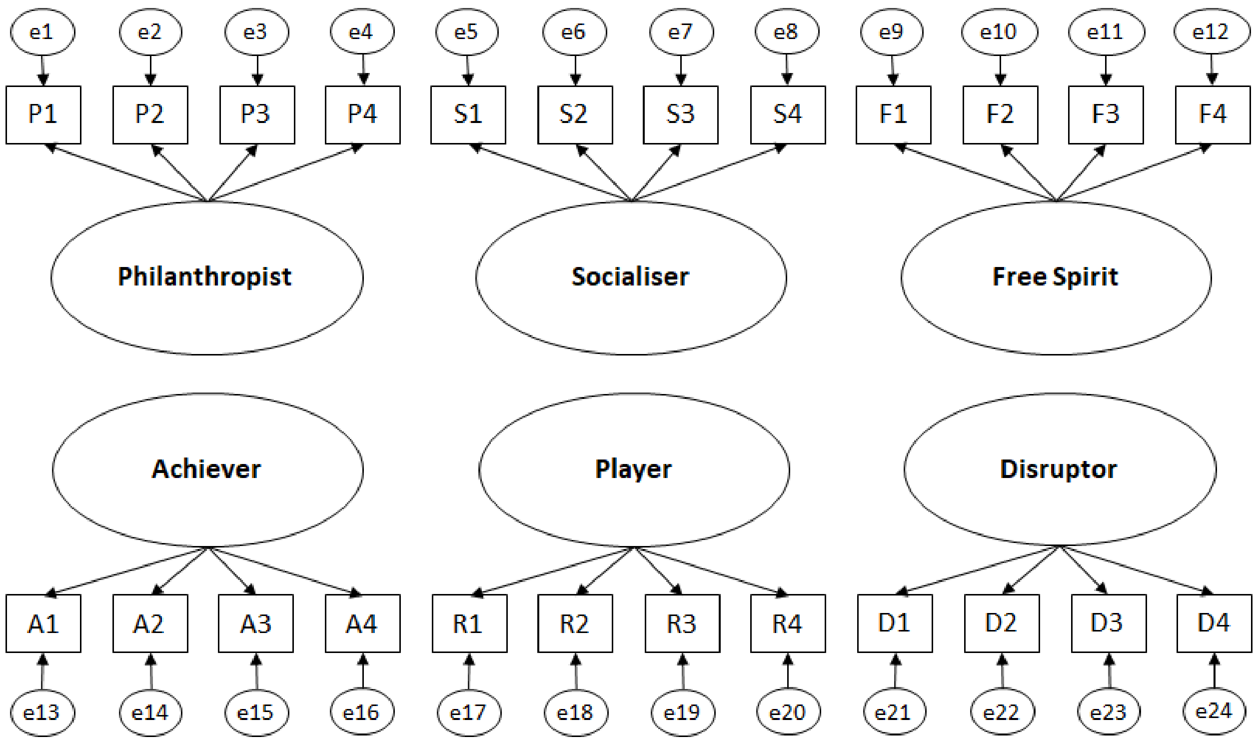


Figure 4-1. Path model used for structural equation modelling.

Table 4-7. Regression weights for each of the Hexad survey items.

User Types	Item	English				Spanish			
		β	B	SE	CR	β	B	SE	CR
Philanthropist (P)	**P1**	.702	1.000			.826	1.000		
	P2	.675	1.156	.153	7.546	.655	0.933	.073	12.717
	P3	.628	0.977	.136	7.158	.714	0.993	.070	14.096
	P4	.612	1.051	.150	7.010	.723	0.990	.069	14.315
Socialiser (S)	**S1**	.804	1.000			.752	1.000		
	S2	.727	0.850	.076	9.843	.823	1.120	.076	14.761
	S3	.668	0.874	.097	9.023	.589	0.847	.080	10.584
	S4	.750	0.981	.097	10.136	.797	1.064	.074	14.382
Free Spirit (F)	**F1**	.630	1.000			.657	1.000		
	F2	.561	0.994	.176	5.638	.638	0.972	.099	9.800
	F3	.475	0.857	.171	5.006	.644	1.052	.107	9.873
	F4	.538	0.823	.150	5.478	.599	1.023	.110	9.328
Achiever (A)	**A1**	.607	1.000			.749	1.000		
	A2	.686	1.155	.174	6.626	.764	1.195	.093	12.850
	A3	.611	1.140	.184	6.208	.691	1.249	.106	11.830
	A4	.654	1.076	.166	6.468	.678	1.046	.090	11.617

Player (R)	**R1**	.693	1.000			.837	1.000		
	R2	.835	1.148	.117	9.845	.918	1.060	.052	20.220
	R3	.720	0.898	.102	8.827	.659	0.730	.054	13.494
	R4	.796	1.050	.110	9.572	.766	0.810	.049	16.519
Disruptor (D)	**D1**	.595	1.000			.662	1.000		
	D2	.719	0.996	.136	7.339	.563	0.641	.074	8.715
	D3	.829	1.337	.173	7.725	.816	1.167	.112	10.425
	D4	.665	1.040	.149	6.988	.585	0.804	.089	8.989

Note. Confirmatory factor analysis conducted with a maximum likelihood structural equation modeling.

For the Spanish scale, the chi-squared test also failed to support the evidence for a good model fit (χ^2_{237} = 559.865, p < .001). However, the calculated RMSEA = .062 (90% CI = [.055, .068]) is on the borderline of the recommended cut for a well-fitted model (.06). Therefore, the CFA results demonstrate that the measure model is very close to an acceptable fit but could still have some improvements. Particularly, items S3, D2, and D4 seem to be the weakest fits for their subscales per the individual regression weights.

4.1.3.4. Distribution

Table 4-8 reports the average scores and standard deviation for each Hexad user type in the sample. For the distribution analyses, we combined English and Spanish responses in a single dataset (N = 556) because our goal was to analyze the Hexad user types more broadly. Thus, the differential languages used in the survey were not relevant to this analysis because they served just to enable users with different native languages to participate. As in previous results, Philanthropists, Free Spirits, and Achievers showed the highest average scores, followed by Socialisers and Players, with Disruptors showing a significantly lower average.

Table 4-8. Average scores and standard deviation for each Hexad user type.

User Types	**Mean Score**	**S.D.**
Philanthropist	23.52	3.82
Socialiser	21.26	4.46
Free Spirit	23.62	3.49
Achiever	23.53	3.64
Player	20.98	5.20
Disruptor	16.05	5.03

In breaking down this distribution by gender, there seems to be a significant gendered difference between men’s and women’s scores on the user types Socialiser and Disruptor at p < .05, as well as those on Philanthropist and Achiever at p < .10, demonstrated by the t test. However, the mean differences are small: less than one point in average, from the 28 available for each subscale (see Table 4-9). Table 4-10 demonstrates that women tend to score slightly higher in philanthropism, socialization, autonomy, and achievement (although autonomy was not significant), whereas men tend to score slightly higher in disruption.

Table 4-9. Independent samples *t* test between user types and gender.

User Types	*t*	*df*	*p*	mean diff.	95% CI of mean diff. lower	upper
Philanthropist	1.872	545	.062	0.622	-0.031	1.275
Socialiser	2.216	545	.027	0.850	0.097	1.604
Free Spirit	1.028	545	.304	0.314	-0.286	0.914
Achiever	1.800	545	.072	0.569	-0.052	1.192
Player	-0.533	545	.594	-0.241	-1.128	0.647
Disruptor	-2.093	545	.037	-0.912	-1.769	-0.056

Table 4-10. Average scores and standard deviation for each Hexad user type by gender.

User Types	Male Mean Score	S.D.	Female Mean Score	S.D.
Philanthropist	23.27	3.87	23.89	3.75
Socialiser	20.98	4.49	21.83	4.30
Free Spirit	23.50	3.47	23.81	3.57
Achiever	23.31	3.68	23.88	3.58
Player	21.07	5.20	20.83	5.19
Disruptor	16.39	4.92	15.48	5.15

Looking at age, results demonstrate significant correlations between age and all user types except Disruptor (see Table 4-11). It seems intrinsic motivations (based on philanthropism, socialization, autonomy, and achievement) increase with age, whereas extrinsic motivations (based on rewards) decrease with age, although the effect sizes are small ($r \leq .2$).

Table 4-11. Bivariate correlation analysis (Pearson's *r*) between user types and age.

User Types	*r*		95% CI lower	upper
Philanthropist	.204	**	.123	.282
Socialiser	.112	**	.029	.193
Free Spirit	.119	**	.036	.200
Achiever	.178	**	.096	.257
Player	-.110	**	-.191	-.027
Disruptor	.045		-.038	.128

** $p < .01$.

4.2 Second Study

In the second study, we analyzed data collected from July to December 2016 from an online survey advertised as a tool to let users test their own Hexad user type. Although it was conducted and reported separately, it occurred roughly during the same period of the first study.

4.2.1. Procedure

The survey was deployed on a public website (Gamified UK[3]) using a specifically developed script. Participants were invited to take the Hexad user types survey (which also employed the 24 items suggested by Tondello et al. [329]; see Table 4-1) to test their own Hexad user type. In addition, they could optionally inform their gender and age range. An e-mail address was asked for, to avoid duplicate answers; however, the addresses were recorded separately from the dataset to maintain anonymity.

After each completed survey, the website calculated the scores for each user type and presented the user with a chart of the results. Furthermore, all anonymous results were openly provided on the same website, reporting only the compounded scores for each user type, but not the participants' disaggregated answers.

This survey could be completed in English, Spanish, Portuguese, Italian, German, French, Turkish, or Russian. The English version was originally suggested by Tondello and colleagues. The German version was also provided by the same researchers, as it was produced during the practitioners' workshop that created the survey items (which was conducted in German). The Spanish and Portuguese versions were the same as those used in the first study. The remaining versions were provided by voluntary translators and, therefore, were produced with less rigour.

4.2.2. Participants

We recruited participants through social media (mainly Twitter, Facebook, and gamification blogs). As previously stated, the survey was advertised as a user type test that allowed users to know their own Hexad user types profile. There were no restrictions on participation (except for the e-mail address check to avoid duplicate responses) and participants did not receive any compensation for participation.

The total number of participants who answered the survey was 1,681. Table 4-12 shows the distribution of languages used by participants. English, Spanish, and Russian were the predominant languages used, whereas the remaining languages did not include enough participants to enable robust analysis. However, notwithstanding the size of the Russian-language user responses, we decided to analyze only the English and Spanish versions for this study because our first survey had no Russian-language version and we thus lacked an equivalent Russian-language dataset.

Therefore, the final dataset contained 1,328 participants: 1,073 in English and 255 in Spanish. There were 426 men, 375 women, 10 who reported as being of other genders, and 517 who did not specify a gender. Participants' ages were collected in ranges as detailed in Table 4-13. The survey did not ask about the participant's home country or native language.

[3] https://www.gamified.uk/

Table 4-12. Distribution of language used to answer the survey.

Language	Frequency	Percent
English	1,073	63.8%
German	26	1.5%
Spanish	255	15.2%
French	19	1.1%
Italian	7	0.4%
Portuguese	5	0.3%
Russian	220	13.1%
Turkish	76	4.5%

Table 4-13. Distribution of participants ages in the final dataset.

Age range	Frequency	Percent
17 or younger	31	2.3%
18-20	80	6.0%
21-29	230	17.3%
30-39	231	17.4%
40-49	139	10.5%
50-59	83	6.3%
60 or older	22	1.7%
N/A	512	38.6%

4.2.3. Results

To enable further comparisons, we analyzed the dataset using the same procedures as in the first study: internal reliability analysis, correlation between user types, exploratory factor analysis, confirmatory factor analysis, description of the user types' distribution, and analysis of the correlations of gender and age with the user type scores in the distribution.

4.2.3.1. Internal Reliability and Correlations

Table 4-14 presents the internal reliability analyses (Cronbach's α) for each subscale corresponding to each of the Hexad user types in the survey. As in the first study, we have also split the sample per the survey's language to evaluate whether the translations or cultural factors could have influenced reliability. Overall, the reliability scores are acceptable ($\alpha > .70$) for the Philanthropist, Socialiser, and Player subscales, but slightly lower for the Free Spirit, Achiever, and Disruptor user types. The results were similar for both languages; however, the Free Spirit score was slightly lower in the Spanish language version of the survey.

Table 4-15 presents the bivariate correlation coefficients and significance levels between each Hexad types and all others. Although the scores vary, the position of significant correlations in this table are similar to those in the first study reported in this chapter.

Table 4-14. Internal reliability scores for each Hexad user type (overall and per language).

User Types	**α (overall)**	**α (en)**	**α (sp)**
Philanthropist	.774	.774	.774
Socialiser	.827	.828	.820
Free Spirit	.642	.660	.543
Achiever	.610	.616	.594
Player	.727	.716	.758
Disruptor	.687	.699	.640

Table 4-15. Bivariate correlation coefficients (Kendall's τ) and significance between each Hexad user type and all others.

User Type	Philanthropist	Socialiser	Free Spirit	Achiever	Player
Socialiser	.382 **				
Free Spirit	.126 **	.034			
Achiever	.207 **	.124 **	.213 **		
Player	.008	.150 **	.076 **	.173 **	
Disruptor	-0.11	-.037	.286 **	.044 *	.032

$^{*}p < .05$. $^{**}p < .01$.

4.2.3.2. Exploratory Factor Analysis

Once more, we conducted an exploratory factor analysis employing the same method as before to enable comparisons between studies. The Kolmogorov–Smirnov test also showed that the distributions of the Likert responses for all variables were significantly not normal for this sample, and there was also significant skewness and kurtosis for some variables. Therefore, we employed the same method as before: we used the software FACTOR 10.8.03 [191] with the Unweighted Least Squares method for factor extraction and a normalized direct oblimin rotation, forcing an analysis with six factors. The correlation matrices were adequate for the analysis, with a KMO = .830 for the English sample and KMO = .768 for the Spanish sample; and Bartlett's test of sphericity was significant for both samples ($\chi^2_{(276)} = 7159.6$, p < .001 for the English sample; $\chi^2_{(276)} = 1830.3$, p < .001 for the Spanish sample).

We present the results separately for English and Spanish in Table 4-16 and Table 4-17. As in the previous study, the overall factor loads from the EFA are higher for the combined items and factors where expected. However, in English, items A2 and A3 seem to be a weaker fit to their factors. In Spanish, item D2 seems to be a weaker fit to its factor; additionally, items F2, F3, and A2 scored less than .30 in their respective factors, appearing to be a better fit with other user types. Moreover, the partial overlapping between factors (represented by the items that score on more than one factor) once again appeared as expected but demonstrates that the survey items are not capable of completely differentiating each user type.

The GFI = .993 for the English sample and GFI = .986 for the Spanish sample. Moreover, the RMSR = .0258 for the English sample, with an expected mean value of RMSR for an acceptable model ≤ .0304 as calculated by FACTOR; and the RMSR = .0368 for the Spanish sample, with an expected mean value of RMSR for an acceptable model calculated by FACTOR ≤ .0626. Again, both indices support the goodness of fit of the model to the data.

Table 4-16. Rotated factor loads for each of the Hexad survey items in English.

		Rotated Factor Loads					
User Types	**Item**	**1 (D)**	**2 (R)**	**3 (F)**	**4 (P)**	**5 (S)**	**6 (A)**
Philanthropist (P)	**P1**				**.825**		
	P2				**.571**		
	P3				**.481**		
	P4				**.687**		
Socializer (S)	**S1**					**.632**	
	S2					**.699**	
	S3					**.543**	
	S4					**.749**	
Free Spirit (F)	**F1**			**.691**			
	F2			**.488**			
	F3			**.475**			
	F4			**.587**			
Achiever (A)	**A1**						**.571**
	A2						**.367**
	A3						**.372**
	A4						**.794**
Player (R)	**R1**		**.692**				
	R2		**.565**				
	R3		**.659**				
	R4		**.482**				
Disruptor (D)	**D1**	**.596**					
	D2	**.814**					
	D3	**.459**					
	D4	**.656**					
Eigenvalues		4.93	3.34	2.29	1.75	1.11	1.05
% of variance		20.56	13.91	9.55	7.31	4.64	4.40

Note. Exploratory factor analysis based on the polychoric correlations between items with an Unweighted Least Squares method and a normalized direct oblimin rotation. For improved readability, only the factor loads ≥ 0.30 are shown. The coefficients in bold type correspond to the item loads in the factor where they were expected to load higher.

Table 4-17. Rotated factor loads for each of the Hexad survey items in Spanish.

		Rotated Factor Loads					
User Types	**Item**	**1 (P)**	**2 (F)**	**3 (R)**	**4 (D)**	**5 (A)**	**6 (S)**
Philanthropist (P)	**P1**	**.772**					
	P2	**.472**					
	P3	**.572**					
	P4	**.692**					

Socializer (S)	**S1**						**.739**
	S2						**.791**
	S3						**.696**
	S4						**.736**
Free Spirit (F)	**F1**		**.481**				
	F2				.394		
	F3				.460	.359	
	F4		**.751**				
Achiever (A)	**A1**					**.716**	
	A2			.307	-.429		
	A3					**.452**	
	A4					**.649**	
Player (R)	**R1**			**.771**			
	R2			**.798**			
	R3			**.576**			
	R4			**.691**			
Disruptor (D)	**D1**				**.633**		
	D2				**.384**		
	D3				**.508**		
	D4				**.525**		
Eigenvalues		4.66	3.40	2.59	1.89	1.38	1.02
% of variance		19.41	14.19	10.78	7.87	5.73	4.24

Note. Exploratory factor analysis based on the polychoric correlations between items with an Unweighted Least Squares method and a normalized direct oblimin rotation. For improved readability, only the factor loads ≥ 0.30 are shown. The coefficients in bold type correspond to the item loads in the factor where they were expected to load higher.

4.2.3.3. Confirmatory Factor Analysis

As with the first survey, we conducted a confirmatory factor analysis to evaluate further the goodness of fit of the Hexad survey scale to the theoretical model. We used the same procedure as before: a CFA using structural equation modeling in SPSS Amos 24 (IBM, 2016) with a maximum likelihood method and all parameters free to be estimated. The six Hexad user types were modeled as latent variables, the 24 survey items were modeled as observed variables, and the four items associated with each user type were modeled as reflections of the respective latent variable (see Figure 4-1). As with our analysis of the first survey, we report the results of the chi-squared test (χ^2) and the root mean square error of approximation (RMSEA) to evaluate the goodness of fit of the model [164]. Table 4-18 details the standardized (β) and unstandardized (B) regression weights, as well as the standard errors (SE) and critical ratios (CR) for each of the scale's items.

For the English scale, the chi-squared test did not support the evidence for a good model fit (χ^2_{237} = 1076.803, p < .001). However, the calculated RMSEA = .057 (90% CI = [.054, .061]) is just below the recommended cut for a well-fitted model (.06 according to Schmitt [303]). Since the RMSEA should be a better indicator of fit due to the large sample, the CFA results suggest that the measure model is a good one to represent the theoretical factors corresponding to the Hexad user types. However, since the statistic is too close to the borderline, improvements would still be welcome. Particularly, items A2, A3, and R3 appear to be weaker fits for their subscale.

Regarding the Spanish scale, the chi-squared test also failed to support the evidence for a good model fit (χ^2_{237} = 526.967, $p < .001$). However, the calculated RMSEA = .069 (90% CI = [.061, .077]) is just above the recommended cut for a well fit model (.06). Therefore, we conclude that the model is close to a good fit; however, improvements could be made. In particular, items F2, F3, A2, A3, and D2 seem to be the weakest fits to their subscales.

Table 4-18. Standardized regression weights for each of the Hexad survey items.

		English				Spanish			
User Types	**Item**	**β**	**B**	**SE**	**CR**	**β**	**B**	**SE**	**CR**
Philanthropist (P)	**P1**	.740	1.000			.719	1.000		
	P2	.694	1.037	.052	19.865	.577	0.851	.105	8.098
	P3	.602	0.871	.050	17.530	.694	1.011	.106	9.538
	P4	.686	1.041	.053	19.695	.731	1.123	.113	9.929
Socialiser (S)	**S1**	.749	1.000			.741	1.000		
	S2	.765	0.937	.041	23.086	.740	.898	.083	10.754
	S3	.735	0.931	.042	22.303	.751	1.097	.101	10.898
	S4	.703	0.957	.045	21.373	.694	0.914	.090	10.139
Free Spirit (F)	**F1**	.625	1.000			.577	1.000		
	F2	.524	0.781	.062	12.654	.405	0.564	.122	4.628
	F3	.558	0.811	.061	13.206	.396	0.662	.145	4.553
	F4	.570	0.851	.064	13.374	.592	1.276	.219	5.828
Achiever (A)	**A1**	.693	1.000			.634	1.000		
	A2	.430	0.786	.070	11.148	.443	1.018	.194	5.247
	A3	.423	0.785	.071	10.998	.458	1.135	.211	5.376
	A4	.633	0.931	.064	14.626	.626	1.227	.189	6.478
Player (R)	**R1**	.609	1.000			.739	1.000		
	R2	.793	1.213	.076	16.028	.745	0.891	.095	9.431
	R3	.470	0.658	.054	12.228	.543	0.681	.091	7.448
	R4	.635	0.969	.064	15.213	.644	0.754	.087	8.633
Disruptor (D)	**D1**	.526	1.000			.668	1.000		
	D2	.591	0.877	.069	12.653	.416	0.425	.085	5.028
	D3	.728	1.311	.096	13.606	.596	0.824	.129	6.383
	D4	.590	1.024	.081	12.644	.547	0.756	.124	6.114

Note. Confirmatory factor analysis conducted with a maximum likelihood structural equation modeling.

4.2.3.4. Distribution

Table 4-19 reports the average scores and standard deviation for each Hexad user type in the sample. As in the first study reported in this paper, Philanthropists, Free Spirits, and Achievers showed the highest average scores, although this time Free Spirits' scores were slightly higher than the other two. Once more, Socialisers and Players followed with somewhat lower scores and Disruptors showed a significantly lower average.

Table 4-19. Average scores and standard deviation for each Hexad user type.

User Types	Mean Score	S.D.
Philanthropist	22.90	3.81
Socialiser	20.77	4.66
Free Spirit	23.16	3.21
Achiever	22.45	3.53
Player	20.21	4.33
Disruptor	17.23	4.78

In breaking down this distribution by gender, the *t* test showed a significant difference between men's and women's scores on the user types Philanthropist, Socialiser, and Disruptor at $p < .05$, and on Free Spirit at $p < .10$. We only considered the two main genders (male/female) in the analysis, as the number of participants who reported a different gender was not big enough to afford useful conclusions. Overall, the mean differences are small: up to 1.42 points in average from the 28 available for each subscale, with the correlation of gender with philanthropism a bit stronger than with the other types (see Table 4-20). Table 4-21 again demonstrates that women tend to score a bit higher in philanthropism, socialization, autonomy, and achievement (although this time the differential score in the 'achievement' category was not significant), whereas men scored a bit higher in 'disruption'.

Table 4-20. Independent samples *t* test between user types and gender.

User Types	*t*	*df*	*p*	mean diff.	95% CI of mean diff. lower	upper
Philanthropist	5.622	799	.000	1.417	0.922	1.911
Socialiser	3.353	799	.001	1.078	0.447	1.709
Free Spirit	1.762	799	.079	0.359	-0.041	0.759
Achiever	1.454	799	.146	0.361	-0.126	0.848
Player	-1.397	799	.163	-0.425	-1.022	0.172
Disruptor	-2.406	799	.016	-0.806	-1.465	-0.148

Table 4-21. Average scores and standard deviation for each Hexad user type by gender.

	Male		Female	
User Types	Mean Score	S.D.	Mean Score	S.D.
Philanthropist	22.55	3.89	23.97	3.14
Socialiser	20.40	4.49	21.47	4.60
Free Spirit	23.21	3.04	23.57	2.68
Achiever	22.26	3.42	22.62	3.60
Player	20.35	4.24	19.92	4.36
Disruptor	17.64	4.60	16.83	4.88

Regarding age, we were not able to perform a correlation analysis as we did in the first study because data were collected categorically (in ranges) instead of in scale (exact values). Therefore, we employed an analysis of variance (ANOVA). We also observed that the variance was not homogeneous across groups; therefore, in addition to the ANOVA tests, we also conducted a non-parametric test (independent-samples Kruskal-Wallis; KW) to verify the results from the ANOVA. Both the ANOVA and the KW tests suggest that age is significantly correlated with participants' scores on the user types Philanthropist, Socialiser, Player, and Disruptor (see Table 4-22). The effect sizes (η^2) suggest moderate correlations. Additionally, since neither the ANOVA nor the KW tests measure effect order, we employed the Jonckheere-Terpstra (JP) test to evaluate if the significant effects were ordered. The results suggested that all significant correlations were in fact ordered. Table 4-23 details the average scores and standard deviations for each user type by age and allows us to interpret the effects. As in the previous study, the results suggest that intrinsic motivations (philanthropism and socialization) increase with age, whereas extrinsic motivations (rewards) decrease with age. In addition, 'disruption' also seems to increase with age.

Table 4-22. One-way ANOVA, Kruskal-Wallis, and Jonckheere-Terpstra tests between user types and age.

User Types	F	df	p (ANOVA)	η^2	p (KW)	p (JP)
Philanthropist	10.871	6, 809	.000	.075	.000	.000
Socialiser	3.441	6, 809	.002	.025	.002	.004
Free Spirit	1.761	6, 809	.104	.013	.131	.186
Achiever	0.976	6, 809	.440	.007	.734	.477
Player	7.898	6, 809	.000	.055	.000	.000
Disruptor	3.622	6, 809	.001	.026	.001	.000

Table 4-23. Average scores and standard deviation for each Hexad user type by age range.

	Philant.		Socialiser		Free Spirit		Achiever		Player		Disruptor	
Age	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
17 or younger	21.74	4.0	21.84	5.7	22.48	3.1	21.65	5.0	22.03	4.7	15.55	4.2
18–20	21.51	3.9	19.71	4.9	23.94	2.6	22.13	3.4	21.95	3.7	17.60	4.0
21–29	22.70	3.9	20.62	4.9	23.07	3.0	22.57	3.3	20.81	4.0	16.36	4.7
30–39	23.23	3.3	20.65	4.4	23.36	2.8	22.49	3.4	19.79	4.0	17.58	4.7
40–49	24.34	3.1	21.68	4.0	23.63	3.1	22.47	3.5	19.44	4.0	17.27	4.9
50–59	24.86	2.5	22.29	3.7	23.59	2.7	23.00	3.0	19.05	4.7	18.42	5.1
60 or older	24.32	3.0	21.41	3.8	23.77	2.9	21.68	3.9	17.59	5.6	18.86	4.6

4.3 Third Study

For the third study, we modified some statements of the Achiever and Free Spirit subscales with the goal of improving the weaknesses identified in the first two studies. We then invited the participants from the second study who had manifested interest in participating of future studies to answer the modified survey. Data were collected from June to July 2017.

4.3.1. Procedure

We employed the same survey used in the second study, with the only difference being the substitution of two Achiever items and one Free Spirit item in the survey:

- Achiever item "It is important to me to always carry out my tasks completely" was replaced by "It is important to me to continuously improve my skills".
- Achiever item "It is difficult for me to let go of a problem before I have found a solution" was replaced by "I enjoy emerging victorious out of difficult circumstances".
- Free Spirit item "I like to try new things" was replaced by "Opportunities for self-expression are important to me".

The rationale for the changes in the Achiever items was to better capture the participant's preference for skill improvement and overcoming difficult situations, which are theorized characteristics for this archetype. On the other hand, we removed the two items related with the willingness to finish a task without interruption, which seemed to work weakly as a representation of this archetype according to the findings from our first two studies. For the Free Spirit subscale, we removed the item that seemed weaker in the first two studies, perhaps because it was too short and ambiguous, and included a new item related to self-expression, which is one of the theorized preferences of the Free Spirit archetype.

This time, the survey could be completed in English or Spanish. Table 4-24 provides the complete listing of the scale items.

Table 4-24. The Gamification User Types Hexad scale used in the third study.

User Types	#	English Items	Spanish Items
Philanthropist	P1	It makes me happy if I am able to help others.	Me hace feliz ser capaz de ayudar a los demás.
	P2	I like helping others to orient themselves in new situations.	Me gusta guiar a los demás en las situaciones nuevas.
	P3	I like sharing my knowledge.	Me gusta compartir mi conocimiento con los demás.
	P4	The wellbeing of others is important to me.	El bienestar de los demás es importante para mí.
Socialiser	S1	Interacting with others is important to me.	Interactuar con los demás es importante para mí.
	S2	I like being part of a team.	Me gusta formar parte de un equipo.
	S3	It is important to me to feel like I am part of a community.	Sentir que formo parte de una comunidad es importante para mí.
	S4	I enjoy group activities.	Disfruto con las actividades grupales.
Free Spirit	F1	It is important to me to follow my own path.	Seguir mi propio camino es importante para mí.
	F2	I often let my curiosity guide me.	A menudo me dejo guiar por la curiosidad.

	F3	Being independent is important to me.	Ser independiente es importante para mí.
	F4	Opportunities for self-expression are important to me.	Tener la oportunidad de expresarme es importante para mí.
Achiever	**A1**	I like overcoming obstacles.	Me gusta superar las dificultades.
	A2	I like mastering difficult tasks.	Me gusta dominar tareas difíciles.
	A3	It is important to me to continuously improve my skills.	Mejorar continuamente mis habilidades es importante para mí.
	A4	I enjoy emerging victorious out of difficult circumstances.	Me gusta salir victorioso de las circunstancias difíciles.
Player	**R1**	I like competitions where a prize can be won.	Me gustan las competiciones en las que se pueda ganar un premio.
	R2	Rewards are a great way to motivate me.	Los premios son una buena manera de motivarme.
	R3	Return of investment is important to me.	Recuperar lo invertido es importante para mí.
	R4	If the reward is sufficient I will put in the effort.	Si el premio es adecuado, voy a hacer un esfuerzo.
Disruptor	**D1**	I like to provoke.	Me gusta provocar.
	D2	I like to question the status quo.	Me gusta cuestionar el estado de las cosas.
	D3	I see myself as a rebel.	Me describo a mí mismo como un rebelde.
	D4	I dislike following rules.	No me gusta seguir las reglas.

4.3.2. Participants

We invited participants from the second study who had authorized us to contact them for future studies by e-mail. Again, participants did not receive any compensation for participation. This time, 152 participants answered the survey in English and 12 in Spanish. Unfortunately, we did not receive a sufficient number of responses in Spanish to allow us to conduct statistical analyses. Therefore, we focus our analyses in the dataset with 152 responses in English (68 men, 56 women, 1 who reported as being of other gender, and 27 who did not specify a gender). Participants' ages were collected in ranges as detailed in Table 4-25.

Table 4-25. Distribution of participants ages in the final dataset.

Age range	Frequency	Percent
17 or younger	16	10.5%
18-20	9	5.9%
21-29	31	20.4%
30-39	27	17.8%
40-49	20	13.2%
50-59	12	7.9%
60 or older	4	2.6%
N/A	33	21.7%

4.3.3. Results

To enable further comparisons, we analyzed the dataset using the same procedures as in the first two studies: internal reliability analysis, correlation between user types, exploratory factor analysis, confirmatory factor analysis, and description of the user types' distribution. We did not perform an analysis of the correlations of gender and age with the user type scores this time because this was not the goal of this study.

4.3.3.1. Internal Reliability and Correlations

Table 4-26 presents the internal reliability analyses (Cronbach's α) for each subscale corresponding to each of the Hexad user types in the survey. Overall, the reliability scores are acceptable (α > .70) for all user types, except Free Spirit (α = .60). Table 4-26 also presents the bivariate correlation coefficients and significance levels between each Hexad types and all others. Once more, the position of significant correlations in this table are similar to those in the first two studies reported in this paper; however, it is noteworthy that this time the Achiever scores were not significantly correlated with Player and Disruptor. Therefore, it seems that the modifications introduced in the scale could better differentiate participants between these user types.

Table 4-26. Internal reliability of each subscale and bivariate correlation coefficients (Kendall's τ) with significance between each Hexad user type and all others.

User Type	**α**	Philanthropist	Socialiser	Free Spirit	Achiever	Player
Philanthropist	.704					
Socialiser	.788	.394 **				
Free Spirit	.596	.252 **	.115			
Achiever	.711	.293 **	.244 **	.391 **		
Player	.748	-.083	.257 **	-.003	.114	
Disruptor	.700	.010	-.097	.326 **	.144	.044

** $p < .01$.

4.3.3.2. Exploratory Factor Analysis

Similar to the first two studies, the Likert scale responses were non-parametric, so we employed the software FACTOR 10.8.03 [191] with the polychoric correlations as input for the factor analysis, the Unweighted Least Squares method for factor extraction and a normalized direct oblimin rotation, forcing an analysis with six factors. The correlation matrix was adequate for the analysis, with a KMO = .714, and Bartlett's test of sphericity was significant ($\chi^2_{(276)} = 1113.1$, p < .001). We present the results in Table 4-27. The overall factor loads from the EFA are higher for the combined items and factors where expected; however, there is a relevant overlapping between some of the Philanthropist items with the Socialiser items. Additionally, the modifications introduced for the Achiever subscale seem to have improved it in comparison with the second study, but the modification to the Free Spirit subscale does not evidence a sufficient improvement: although the new item (F4) weighted well in the Free Spirit factor, item F2 did not contribute well to the factor.

Nonetheless, the Goodness of Fit Index (GFI) = .981 and the Root Mean Square of Residuals (RMSR) = .0430, with an expected mean value of RMSR for an acceptable model ≤ .0814 as calculated by FACTOR. Thus, both indices support the goodness of fit of the model to the data.

Table 4-27. Rotated factor loads for each of the Hexad survey items in English.

		Rotated Factor Loads					
User Types	**Item**	**1 (P)**	**2 (R)**	**3 (S)**	**4 (F)**	**5 (D)**	**6 (A)**
Philanthropist (P)	**P1**	**.575**					
	P2	**.602**					
	P3	**.795**					
	P4	**.584**					
Socializer (S)	**S1**			**.565**			
	S2			**.718**			
	S3			**.674**			
	S4			**.704**			
Free Spirit (F)	**F1**				**.735**		
	F2					.361	
	F3				**.419**		
	F4				**.504**		
Achiever (A)	**A1**						**.817**
	A2						**.727**
	A3						**.457**
	A4						**.556**
Player (R)	**R1**		**.585**				
	R2		**.520**				
	R3		**.757**				
	R4		**.706**				
Disruptor (D)	**D1**					**.635**	
	D2					**.860**	
	D3					**.455**	
	D4					**.631**	
Eigenvalues		4.90	3.14	2.64	1.72	1.28	1.19
% of variance		20.44	13.10	11.00	7.16	5.32	4.97

Note. Exploratory factor analysis based on the polychoric correlations between items with an Unweighted Least Squares method and a normalized direct oblimin rotation. For improved readability, only the factor loads ≥ 0.30 are shown. The coefficients in bold type correspond to the item loads in the factor where they were expected to load higher.

4.3.3.3. Confirmatory Factor Analysis

As before, we conducted a confirmatory factor analysis to evaluate further the goodness of fit of the Hexad survey scale to the theoretical model. We used the same procedure as before: a CFA using structural equation modeling in SPSS Amos 24 (IBM, 2016) with a maximum likelihood method and all parameters free to be estimated. The six Hexad user types were modeled as latent variables, the 24 survey items were modeled as observed variables, and the four items associated with each user type were modeled as reflections of the respective latent variable (see Figure 4-1).

Table 4-28 details the standardized (β) and unstandardized (B) regression weights, as well as the standard errors (SE) and critical ratios (CR) for each of the scale's items.

Like the first two studies, the chi-squared test did not support the evidence for a good model fit ($\chi^2_{237} = 372.480$, $p < .001$). However, the calculated RMSEA = .062 (90% CI = [.049, .073]) is on the borderline of the recommended cut for a well-fitted model (.06 according to Schmitt [303]). The estimated model fit is very similar to that achieved in the second study presented in this paper. This time, the items with the lower weight for their subscales were F2, F3, A3, and R3.

Table 4-28. Regression weights for each of the Hexad survey items in English.

User Types	Item	β	B	SE	CR
Philanthropist (P)	**P1**	.602	1.000		
	P2	.634	1.212	.224	5.413
	P3	.575	1.083	.212	5.104
	P4	.628	1.239	.230	5.385
Socialiser (S)	**S1**	.634	1.000		
	S2	.762	1.175	.168	6.995
	S3	.693	1.223	.185	6.604
	S4	.697	1.243	.187	6.636
Free Spirit (F)	**F1**	.651	1.000		
	F2	.453	0.601	.141	4.248
	F3	.371	0.579	.161	3.595
	F4	.630	1.115	.211	5.288
Achiever (A)	**A1**	.681	1.000		
	A2	.625	1.049	.179	5.852
	A3	.496	0.629	.128	4.903
	A4	.679	1.140	.186	6.131
Player (R)	**R1**	.724	1.000		
	R2	.875	1.214	.154	7.860
	R3	.388	0.444	.102	4.345
	R4	.602	0.804	.120	6.679
Disruptor (D)	**D1**	.659	1.000		
	D2	.547	0.946	.223	4.250
	D3	.787	1.805	.380	4.755
	D4	.655	1.479	.321	4.603

Note. Confirmatory factor analysis conducted with a maximum likelihood structural equation modeling.

4.3.3.4. Distribution

Table 4-29 reports the average scores and standard deviation for each Hexad user type in the sample. Once more, Philanthropists, Free Spirits, and Achievers showed the highest average scores, with Achievers' scores being slightly higher than the other two this time. Also, like the first two studies, Socialisers and Players followed with somewhat lower scores and Disruptors showed a significantly lower average.

Table 4-29. Average scores and standard deviation for each Hexad user type.

User Types	Mean Score	S.D.
Philanthropist	23.68	2.93
Socialiser	20.98	4.37
Free Spirit	23.45	2.95
Achiever	24.26	3.00
Player	20.66	4.44
Disruptor	16.72	4.68

4.4 Discussion

This research analyzed data from three substantial survey studies aimed at evaluating the Gamification User Types Hexad scale proposed by Tondello et al. [329] in two languages: English and Spanish (see Table 4-1 for the complete scales used). To that end, we carried out a reliability analysis as well as exploratory and confirmatory factor analyses on the three data sets. In addition, we examined the distribution of each user type in the sample and how participant's demographics (gender and age) relate to their scores. These are the main findings:

- Empirical evidence supports the structural validity of the scale in both English and Spanish. However, some improvements are desirable to improve the reliability of a few specific survey items, particularly those related to the Free Spirit and Achiever user types.
- Philanthropist and Socialiser user types seem to be moderately correlated.
- Philanthropist, Free Spirit, and Achiever are the prevalent user types. On the other hand, Disruptor is the least common user type.
- Results suggest that a person's user type is correlated with their gender and age. Women seem to score slightly higher than males on average in all the intrinsic motivations, whereas men seem to score slightly higher in disruption. Additionally, intrinsic motivations seem to slightly increase with age, whereas extrinsic motivations seem to decrease with age.

The following subsections discuss each one of these findings in more detail.

4.4.1. Scale Validity

The reliability analysis from the first study showed that most subscales are internally consistent (see Table 4-3). A notable exception is the Free Spirit subscale, which showed slightly lower reliability scores in both languages. The analysis from the second study also showed that most subscales are internally consistent, with the Free Spirit and Achiever subscales showing slightly lower consistencies than desired (see Table 4-14). Overall, when compared to the prior work by Tondello and colleagues, the results are similar. Therefore, these results evidence that the internal consistency of the subscales is adequate, but that there is scope for improvements. However, we were careful to not rely only on Cronbach's alpha as the indicator of scale dimensionality and consistency because it is well known that high alpha values can instead be indicators of lengthy scales, parallel items, or narrow coverage of the constructs under consideration [272]. Thus, we also carried out exploratory and confirmatory factor analyses to further verify the scale's internal consistency with more robust methods.

It is noteworthy that the lower reliability scores of Free Spirit and Achiever items in Spanish did not occur in the first study. Unfortunately, we do not have data about the participant's native country in the second study, but we do know that most participants who answered the survey in the first study were from Spain. Therefore, the difference that appeared in the second study might be because participants were not as familiar with the language as the participants in the first study, or were from a different Spanish-speaking country, which might have different linguistic or cultural norms than the Spanish participants.

The exploratory factor analysis of our first survey showed that most items loaded higher in the factors they were expected to, except for a few Free Spirit items. These items do not seem to be a good representation of their factor and were likely the reason the internal consistency of the Free Spirit subscale was a bit lower than the others. In our study of the second survey, the EFA similarly showed a good correspondence of higher items' loads with the expected factors, except for some Free Spirit and Achiever items. Additionally, there were a few issues with Philanthropist items in Spanish. Thus, besides confirming potential issues with the same Free Spirit items, the EFA of our second survey explains the lower consistency to be found in the Achiever subscale. As it happens, the prior work of Tondello et al. has also pointed to lower loads for items F2, F3, A2, and A3 in their respective factors. Therefore, we conclude that although the subscales are consistent overall, these four items should be improved to enhance the scale's reliability.

The confirmatory factor analysis from our study of the first survey suggested that the measurement model is close to a good fit with the theory, but improvements are desirable. In English, the CFA also points to potential improvements in the Free Spirit items. However, the standardized regression weights were more balanced in Spanish; thus, they did not help us identify which items needed improvement. In our analysis of the second survey, the CFA showed a slightly better fit between the measurement model and the theory in English—just within the acceptable threshold considering the calculated RMSEA. However, the same did not occur in Spanish, where the RMSEA remained close but slightly above the borderline. An analysis of the standardized regression weights suggests a need to improve Achiever items A2, A3, and R3 in English and F2, F3, A2, A3, and D2 in Spanish.

To investigate potential improvements in the scale regarding the Free Spirit and Achiever subscales, we then conducted the third study replacing one item of the Free Spirit subscale and one item of the Achiever. The data were only analyzed in English because the new dataset did not contain enough responses in Spanish (N = 12). The results of the EFA and CFA showed that the overall reliability and model fit remained similar in comparison with the first two studies. However, an inspection of the item weights in both factor analyses showed that the two newly introduced items F4 and A4 loaded well in their respective subscales. This might suggest that these replacements represent a step in the right direction and that these two subscales might be improved even further in the future with additional adjustments.

Looking at the correlations between user types, there are several significant ones. In the results of the first survey, the most relevant correlations (with $\tau > .20$) occurred between Philanthropist and Socialiser, Philanthropist and Free Spirit, and Free Spirit and Achiever (see Table 4-4). In the second study, they occurred between Philanthropist and Socialiser, and Free Spirit and Disruptor (see Table 4-15). In the third study, they occurred between Philanthropist and Socialiser, Free Spirit and Achiever, and Free Spirit and Disruptor (see Table 4-26). When comparing these results to prior work, we noted that Tondello and colleagues found several more significant correlations, between almost all combinations except for those with the Disruptor type. Since the two survey studies presented in this work analyzed much larger and diverse datasets, the results may be considered more dependable.

The correlation between the Philanthropist and Socialiser user types needs special attention because it showed consistently higher coefficients ($\tau \approx 0.40$) in all studies, suggesting a moderate correlation. The theoretical background suggests a partial overlap between these user types, since both are related to social interactions; however, there should be a difference in that Philanthropists should be more motivated by interactions in which they can help others, whereas Socialisers should be more motivated by the social interactions per se, even those that do not involve helping others. The results from all the studies suggest that this overlap might be even stronger than anticipated, meaning that a correlation between these two types does indeed seem to exist, i.e., one cannot be highly motivated by socialization without being at least moderately motivated by the will to help others, and vice versa.

The correlations between Achiever and Free Spirit scores that consistently appeared in all analyses also deserve attention because they were not predicted by the theory. Moreover, considering the lower consistency scores of some of the items in these subscales, consistently demonstrated by the factor analyses, we conclude that future improvement of these items should help us discriminate between these two user types.

4.4.2. User Types Distribution

Across all the three studies, the Philanthropist, Free Spirit, and Achiever user types consistently scored higher on average than the other types. This suggests that these are generally the three strongest motivations for user interaction with gameful systems. This is consistent with self-determination theory, which posits that perceived autonomy and competence are innate psychological needs that individuals seek to satisfy to increase their happiness. Similarly, SDT suggests that the pursuit of meaning leads to easier internalization of necessary (but not intrinsically enjoyable) tasks and increased happiness. The Socialiser and Player user types consistently scored just a bit lower than the three strongest types across all studies, i.e., about 2–3 points (out of 28) lower in average. This also makes sense according to SDT, since 'relatedness' is the third psychological need that facilitates intrinsic motivation, and rewards are one of the common means of facilitating extrinsic motivation. On the other hand, the Disruptor user type consistently scored lower than all the other types, about 5–7 points lower than the highest scoring types. This clearly demonstrates that the motivation for change is less prevalent in the cohort than other motivation factors, although it is still relevant.

Regarding the correlations of demographic variables in the user types' scores, results from both studies suggest that both age and gender are correlated to an individual's user types profile. Women seem to score slightly (just under one point) higher than males on average in all the intrinsic motivations, whereas men seem to score slightly (also just under one point) higher in disruption. Additionally, all the user types showed some correlation with age, suggesting that the intrinsic motivations slightly increase with age (about 1–3 points from a person's 20s to their 60s), whereas extrinsic motivations decrease with age (also about 1–3 points). Disruption also seemed to increase with age, but the effect was only statistically significant in the results of the second survey. These results suggest that the motivations to interact with gameful systems are not stable through an individual's lifetime and vary over time, perhaps in a consistent way; however, the expected difference is small, so we should expect a small variation from one's basic motivations rather than a wholesale deviation. Therefore, as a guideline, designers can expect that older users will be slightly more intrinsically motivated than younger ones, particularly regarding the motivation of purpose, which showed a proportionally stronger correlation with age than the other user types, and slightly less motivated by extrinsic rewards.

4.4.3. Limitations

The goal of the three studies presented in this article was to validate the factor structure of the Gamification User Types Hexad scale with large samples. Although we collected large datasets in the surveys, the geographical distribution of participants in the first study was concentrated in the countries where the survey was more intensively disseminated, with a special concentration in Spain. The second survey was available in more languages and was more broadly disseminated on the internet, thus, we believe it might have attracted a more diverse sample. However, we did not collect information on the participants' country of origin or native language, so we cannot be certain. On the other hand, the third study collected data from a smaller number of participants. Therefore, future studies should aim to repeat the scale validation with an even more diverse participant sample, trying to collect data from participants from all over the world. Moreover, although we collected data in several languages, only English- and Spanish-language responses provided large enough cohorts to enable meaningful analysis, in both cases. Therefore, we concentrated our efforts on validating these two versions of the scale, leaving the additional translations to be validated in future work.

Furthermore, although the results showed that the scale is generally reliable, they also identified specific points for improvement, which we have highlighted, and which should be addressed in future work.

Finally, Tondello et al. also carried out additional analyses that we did not reproduce: test-retest stability, correlation of the Hexad user types with personality traits, and correlation of the Hexad user types with different game design elements. This is because our goal was focused on validating the factor structure of the scale. Moreover, the process followed to create the scale items described by Tondello et al. was meant to guarantee the construct validity of the scale because the items were generated by an expert panel and validated by a different expert panel. However, they did not report any measure of construct validity, and we did not further investigate it in this work. Consequently, future work should also repeat these analyses with larger samples to verify Tondello et al.'s findings, as well as employ adequate methods to assess the face, content, criterion, and construct validity of the scale.

4.5 Conclusion

In the present work, we conducted three large scale survey studies to validate the structure of the Gamification User Types Hexad scale in English and Spanish, and to investigate the distribution of each user type in the cohorts. We demonstrated that the scale structural validity is generally acceptable through reliability analysis and factor analysis. This means that the Hexad user types survey is suitable for use in future work investigating the effects of gamification or developing guidelines and methods for personalized gameful design. Based on the results presented in this paper, we recommend that future work use the modified scale we employed in our third study (see Table 4-24 for the complete scale). The scale can be used to assess participants' user types in future HCI research involving gamification or gameful design. This could be useful, for example, to verify if the effects of gameful interventions or methods are moderated by the user types. It can also be used by practitioners to design applications that are personalized to the preferences of individual users.

Nevertheless, the results also suggested that some improvements could be made to improve the Hexad scale's validity. Particularly, looking at the modified survey used in our third study, the following survey items should still be investigated and potentially improved to enhance the reliability of the Free Spirit and Achiever subscales and better discriminate (reduce the correlation) between them: F2 ("I often let my curiosity guide me."), F3 ("Being independent is important to me."), and A3 ("It is important to me to continuously improve my skills."). Additionally, there were some additional items that only had issues in one of the studies and for one of the languages, thus suggesting that further studies should be conducted to verify our findings. Moreover, future work can also investigate the face, content, criterion, and construct validity of the scale.

Regarding the distribution of user types in our cohorts, the results suggest that Philanthropist, Free Spirit, and Achiever are on average the strongest motivations, closely followed by Socialiser and Player; conversely, the Disruptor user type consistently has lower average scores. The participants' user type scores were also significantly correlated to their genders and ages. Women scored slightly higher than men in all intrinsic motivations, whereas men scored slightly higher in disruption on average. Additionally, the influence of intrinsic motivators seems to increase as a person ages, whereas that of extrinsic motivations (rewards) seems to decrease with age.

Furthermore, the evidence suggests there is a stronger correlation between the Philanthropist and Socialiser types than the theory anticipated, suggesting the possibility of an improvement to the theory itself, i.e., it should acknowledge that a person who is highly motivated by philanthropism will probably also be motivated by socialization in some degree, and vice versa.

Our work provides a valuable contribution to HCI research in gamification and gameful design by presenting highly robust empirical evidence on the structural validity of the Gamification User Types Hexad Scale. This will allow researchers to use the scale in future studies to better understand the mechanisms and effects of gameful interventions, ultimately leading to a better comprehension of the psychological processes behind them and enabling the creation of better methods and guidelines to design effective and personalized gameful systems.

Chapter 5 Elements of Gameful Design Classified by User Preferences

The purpose of this study was to create a new conceptual framework for classifying gameful design elements based on participants' self-reported preferences to understand user behaviour in gamification. While the Hexad framework describes psychological characteristics of the users, this work proposes a novel way to organize gameful design elements.

To operationalise the proposed framework, we asked participants about how much they enjoy 59 design elements frequently used in gameful systems (gathered from a literature review). Next, we conducted an exploratory factor analysis to cluster these design elements into eight groups. Moreover, after establishing a model of gameful design elements, we further analyzed the data to find patterns that could potentially be used to inform gameful design. Therefore, we also present results that depict the overall participant's preferences for each group of design elements, as well as the relationship between the design element groups with the Hexad user types, personality traits, age, and gender.

This contribution is important to HCI and gamification because it presents the first conceptual framework of design elements constructed in the specific context of gameful design and based on user preferences. Gamification researchers and practitioners have relied—until now—on models that were previously created in the context of games, assuming they would be generalizable to gamification without empirical evidence. Our work enables future studies and industry applications to be built upon a model empirically constructed and validated specially for gamification.

Furthermore, current gameful design practice often involves selecting design elements from a list to try and recreate patterns found in games, with little guidance regarding how each design element affects the user experience (see Section 2.1.6). Design elements are usually classified by their motivational significance or structural characteristics [75], but these classifications do not help designers choose the best pattern to solve specific user needs. As a result, designers often rely on some combination of a small subset of design elements, such as points, badges, and leaderboards, simply because these are the easiest elements to implement. Therefore, a better understanding of the effects of each design element is needed to foster the utilization of a broader variety of elements selected to solve specific needs. Our work contributes with the fulfillment of this need by presenting a novel classification of gameful design elements based on user preferences, thus allowing designers to better understand the potential effect of each element on user enjoyment and make more informed design decisions.

5.1 Methodology

The process of creating a framework of gameful design elements followed these steps:

1. **Survey design**: a literature review to create a list of gameful design elements commonly employed in gamification;
2. **Data collection**: an online survey to understand participants' preferences for the elements in the list;
3. **Factor analysis**: a principal component analysis to cluster the elements into groups according to user preferences;
4. **Component interpretation**: an analysis of the composition of each cluster to interpret and label them;
5. **Hierarchical clustering**: a hierarchical cluster analysis to further cluster the element groups into high level constructs.

5.1.1. Survey Design

We compiled a list of gameful design elements for the survey by conducting an informal literature review of both academic and non-academic sources. By also reviewing non-academic sources, we purposefully included design elements that are frequently used by practitioners but have not been examined in HCI studies yet. Thus, we provide the first study of how these elements relate to other elements that have already been investigated and how they explain user preferences.

The final list contains 59 gameful design elements. Academic sources included Tondello et al. [329] (56%), Jia et al. [140] (14%), and Ferro et al. [87] (19%). The inclusion criterion was peer-reviewed publications that contained a list of design elements used in the specific context of gamification, thus excluding publications in the context of gaming. Non-academic sources included lists of gamification elements from the following resources: Gamified UK [199,202] (73%), Yu-kai Chou Gamification [54] (34%), Enterprise Gamification [84] (29%), Werbach and Hunter [339] (27%), and Zichermann and Cunningham [353] (24%). The inclusion criteria were publications that contained a list of design elements used in the specific context of gamification and were published by authors who had been consistently listed in one of the top 100 positions in Rise's Gamification Gurus Power 100 board[4]. The numbers in brackets refer to the percentage of the 59 surveyed elements that were identified in each source; they add up over 100% because many elements appeared in more than one source.

The process of creating the list of design elements consisted on reviewing the selected sources one by one and adding all the elements described in the source with enough details to understand how they are applied. Additionally, before being added to the list, each new element was compared with the elements already in the list for similarities in their name or description. Elements that were considered similar in the researchers' judgment were merged together, whereas each different element was added as a new entry. Table 5-1 provides the complete list of elements used in the survey. It includes information about the source for each element and their descriptions as presented in the survey, as well as the mean preference scores (on a 5-point Likert scale) for each element by the participants.

[4] https://www.rise.global/gurus

Table 5-1. Gameful design elements included in the survey.

Name	References	Description	Mean	SD
Access	[2,5]	Access to advanced system features is only available to users who have contributed or achieved more.	3.08	1.16
Administrative roles	[5,6]	Acting as a system moderator or administrator, with increased responsibility to care for and help others.	3.05	1.12
Anarchic gameplay	[5,6]	Being free to do whatever I like with the system without any rules or bounds.	3.76	1.10
Anchor Juxtaposition	[1]	Being given the choice to achieve something (e.g. leveling up or getting a reward) either by completing several tasks or by paying money (virtual or real).	2.39	1.29
Anonymity	[5,6]	Being able to remain anonymous while using the system, i.e., I don't need to reveal my real identity.	4.18	0.94
Aura effect	[1]	Being able to take the opportunity for an unfair advantage (i.e., when someone's effort/time/labour makes my activity easier).	2.94	1.08
Avatar	[2,7]	Being represented in the game or system by a customizable digital character (an avatar).	4.14	0.88
Badges or Achievements	[2,3,4,5,6,7,8]	Receiving recognition for accomplishing meaningful goals inside the application or game.	3.84	0.97
Beginner's luck	[1]	I am helped to achieve a high rate of success in the first few tasks or quests.	2.89	1.08
Boss battles	[1,5,6,7]	Test everything I have learned and mastered in one epic challenge. Boss battles are often more difficult than regular challenges and may require a group to overcome.	3.97	1.07
Certificates	[5,6]	Receiving certificates for completing special challenges or achievements.	3.58	1.01
Challenges	[3,4,5,6,7,8]	Tackling difficult tasks to test my knowledge or skills.	4.24	0.78
Collection	[1,2,5,6,7,8]	Completing collections of items or achievements with special meaning in the application or game.	3.80	1.04
Creativity tools	[5,6]	Creating my own content and expressing myself freely.	3.86	0.99
Customization	[3,5,6,8]	Customizing my experience and how I present myself to others.	4.34	0.85
Development tools	[5,6]	Developing add-ons or plugins to add new features or content to the application or game.	3.64	0.96
Easter eggs	[1,5,6]	Finding surprise content deeply hidden inside the application or game's structure.	4.34	0.82
Exploratory tasks	[5,6]	Being free to explore the application or game and discover new ways of interacting with it.	4.39	0.74
Free lunch	[1]	Being rewarded with free boosters to make me feel more competent.	3.01	1.11
Friend invite	[1]	The system easily allows me to invite others into it.	3.56	1.10
Gifting	[1,2,5,6,7,8]	Giving gifts or sharing items with other users to help them achieve their goals or to express our relationships.	3.47	1.02
Glowing choice	[1]	If I am stuck too long on a problem, the system provides free hints or clues to help me move forward.	3.14	1.14
Guilds or Teams	[5,6,7,8]	Gathering on small or large guilds or teams for collaboration or team-based competition.	3.22	1.14
Humanity hero	[1,8]	Feeling that playing a game or using a system will let me collaborate to a worldwide cause.	3.61	0.94
Innovation platforms	[5,6]	Being able to suggest and discuss new features to the application or game.	3.88	0.93
Knowledge sharing	[5,6]	Sharing my knowledge with other users in forums, questions and answers, or likewise features.	3.70	0.96
Leaderboards	[2,3,4,5,6,7,8]	Comparing myself to others and show my status to others.	2.99	1.13
Learning	[1,5,6]	Being invited to learn new skills that may be useful inside the system or in real life.	4.29	0.74
Levels or Progression	[2,3,4,5,6,7,8]	Being informed how much I have progressed in the system and how much I still can go to reach the top.	4.14	0.83

Name	References	Description	Mean	SD
Loss Aversion	[5]	Being motivated to take an action out of fear of losing something (e.g., status, friends, points, achievements, progress, possessions).	2.58	1.22
Lotteries or Games of chance	[5,6,7]	Earning rewards based on mere lucky or chance.	2.35	1.10
Meaning or Purpose	[2,5]	Understanding that that my effort will fulfill a meaningful goal (real or virtual) or feeling I am part of something greater than myself.	4.17	0.82
Meaningful choices	[1]	I can choose between different ways of completing tasks or different rewards and the choices can lead to different results.	4.55	0.66
Mystery Box	[2,5]	The system leaves some things unexplained and motivates me to seek the answers through curiosity.	3.96	0.87
Narrative or Story	[1,2,3,4,5]	The system tells a story and lets me be part of the story through my actions and decisions.	4.46	0.79
Nonlinear gameplay	[6]	Completing the same goals through different paths while still achieving similar results.	4.32	0.86
Personalization	[1]	The system learns about me with time and begins to recommend new activities or products that I might enjoy.	3.32	1.26
Points	[2,3,4,5,6,7,8]	Receiving points or experience for completing specific tasks. Points may be used to redeem rewards or towards progression.	3.99	0.82
Power-ups or boosters	[1]	Receiving a limited-time advantage or power to make a section of the game easier or allowing me to achieve otherwise impossible goals.	3.03	1.10
Progress Feedback	[5]	Having a clear understanding of how far I am and what I need to do to achieve the next level or complete the next achievement.	4.18	0.76
Protection	[1]	Being invited to protect something (e.g. a virtual character) from harm.	3.29	1.07
Quests	[3,5,6,7,8]	Being invited to complete specific tasks to achieve meaningful goals.	4.14	0.79
Rewards or Prizes	[1,2,3,4,5,6, 7,8]	Receiving rewards or prizes by completing specific tasks, goals, or achievements, or by progressing to specific levels.	4.14	0.73
Scarcity	[1]	Some items or achievements are really rare or difficult to obtain.	3.72	0.98
Scarlet letter	[1]	The system lets other users notice when I am stuck on a level or task, thus encouraging me to keeping moving forward.	2.54	1.13
Signposting	[5]	Just-in-time cues show me the next possible actions or paths to follow.	3.23	1.00
Social comparison or pressure	[5,6]	Comparing my performance with others and finding out how I rank among my friends or everyone else.	2.93	1.13
Social competition	[2,5,6]	Challenging and proving myself against others into specific tasks.	3.15	1.21
Social discovery	[5,6]	Finding others through name search or based on similar interests or status.	3.11	0.96
Social networks	[5,6,7]	Connecting with as many other users as I want through an accessible social network.	2.73	1.08
Social status	[2,3,5,8]	Promoting myself for greater visibility by making my achievements or progress visible to others.	2.82	1.10
Theme	[4,5]	The system is described by means of a real of fictional central theme.	4.13	0.74
Time Pressure	[2,5]	The system reduces the time available for me to complete specific tasks.	2.36	1.05
Trading	[5,6,7]	Trading collected items or rewards with other users.	3.31	1.07
Tutorials	[2,5,8]	Getting used to the system with a tutorial or introduction on how everything works (also known as onboarding).	3.51	1.09
Unlockable or rare content	[5,6,7]	Unlocking special content after carrying out some special effort or exploring different paths.	4.14	0.81
Virtual economy	[2,5,6]	Earning virtual currency and using it to buy virtual or real goods.	3.47	1.05
Virtual World	[3]	The game happens in a virtual world where players inhabit and interact.	4.03	0.92
Voting mechanisms	[5,6]	Voting or presenting my opinions on the directions of the application or game.	3.68	0.92

5.1.2. Survey Instrument

The survey was deployed as an online instrument between February and March 2017 using the LimeSurvey software. All questions were in English and were grouped as follows:

- **User types:** The 24-items Hexad user types scale [329].
- **Preferred gameful design elements:** We asked how much participants enjoyed the 59 different design elements commonly used in gamification on a 5-point Likert scale.
- **Personality:** The 10-items Big 5 [107] personality traits scale (BFI-10; [283]).
- **Demographic information:** Participant's country, language, age, gender, education, and gaming habits and preferences.

The survey could be completed anonymously and, prior to the decision to participate, participants were presented with an online informed consent form. In addition, the long question groups (user types and gameful design elements) had attention check questions (e.g., "Please select '3' in this item to show us that you are carefully reading all questions.") to verify if participants were reading all the items with attention.

5.1.3. Participants

We recruited participants by email (in both academic and non-academic environments), social networks (Facebook, Twitter, and Reddit), and online gaming forums. Participants were required to be at least 15 years old to participate and were not offered a direct remuneration, but they were offered an opportunity to enter a draw to win one of two $ 50 prizes.

In total, 196 participants completed the survey. However, we discarded eight participants who did not complete all question groups or failed to select the correct answer in at least one of the attention check items. Therefore, the final dataset contained 188 responses (124 men, 53 women, 4 transgender, 3 non-binaries, and 4 did not indicate their gender). Participants' age ranged from 15 to 71 ($M = 26.7$, $SD = 9.7$) and were skewed towards younger participants (with 74% of participants being 30 or less), possibly because of the topic of the survey being more appealing to a younger audience. Participants were distributed geographically as follows: 60.6% from North America, 25.5% from Europe, 5.3% from South America, 4.8% from Oceania, 2.7% from Asia, and 1.1% from Africa. However, 98.9% of participants reported having a very good or native understanding of English. Therefore, we operate under the assumption that lack of English proficiency was not a detriment to our study.

Participants' scores in the Hexad user types followed a similar distribution as other reports (see Chapter 4), with the following means and standard deviations: Free Spirit: 23.1 (2.8); Philanthropist: 22.8 (3.6); Achiever: 22.4 (3.4); Player: 21.1 (4.0); Socialiser: 18.3 (4.8); and Disruptor: 15.4 (4.6).

5.2 Results

In this section, we first present the exploratory factor analysis used to cluster the gameful design elements into eight groups. Next, we describe the characteristics of each group and their average scores in the participant sample. Finally, we analyze how the independent variables (user type scores, personality traits, gender, and age) influence the element groups' scores. All analyses were conducted in SPSS 23 (IBM, 2015).

5.2.1. Exploratory Factor Analysis

We employed a principal component analysis (PCA) to cluster the 59 surveyed gameful design elements into groups. PCA is a standard method for creating groupings in data based on the covariance and correlation of items. This allowed us to establish a classification and analyze user preferences with a more manageable number of categories.

Since our investigation was exploratory, the first step was to evaluate if all the included gameful design elements could be successfully grouped into clusters because we had no prior theory to justify the inclusion or exclusion of each element. A PCA requires variables to be at least partially correlated between themselves to be able to reduce the number of components. Thus, we first analyzed the correlation matrix between all 59 variables and removed variables with only three or less relevant correlations. We considered correlations with $r \geq .3$ as relevant, as suggested by Field [90] (p. 648). Moreover, we also performed an initial PCA and noted the variables that appeared isolated in one of the components—meaning variables that were the only item loading highly in one of the components—and removed them. We performed this procedure three times, until we found no more variables to remove.

After the removal process, we had removed a total of ten variables from the analysis (16.9%): *Non-linear gameplay*, *Anonymity*, *Anarchic gameplay*, *Tutorials*, *Loss aversion*, *Time pressure*, *Scarcity*, *Aura effect*, *Protection*, and *Virtual worlds*. This means that these variables could not be clustered with any other of the variables in the dataset. Therefore, user preferences for these design elements must be analyzed individually, not by clustering them with other elements.

For the final dataset with the remaining 49 variables, the Kaiser-Meyer-Olkin measure verified the sample adequacy for the analysis, KMO = .77 (a good sample size, according to Field [90]). Moreover, Bartlett's test of sphericity was significant ($\chi^2_{(1176)} = 3486.2$, $p < .001$), indicating that the correlations between items were sufficiently large for PCA.

We used parallel analysis and Velicer's minimum average partial (MAP) test to determine the number of components to retain in the final analysis because these procedures are validated and, thus, more adequate than a simple eigenvalues inspection [250]. The analyses suggested we should retain eight components. Moreover, we used an Oblimin rotation because we expected that some elements could appear in more than one component. Table 5-2 presents the final structure matrix.

Table 5-2. Exploratory factor analysis (structure matrix) of the gameful design elements.

	Rotated Factor Loads							
Gameful Design Elements	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Social comparison or pressure	.821							
Leaderboards	.801							
Social competition	.789							
Social networks	.720							
Social status	.716							
Guilds or teams	.668						-.430	
Friend invite	.647						-.420	
Social discovery	.617						-.419	
Trading	.536						-.388	
Scarlet letter	.527	.377					-.414	-.381
Glowing choice		.819						
Beginner's luck		.695						
Signposting		.626						
Anchor juxtaposition		.561						
Power-ups or boosters		.555						
Humanity hero		.516	.371			-.395	-.363	
Personalization		.511			-.427			
Free lunch		.488						-.390
Mystery box			.700					
Easter eggs			.673					
Theme			.625					
Narrative or story			.485					-.361
Access				.632				
Lotteries or games of chance				.580				
Boss battles	3.71			.547				
Challenges			.401	.490				
Avatar					-.761			
Customization					-.761			
Points				.361	-.604			-.352
Virtual economy				.376	-.446			
Levels or progression						-.620		
Meaning or purpose						-.584		
Progress feedback						-.539		-.358
Learning			.404			-.459		
Knowledge sharing							-.680	
Gifting	.475						-.657	
Innovation platforms							-.651	
Development tools							-.625	
Administrative roles							-.568	

Voting mechanisms							-.496	
Exploratory tasks			.457				-.487	
Creativity tools					-.399		-.456	
Meaningful choices						-.391	-.448	
Badges or achievements								-.830
Certificates								-.736
Collection								-.594
Rewards or prizes				.389	-.381			-.530
Unlockable or rare content			.436					-.506
Quests					-.366	-.438		-.484
Internal reliability (α)	.874	.787	.736	.668	.696	.674	.844	.771
Eigenvalues	9.077	4.164	3.123	2.577	2.154	1.855	1.769	1.694
% of variance	18.524	8.498	6.374	5.260	4.397	3.785	3.610	3.457

Note. Extraction method: Principal component analysis. Rotation method: Oblimin with Kaiser normalization. The components were labelled: (1) socialization, (2) assistance, (3) immersion, (4) risk/reward, (5) customization, (6) progression, (7) altruism, (8) incentive. For improved visualization, the factor loadings < .36 (absolute values) are suppressed.

Field [90] (p. 644) recommends considering factor loadings greater than .36 as significant for a sample size of 200 and an *alpha* level of .01. Thus, we calculated the scores and internal reliability coefficients for each component using all the gameful design elements that loaded higher than .36 in the component. All components showed adequate reliability with α ≥ .674 (see Table 5-2).

5.2.2. Component Interpretation

After completing the PCA, we analyzed the composition of each component to interpret and label them. First, two researchers interpreted the component structure matrix independently. Next, both compared their interpretations, discussed similarities and divergences, and agreed on a label for each component. We labelled the eight components as follows:

1. **Socialization.** All elements in this component correspond to some form of social interaction, including both collaborative, competitive, and entirely social interactions.
2. **Assistance.** All elements in this component correspond to the user receiving some sort of aid for their progression, either from the system or from other users.
3. **Immersion.** The highest loading elements in this component are related to immersion and curiosity. This component includes elements related with a narrative or story and elements related with exploration and unpredictability.
4. **Risk/Reward.** The highest loading elements in this component are related to challenges, gambling, and the rewards that come from winning. Thus, this component represents the expectation of winning economically or socially valuable prizes both from challenges and lotteries.
5. **Customization.** The highest loading elements in this component are related to three different ways of customizing one's own experience: (1) customizing the user's avatar or experience, (2) automatic personalization, or (3) redeeming freely chosen goods with virtual currency or points.

6. **Progression.** The elements in this component are related to progression and meaning. Thus, this component represents the will to be involved in meaningful goals and to feel one is progressing towards achieving them.
7. **Altruism.** All elements in this component correspond to diverse ways of making a useful contribution, either to the system or to other users, including sharing knowledge or goods, contributing to improve the system, and collaborating with other users.
8. **Incentive.** All elements in this component correspond to incentives or rewards that the user might receive, such as badges, achievements, collectible items, and rewards.

Table 5-3 presents the descriptive statistics for the eight groups of gameful design elements. We calculated the mean and standard deviation based of the original five-point Likert scale responses to all the items that loaded higher than .36 in each component. Overall, *immersion* and *progression* are the groups of design elements that score higher in user preferences, whereas *socialization* and *assistance* are the groups that score lower. However, the difference is not extensive: there is only a 1.15-point difference out of 5.0 (23%) in the difference between the highest and the lowest scoring groups.

For greater precision in the correlation analyses, we also computed participants' standardized scores for each one of the eight components as part of the PCA using the regression method. Standardizing the linear regression model generates scores for each component with a mean of zero and a standard deviation of 1.0. We used the scores calculated with this method for all subsequent correlation analyses.

Table 5-3 also shows the bivariate correlations of the eight groups between themselves. There is a moderate correlation between *socialization* and *altruism*, which is explained by the fact that both are related to social interactions. The difference is that the focus of the former is on the interactions themselves, whereas the latter is more focused on contributing, which can be directed at other users, but also at the system. There are also significant, but weaker correlations between *socialization* and *incentive*; *assistance* and *customization*; *assistance* and *incentive*; *immersion* and *altruism*; *customization* and *incentive*; and *altruism* and *incentive*. It is noteworthy that *incentive* showed the highest number of correlations (four).

Table 5-3. Descriptive statistics and bivariate correlations for the groups of gameful design elements.

			Correlations (r)							
Components	**Mean**	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1- Socialization	3.15	0.71	–							
2- Assistance	3.02	0.68	.042	–						
3- Immersion	4.17	0.46	.065	.008	–					
4- Risk/Reward	3.60	0.56	.143	.029	.003	–				
5- Customization	3.92	0.53	.069	.157 *	.078	.055	–			
6- Progression	4.16	0.46	.147	.056	.103	.088	.071	–		
7- Altruism	3.57	0.54	.284 **	.050	.164 *	.033	.150	.101	–	
8- Incentive	3.78	0.53	.157 *	.172 *	.132	.121	.199 *	.131	.174 *	–

* $p < .05$. ** $p < .01$.

5.2.3. Factors that Influence User Preferences

To understand which factors influence user preferences for each one of the eight gameful design element groups, we analyzed how the participant's user type scores, personality traits, age, and gender influenced their scores for each group.

5.2.3.1. User Types

Table 5-4 presents the bivariate correlations coefficients between the groups of gameful design elements and participant's user type scores.

The results lead to the following interpretation:

1. **Socialization** elements are strongly preferred by socialisers. In addition, achievers and players also show a moderate preference for these elements.
2. **Assistance** elements only show a weak preference by socialisers. Other than that, the user type scores do not influence the preference for receiving aid.
3. **Immersion** elements are strongly preferred by free spirits and achievers. Moreover, philanthropists and disruptors also show a weak preference for these elements.
4. **Risk/Reward** elements are moderately preferred by achievers and players and slightly preferred by disruptors.
5. **Customization** elements' preferences do not seem to be affected by the participant's user type scores at all.
6. **Progression** elements are only marginally preferred by achievers and philanthropists.
7. **Altruism** elements are strongly preferred by philanthropists. Additionally, there is a moderate preference by socialisers and a lighter preference by achievers.
8. **Incentive** elements are strongly preferred by players.

Table 5-4. Bivariate correlations between the groups of gameful design elements and the Hexad user types.

Components	Correlations (r)					
	Free Spirit	**Philanthropist**	**Achiever**	**Player**	**Socialiser**	**Disruptor**
1- Socialization	.003	.104	.283 **	.263 **	.480 **	.125
2- Assistance	.126	.112	-.015	-.016	.190 *	.025
3- Immersion	.406 **	.107 *	.394 **	.053	.100	.165 *
4- Risk/Reward	.120	.084	.361 **	.247 **	.026	.183 *
5- Customization	.117	-.019	-.070	.130	-.069	.006
6- Progression	.013	.170 *	.186 *	.104	.072	.084
7- Altruism	.149	.377 **	.179 *	.143	.227 **	.093
8- Incentive	030	.024	.056	.351 **	.103	.003

$^{*}p < .05.$ $^{**}p < .01.$

5.2.3.2. Personality Traits

Table 5-5 presents the bivariate correlation coefficients between the groups of gameful design elements and participant's personality traits scores. Results show that extraversion can partly explain the preferences for socialization and assistance, openness can partly explain the preference for customization, and neuroticism can partly explain the preference for incentive. However, these correlations are only moderate in strength.

Table 5-5. Bivariate correlations between the groups of gameful design elements and the Big 5 personality traits.

Components	Correlations (r)				
	Extraversion	**Agreeableness**	**Conscientiousness**	**Neuroticism**	**Openness**
1- Socialization	.323 **	.067	.029	-.144	-.027
2- Assistance	.316 **	.106	.040	.046	.147
3- Immersion	.035	.119	.019	.119	.140
4- Risk/Reward	.086	-.077	.068	-.030	-.019
5- Customization	.035	.000	-.154	.145	.306 **
6- Progression	0.31	-.080	.079	.044	-.044
7- Altruism	.002	.015	.053	.092	.084
8- Incentive	.107	.052	-.136	.194 *	.019

$^{*}p < .05$. $^{**}p < .01$.

5.2.3.3. Age and Gender

Table 5-6 presents the relationship between the groups of gameful design elements and the participant's age and gender. The results suggest that preferences for risk and reward, customization, altruism, and incentive decrease slightly with age. Socialization and immersion also seemed to slightly decrease, while assistance seemed to slightly increase with age, but the effects were not significant. Finally, the preference for progression was the most stable irrespective of age.

Table 5-6. Bivariate correlations between the groups of gameful design elements and age and independent samples T test between the groups and gender.

Components	Age (r)	Female		Male		T-test		Mean diff.		95% CI	
		M	SD	M	SD	t	p	M	SD	lower	upper
1- Socialization	-.138	-0.366	1.027	0.205	0.941	-3.269	.001	-0.571	0.175	-0.915	-0.226
2- Assistance	.113	0.628	0.856	-0.287	0.944	0.508	.000	0.915	0.166	0.587	1.243
3- Immersion	-.137	0.369	0.949	-0.076	0.952	2.596	.010	0.446	0.172	0.106	0.785
4- Risk/Reward	-.150 *	0.020	0.969	-0.016	0.995	0.201	.841	0.036	0.178	-0.316	0.388
5- Customization	-.186 *	0.311	1.008	-0.136	0.984	2.499	.014	0.447	0.179	0.094	0.801
6- Progression	-.004	0.165	1.000	-0.073	1.004	0.312	.192	0.238	0.181	-0.120	0.595
7- Altruism	-.175 *	-0.246	0.922	0.130	0.977	-2.168	.032	-0.376	0.174	-0.719	-0.033
8- Incentive	-.162 *	0.233	0.965	-0.112	1.002	1.930	.055	0.346	0.179	-0.008	0.700

$^{*}p < .05$.

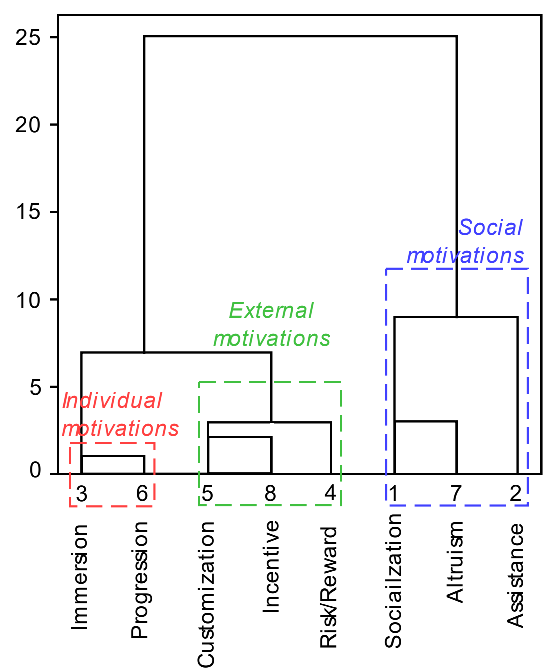
We only analyzed the data for the two main genders (female and male) because the number of participants who self-identified with other genders was too small to allow us to conduct statistical tests. Women scored significantly higher than men in assistance, immersion, customization, and incentive. On the other hand, men scored significantly higher in socialization and altruism. These results suggest that men tend to be more sociable and collaborative in gameful systems, whereas women tend to be more immersed in the narrative, customize their experience more often, and are generally more willing to receive aid.

5.2.4. Hierarchical Clustering

To verify if the groups of gameful design elements could be further clustered into higher level categories, we performed a hierarchical cluster analysis. This is important to understand how the groups relate to each other. The results demonstrate that the eight groups of gameful design elements can be further clustered into three high-level motivational categories (see Table 5-7). Figure 5-1 shows the resulting dendrogram.

Table 5-7. High level categories of gameful design elements.

Categories	Groups	Notes
Individual Motivations	3- Immersion 6- Progression	This category represents the user's interest in their own experience within the system.
External Motivations	4- Risk/Reward 5- Customization 8- Incentive	This category represents the user's interest in earning external incentives and tailoring the system to them.
Social Motivations	1- Socialization 2- Assistance 3- Altruism	This category represents the user's interest in relatedness and social interactions.



Note. Ward linkage; squared Euclidean distance. The dendrogram shows how the groups can be hierarchically clustered according to their proximity in participants' responses.

Figure 5-1. Dendrogram of the groups of gameful design elements.

5.3 Discussion

The findings from this study show that 49 of the most frequently used gameful design elements can be grouped into eight principal components according to user preferences. In addition, we showed that 10 out of the 59 elements included in our survey could not be grouped with any other.

The overall difference between the components regarding user preferences is not extraordinary but still pronounced, with approximately 20% difference between the lowest and the highest scoring groups. Moreover, by analyzing how the participants' gender, age, user types, and personality traits influenced their scores in each group, we established a clear model of user preferences:

1. **Socialization** elements are preferred by men, socialisers, and extroverts.
2. **Assistance** elements are preferred by women and extroverts.
3. **Immersion** elements are preferred by women, achievers, and free spirits.
4. **Risk/Reward** elements are preferred by younger achievers and players.
5. **Customization** elements are preferred by younger women who are more open to experiences.
6. **Progression** preferences are not clearly explained by any of studied variables, although achievers and philanthropists tend to enjoy them more than others.
7. **Altruism** elements are preferred by younger men, philanthropists, and socialisers.
8. **Incentive** elements are preferred by younger players, who score higher on neuroticism.

5.3.1. Categories of Gameful Design Elements

By looking at how the gameful design elements were classified in eight groups and three categories and comparing this model with prior literature on gaming motivations, we can understand how the users' experiences with gameful applications have remarkable differences in comparison with games. Artificially constructed challenges are at the heart of game design. Therefore, game-oriented models, such as Yee's gamer motivation profile [345], demonstrate players' preferences for different types of challenges, such as action, social, achievement, or creativity. Similarly, only socialization and immersion are present in both Hamari and Tuunanen's [121] proposed dimensions and our framework, and only socialization and exploration are present in both the BrainHex [234] and our framework, whereas the remaining motivations in those models refer to types of game challenges that are not common in gamification.

Differently, the challenges faced by the user in a gameful application are usually real-world tasks, not artificially created tasks. Thus, gameful applications often aim to support the user in overcoming these natural challenges. Consequently, the groups of gameful design elements reflect different approaches to offer this support to users instead of creating different types of artificial challenges. In the following, we interpret the categories of design elements that emerged from our analysis regarding this notion of natural compared to artificial challenges.

5.3.1.1. Individual Motivations

Both groups in this category include elements aimed at supporting the user at the individual level so they can successfully achieve their goals. *Immersion* enables users to have a more engaging experience, to feel that they are part of something bigger than themselves. On the other hand, *progression* helps users track their completed steps and plan the next ones towards achieving their goals. Thus, both design elements contribute to increasing the user's self-efficacy (i.e., their belief in their own abilities) within a gameful system.

5.3.1.2. External Motivations

These groups include elements aimed at providing external incentives for carrying out the activities that make up part of the gameful system. In this sense, *incentive* is the category that most clearly identifies different types of external incentives that are frequently used as sources of extrinsic motivation.

In contrast, *risk and reward* are harder to interpret as a group of gameful design elements. The elements in this group seem diverse, such as access to exclusive features, games of chance, and challenges. However, Caillois [46] has previously described this combination involving both games of skill and chance (*agôn* and *alea* in Caillois's play style classification). In this case, both types of game represent different means by which players can feel empowered to overcome the limitations that they face in real life. In games, every player has an equal chance of winning by either improving the skills required by the game or via chance. Thus, winning is the feeling that users seek when facing challenges or lotteries. Even when the games are based on skill, there is still gambling involved, as winning depends as much on one's own skill as on the chance of facing an opponent which is less skilled. Hence, the thrill of the unexpected is also present, although in a different format than that of the games of chance, which depend solely on luck.

Finally, *customization* might also not seem like an obvious external motivation. However, the elements included in this group are means for the user to make the system work in their favour. Therefore, they empower users to modify the external factors that influence their ability to achieve their goals.

5.3.1.3. Social Motivations

The groups in this category include the elements that allow users to interact with others while carrying out their activities in the gameful system. Thus, *socialization* enables users to interact with each other, collaborate in carrying out their tasks, or compare themselves with others. *Altruism* allows users to feel they are part of something meaningful and make a contribution to a worthy cause. And finally, *assistance* allows users to receive aid from other users or from the system, thus, helping them alleviate any difficulty that they might experience in carrying out their tasks by themselves.

5.3.1.4. Comparison with prior Frameworks of Gamification Elements

Our framework differs significantly from prior frameworks of gamification elements because it is the first approach to classify design elements based on user preferences.

Robinson and Bellotti [290] suggested a model with six categories of gamification elements based on their role in the user experience. In comparison, only socialization and incentives are present in both their framework and ours, whereas the remaining categories are quite different. Exton and Murray [85] merely attributed to each element a potential to afford different types of motivation, without any organization in categories; therefore, our approach is remarkably different from theirs. Finally, Phillips et al. [277]and Rapp [284] focused exclusively on classifying rewards and incentives in games; thus, their works provide a more in-depth look into the design elements that are part of the incentives group in our framework.

Since each one of these frameworks focused on different classification criteria, they are complementary and each one of them can contribute important information to the gameful design process. Remarkably, our framework is the first one to consider different user preferences in its construction, whereas the existing frameworks focus on different structural or motivational aspects without accounting for individual user differences.

5.3.2. Usage of the Framework

We have previously noted that most gameful design methods do not consider user preferences as part of their process. To address this issue, we suggest several possible usage scenarios for this framework. In a general approach, understanding the different groups of design elements and the overall characteristics of the users who are more likely to enjoy the elements from each group will allow gameful designers to create applications that can be potentially more attractive for the target user base. By understanding how different design elements appeal to different users, and which elements are similar in terms of user preferences, designers will be better equipped to employ a variety of elements instead of always relying on the same small subset of elements. Additionally, by knowing the characteristics of a product and of the population, marketing and customer relations can be better planned and directed.

Furthermore, this framework could be used to tailor the gameful experience for each particular user by adapting the system with the design elements that the user is more likely to enjoy. For this purpose, user preferences could be profiled automatically, by logging the frequency of user interaction with different activities. Alternatively, the user could be invited to answer a survey aimed at computing a preference score for each one of the eight groups. By knowing how the elements are grouped together, it is possible to assess an individual's preference for each one of the eight groups by asking them only about the elements that more strongly represent the group (i.e., the elements with the highest loading coefficients for each component). Depending on the degree of accuracy desired, we suggest using three or four gameful design elements for each group to compute an overall individual preference score for the group. Table 5-8 demonstrates that the internal reliability remains above .60 for most groups even if only three or four elements are used. Therefore, by asking an individual about their preferences using a list of 24 (three per group) or 32 (four per group) gameful design elements, it is possible to estimate their preference for any one of the 49 studied elements with a reasonable degree of accuracy.

Table 5-8. Top loading gameful design elements per group and internal reliability of subscales using only the top three or four elements per group.

	1- Socialization	**2- Assistance**	**3- Immersion**	**4- Risk/Rewards**
1	Social comparison	Glowing choice	Mystery box	Access
2	Leaderboards	Beginner's luck	Easter eggs	Lotteries
3	Social competition	Signposting	Theme	Boss battles
4	Social networks	Anchor juxtaposition	Narrative/Story	Challenges
α (3 items)	.875	.691	.624	.475
α (4 items)	.840	.703	.651	.525

	5- Customization	**6- Progression**	**7- Altruism**	**8- Incentive**
1	Avatars	Levels/Progression	Knowledge sharing	Badges/Achievements
2	Customization	Meaning/Purpose	Gifting	Certificates
3	Points	Progress feedback	Innovation platforms	Collections
4	Virtual economy	Learning	Development tools	Rewards/Prizes
α (3 items)	.671	.550	.610	.727
α (4 items)	.653	.563	.684	.725

Moreover, the assessment of an individual's preference for elements of each group can also inform HCI research intended to study the mechanisms and effects of different elements. By understanding that different participants might have different dispositions to enjoy diverse gameful design elements, participants' scores in each group of design elements might be used as a control variable for the effects being studied.

5.3.3. Limitations

While our study design was valid, and our results were significant, we had a few minor limitations. First, all measures were self-reported and, thus, subject to participants' level of understanding of the statements in the survey and their awareness of their own preferences toward diverse gameful design elements. Furthermore, the use of short scales is subject to acquiescence issues. This could be an issue because we used a short 10-items BFI scale due to the already considerable length of our survey. Nonetheless, the BFI-10 has been validated by several studies. Thus, we consider that our survey was adequate for the goals of our study, which were to explore possible factors that might influence user preferences without testing any particular hypothesis. Therefore, the findings from this study should represent an invitation for future research that could verify specific claims in focused studies.

Moreover, although our sample size was sufficient to perform the statistical analyses, our study was an exploratory pilot, aimed at constructing an initial conceptual framework of gameful design elements. Therefore, we intend to conduct additional studies with larger and more diverse samples to verify our findings and confirm the validity of our framework.

Finally, we did not observe participants' behaviour when interacting with gameful systems to verify if their scores in each one of the groups of gameful elements would predict their real behaviour. Hence, future studies will need to investigate the relationship between an individual's self-reported preferences and their actual behaviour in gameful systems.

5.4 Conclusion

The current study investigated user preferences for gameful design elements frequently employed in gamification. It is the first exploratory study to investigate design elements specifically used in gameful systems, instead of trying to generalize previous work in games user research to gamification. Specifically, this study contributes to the HCI and gamification communities by presenting a novel model of eight groups of gameful design elements in three categories: *individual motivations* (immersion and progression); *external motivations* (risk/reward, customization, and incentives); and *social motivations* (socialization, altruism, and assistance).

Additionally, we described the defining characteristics of each group and the gameful design elements that compose them. We also explained the typical characteristics of the users who are more likely to prefer each group. Finally, we proposed different ways in which this framework can be used to inform gameful design. This can be achieved either by automatically profiling user preferences by observing their behaviour, or by explicitly asking users about their preferences toward a reduced set of elements and extrapolating their preferences for the remaining elements.

These findings extend our understanding of user preferences in gamification and will enable researchers and practitioners to design better tailored gameful systems in the future.

Chapter 6 Heuristic Evaluation for Gameful Design

Although many gameful design methods have recently emerged for gamification, designers still lack standard evaluation methods. There are no guidelines for UX experts (i.e., people with background knowledge in UX) to evaluate a gameful implementation early in the project. As discussed in Section 2.4.1, some heuristic evaluation models for games exist, but there are some shortcomings for their direct application to gameful applications.

The benefit of using a gamification inspection method is that it allows a rapid and early evaluation of a gameful design. While several studies have investigated the effectiveness of gameful applications by studying their users [120], user tests are conducted after a prototype has already been implemented. Although concerns have been voiced that heuristic evaluation can be influenced by subjective interpretations [340], it remains a valuable tool for practitioners who operate under tighter time constraints than researchers. Heuristics allow researchers a finer focus in the user tests that are usually done subsequently to improve a product.

While UX tests focus on identifying issues related to usability, ergonomics, cognitive load, and affective experiences, gamification is concerned with understanding and fostering the user's motivation to use a product, system, or service. Thus, gamification methods rely on motivational psychology research, such as self-determination theory (SDT; [66,296–298]; see also Section 2.1.4.1), to understand human motivation. Our heuristics were motivated and informed by this work from psychology.

Several gameful design frameworks and methods have been suggested (see Section 2.1.6) with prescriptive guidelines for augmenting an application with motivational affordances, which are properties added to an object that allow its users to experience the satisfaction of their psychological needs [73,351]. In gameful design, motivational affordances are used to facilitate intrinsic and extrinsic motivation. Thus, motivational affordances supporting a user's feelings of competence, autonomy, and relatedness can facilitate intrinsic motivation, whereas external incentives or rewards facilitate extrinsic motivation.

Therefore, we developed a new set of guidelines for heuristic evaluation of gameful design in interactive systems. We began our research by reviewing several gameful design frameworks and methods to identify which dimensions of motivational affordances were common among them. Next, we created a set of heuristics focused on each of the identified dimensions. The resulting set of heuristics provides a new way of evaluating gameful user experiences. It is the first inspection tool focused specifically on evaluating gameful design through the lens of intrinsic and extrinsic motivational affordances. The aim of our inspection tool is to enable any UX expert to conduct a heuristic evaluation of a gameful application more easily, even if said expert does not have a profound background expertise in gameful design or motivational psychology.

To evaluate the proposed heuristics, we conducted a study with five UX or HCI professionals who evaluated two online gameful applications. Three participants used our gameful design heuristics, while the remaining two used a two-page description of gamification and motivational affordances. Results show that usage of our heuristics led to more motivational issues being identified in the evaluated applications, as well as a broader range of identified issues, comprising a larger number of different dimensions.

6.1 Review of Gameful Design Methods

To the best of our knowledge, no heuristics set is available for gameful design. Some of the existing gameful design methods, namely Octalysis [53], Hexad [329], and Lens of Intrinsic Skill Atoms [75], suggest procedures to evaluate an existing system. Nevertheless, these procedures are aimed at providing a starting point for the design process. They are less suited for being used as an evaluation tool by an independent quality control team because they lack a concise set of heuristics with concise descriptors, which could be quickly checked by an UX expert. Moreover, the lack of this concise format implies that an evaluator would need to intensively study these methods before being able to conduct an evaluation. Therefore, presently, there is no evaluation method for gameful applications that can be easily learned even by UX professionals who are not profoundly familiar with gameful design. Our research fills this gap.

Several gameful design frameworks and methods are currently available (see Section 2.1.6 and [75,224,230] for comprehensive reviews). Therefore, we decided to review these existing methods to extract the different dimensions of motivational affordances that need to be considered in gameful design. Since the reviewed methods synthesize the current set of best practices in gameful design, we considered that they could provide an adequate starting point to identify motivational dimensions of concern.

Moreover, as stated before, some of these models are already suggested as evaluation methods. However, only a few of the reviewed methods feature a classification of motivational affordances in different dimensions, which we could use as a theoretical background to devise our heuristics. Therefore, we expanded the scope of our analysis to include methods including this feature. Table 6-1 lists the frameworks and methods we considered, including the rationale for including them in our analysis.

Table 6-1. A summary of existing gameful design frameworks and methods considered in our research.

Framework / Method	References	Included in the Analysis?	Rationale
Gamification by Design	Zichermann and Cunningham [353]	No	Does not provide a classification of dimensions of motivational affordances.
Gamification Framework	Francisco-Aparicio et al. [93]	No	Does not provide a classification of dimensions of motivational affordances.

Gamification Model Canvas	Jiménez [141]	No	Does not provide a classification of dimensions of motivational affordances.
Gamify	Burke [42]	No	Does not provide a classification of dimensions of motivational affordances.
User Types HEXAD	Tondello et al. [329]	Yes	Provides a classification with six user types that are further used to classify sets of game elements for each type.
The Kaleidoscope of Effective Gamification (KEG)	Kappen and Nacke [150]	Yes	Provides a classification with several layers of motivational affordances that can be used to design or evaluate gameful systems.
The Lens of Intrinsic Skill Atoms (Motivational Design Lenses – MDL)	Deterding [75]	Yes	Provides a classification of motivational design lenses that can be used to design or evaluate gameful systems.
Loyalty 3.0	Paharia [271]	No	Does not provide a classification of dimensions of motivational affordances.
The RECIPE for Meaningful Gamification	Nicholson [239]	Yes	Provides six different motivational dimensions for gameful design.
Octalysis Framework	Chou [53]	Yes	Provides a classification with eight dimensions of motivation that can be used to design or evaluate gameful systems.
Six Steps to Success	Werbach and Hunter [338]	No	Does not provide a classification of dimensions of motivational affordances.
Super Better	McGonigal [217]	Yes	Proposes a gameful design method based on seven steps, which can be mapped as motivational dimensions.

After reviewing the listed frameworks and methods and selecting six of them for further analysis (see Table 6-1), we conducted a comparison of the motivational dimensions suggested by each model to map the similarities between them, using the following procedure:

1. The first framework was added as the first column of a table, with each one of its suggested motivational dimensions as a separate row. We chose the Octalysis framework as the first one because it comprises the highest number of dimensions (eight), which facilitated the next steps, but the results would be the same if we had selected any other framework to begin with.
2. Next, we iteratively added each one of the remaining models as additional columns into the table. For each added model, we compared each one of its suggested dimensions with the rows that already existed in the table. When the new dimension to be added corresponded to one of the dimensions already in the table, we added it to the relevant existing row. Otherwise, we added a new row to the table creating a new dimension. In some cases, the addition of a new dimension also prompted the subdivision of an existing

row. For example, competence motivations were split into challenge/competence and completeness/mastery.

3. After adding all the models to the table, we observed the characteristics of the dimensions named in the rows and created for each of the latter a unique label, comprising the meaning of all the dimensions it encompassed.

The resulting model consists of twelve common dimensions of motivational affordances (see Table 6-2). The similarity analysis between dimensions of different models was conceptual, meaning that we studied the description of each dimension as presented by their original authors and decided whether they represented the same core construct as any of the dimensions already present in the table. Similarly, we derived the labels for each one of the twelve resulting dimensions (first column of Table 6-2) by identifying the core concepts of each dimension. In the resulting classification, we noted that these dimensions were strongly based on: (1) the theories of intrinsic and extrinsic motivation [296–298], (2) behavioural economics [118], and (3) the practical experience of the authors of the analyzed frameworks. The entire initial analysis was conducted by one of the researchers; next, all collaborators also analyzed the resulting table. We then conducted an iterative loop of feedback and editing until none of the researchers had additional suggestions to improve the final model.

Table 6-2. Common dimensions of motivational affordances from the reviewed gameful design methods.

Dimension	**Octalysis** [53]	**HEXAD** [329]	**KEG** [150]	**MDL** [75]	**RECIPE** [239]	**Super Better** [217]
Purpose and Meaning	Epic Meaning & Calling	Philanthropist			Information; Reflection	Epic win
Challenge and Competence	Development & Accomplishment	Achiever	Competence; Challenge	Challenge lenses; Intrinsic rewards	Engagement	Challenge; Bad guys
Completeness and Mastery	Development & Accomplishment	Achiever	Competence; Achievements	Goal lenses; Action lenses; Intrinsic rewards		Complete quests
Autonomy and Creativity	Creativity & Feedback	Free Spirit	Autonomy	Object lenses; Intrinsic rewards	Play; Choice	
Relatedness	Social Influence & Relatedness	Socialiser	Relatedness	Intrinsic rewards	Engagement	Recruit allies
Immersion			Perceived Fun		Exposition	Secret identity
Ownership and Rewards	Ownership & Possession	Player	Extrinsic motivation	Intrinsic rewards		Power-ups
Unpredictability	Unpredictability & Curiosity	Free Spirit		Varied challenge; Varied feedback; Secrets	Play	
Scarcity	Scarcity & Impatience					
Loss avoidance	Loss & Avoidance					
Feedback	Creativity & Feedback			Feedback lenses		
Change and Disruption		Disruptor				

6.2 Gameful Design Heuristics

Our set of heuristics aims to enable experts to identify gaps in a gameful system's design. This is achieved by identifying missing affordances from each of the dimensions.

Before devising the heuristics, we also looked into prior research on motivation (SDT [296,297]) to categorize the twelve dimensions into *intrinsic*, *extrinsic*, and *context-dependent* motivational categories. This is a common practice in gameful design and many of the reviewed methods also employ a similar classification. Although it is a simplification of the underlying theory, this simple categorization helps designers and evaluators better understand the guidelines and focus their attention on specific motivational techniques.

We used the following criteria to split our heuristics into categories. *Intrinsic motivation* includes affordances related to the three intrinsic needs introduced by SDT [296,297] (competence, autonomy, and relatedness), as well as 'purpose' and 'meaning' as facilitators of internalization [65,134,275] and 'immersion', as suggested by Ryan and Rigby [288,298] and Malone [193]. *Extrinsic motivation* includes affordances that provide an outcome or value separated from the activity itself as suggested by SDT [297] and Chou [53]: ownership and rewards, scarcity, and loss avoidance. *Context-dependent* motivation includes the feedback, unpredictability, and disruption affordances, which can afford either intrinsic or extrinsic motivation depending on contextual factors. For example, the application can provide feedback to the user regarding both intrinsically or extrinsically motivated tasks; therefore, feedback might afford intrinsic or extrinsic motivation according to the type of task with which it is associated.

We constructed the heuristics based on an examination of the literature cited in Table 6-2, by writing adequate guidelines for each of the twelve identified dimensions. Following the literature review, we created these guidelines by studying the descriptions of each dimension in the original models, identifying the main aspects of each dimension, and writing concise descriptions of each aspect to assist expert evaluation. We employed the following procedure:

1. For each one of the twelve motivational dimensions, we first studied the underlying concepts and wrote a short description of the dimension itself, aimed at guiding expert evaluators' understanding of each dimension.
2. Next, for each dimension, we identified the main aspects of concern, meaning the aspects that should be considered by designers when envisioning a gameful system, as suggested by the reviewed frameworks or methods. We argue that these aspects of concern, when designing a system, should also be the main points of evaluation.
3. For each aspect of concern, we then wrote a concise description aimed at guiding experts into evaluating whether the aspect being scrutinized was considered in the evaluated system's design.

Figure 6-1 presents the final set of 28 heuristics organized within the 12 dimensions, following the initial analysis, framing, and iterative feedback mentioned above. Table 6-3, Table 6-4, and Table 6-5 details them by presenting the description of each dimension and each heuristic.

Additionally, we have extended the gameful design heuristics by writing a set of questions for each heuristic. These questions inquire about common ways of implementing each guideline, helping the evaluators observe if the guideline is implemented in the system at all. The complete set of questions can be found in Appendix A.

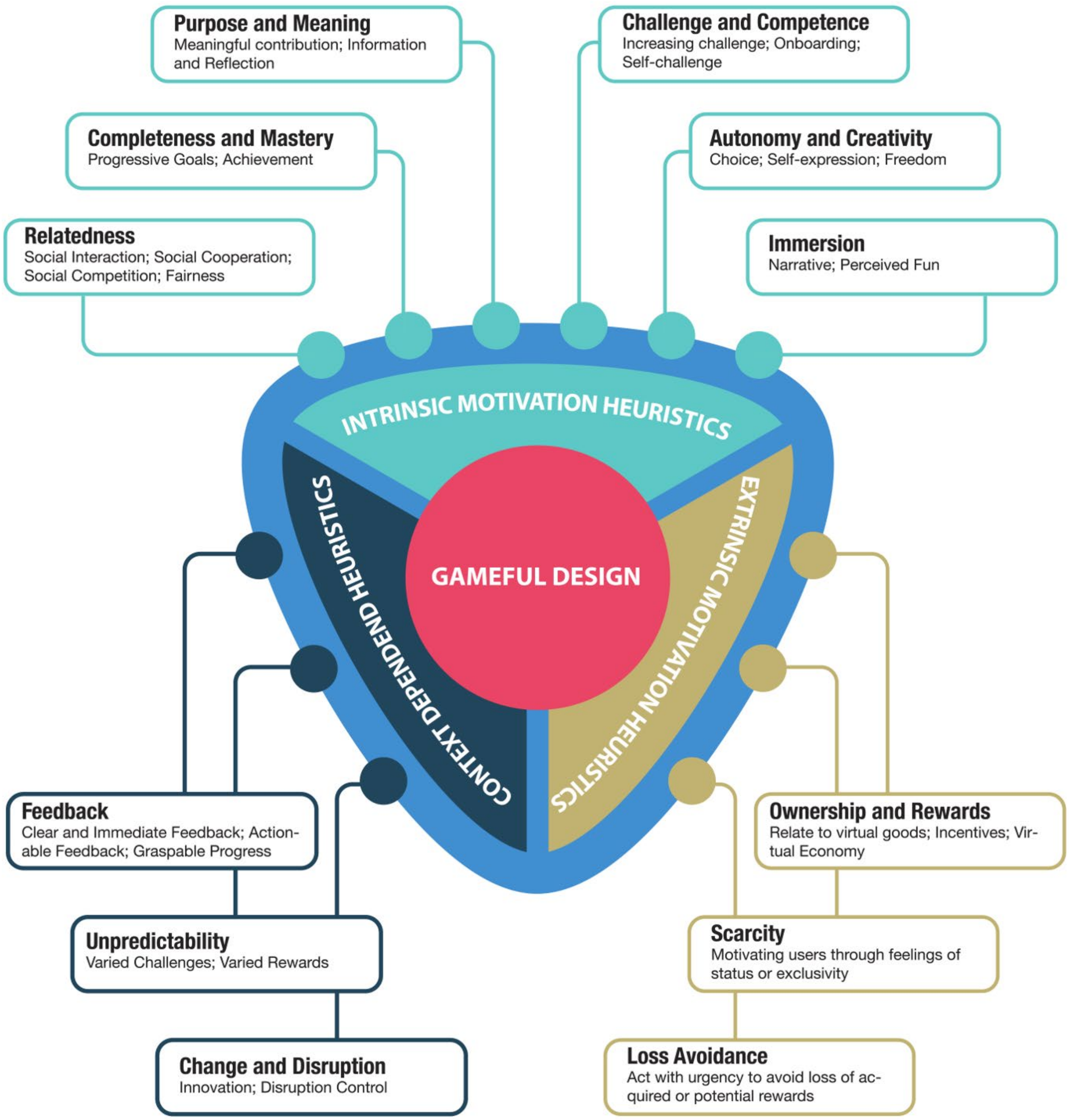


Figure 6-1. Summary of all the gameful design heuristics.

Table 6-3. Intrinsic motivation heuristics.

Intrinsic Motivation Heuristics

Purpose and Meaning: Affordances aimed at helping users identify a meaningful goal that will be achieved through the system and can benefit the users themselves or other people.

I1. *Meaning*: The system clearly helps users identify a meaningful contribution (to themselves or to others).

I2. *Information and Reflection*: The system provides information and opportunities for reflection towards self-improvement.

Challenge and Competence: Affordances aimed at helping users satisfy their intrinsic need of competence through accomplishing difficult challenges or goals.

I3. *Increasing Challenge*: The system offers challenges that grow with the user's skill.

I4. *Onboarding*: The system offers initial challenges for newcomers that help them learn how it works.

I5. *Self-challenge*: The system helps users discover or create new challenges to test themselves.

Completeness and Mastery: Affordances aimed at helping users satisfy their intrinsic need of competence by completing series of tasks or collecting virtual achievements.

I6. *Progressive Goals*: The system always presents the next actions users can take as tasks of immediately doable size.

I7. *Achievement*: The system lets users keeps track of their achievements or advancements.

Autonomy and Creativity: Affordances aimed at helping users satisfy their intrinsic need of autonomy by offering meaningful choices and opportunities for self-expression.

I8. *Choice*: The system provides users with choices on what to do or how to do something, which are interesting but also limited in scope according to each user's capacity.

I9. *Self-expression*: The system lets users express themselves or create new content.

I10. *Freedom*: The system lets users experiment with new or different paths without fear or serious consequences.

Relatedness: Affordances aimed at helping users satisfy their intrinsic need of relatedness through social interaction, usually with other users.

I11. *Social Interaction*: The system lets users connect and interact socially.

I12. *Social Cooperation*: The system offers the opportunity of users working together towards achieving common goals.

I13. *Social Competition*: The system lets users compare themselves with others or challenge other users.

I14. *Fairness*: The system offers similar opportunities of success and progression for everyone and means for newcomers to feel motivated even when comparing themselves with veterans.

Immersion: Affordances aimed at immersing users into the system to improve their aesthetic experience [131], usually by means of a theme, narrative, or story, which can be real or fictional.

I15. *Narrative*: The system offers users a meaningful narrative or story with which they can relate to.

I16. *Perceived Fun*: The system affords users the possibility of interacting with and being part of the story (easy fun; [180]).

Table 6-4. Extrinsic motivation heuristics.

Extrinsic Motivation Heuristics

Ownership and Rewards: Affordances aimed at motivating users through extrinsic rewards or possession of real or virtual goods. Ownership is different from competence when acquiring goods is perceived by the user as the reason for interacting with the system, instead of feeling competent.

E1. *Ownership*: The system lets users own virtual goods or build an individual profile over time, which can be developed by continued use of the system and with which users can relate to.

E2. *Rewards*: The system offers incentive rewards for interaction and continued use, which are valuable to users and proportional to the amount of effort invested.

E3. *Virtual Economy*: The system lets users exchange the result of their efforts with in-system or outside rewards.

Scarcity: Affordances aimed at motivating users through feelings of status or exclusivity by means of acquisition of difficult or rare rewards, goods, or achievements.
E4. *Scarcity*: The system offers interesting features or rewards that are rare or difficult to obtain.
Loss Avoidance: Affordances aimed at leading users to act with urgency, by creating situations in which they could lose acquired or potential rewards, goods, or achievements if they do not act immediately.
E5. *Loss Avoidance*: The system creates urgency through possible losses unless users act immediately.

Table 6-5. Context-dependent heuristics.

Context-Dependent Heuristics
Feedback: Affordances aimed at informing users of their progress and the next available actions or challenges.
C1. *Clear and Immediate Feedback*: The systems always inform users immediately of any changes or accomplishments in an easy and graspable way.
C2. *Actionable Feedback*: The system always informs users the next available actions and improvements available.
C3. *Graspable Progress*: Feedback always tells users where they stand and what is the path ahead for progression.
Unpredictability: Affordances aimed at surprising users with variable tasks, challenges, feedback, or rewards.
C4. *Varied Challenges*: The system offers unexpected variability in the challenges or tasks presented to the user.
C5. *Varied Rewards*: The system offers unexpected variability in the rewards that are offered to the user.
Change and Disruption: Affordances aimed at engaging users with disruptive tendencies [329] by allowing them to help improve the system, in a positive rather than destructive way.
C6. *Innovation*: The system lets users contribute with ideas, content, plugins, or modifications aimed at improving, enhancing, or extending the system itself.
C7. *Disruption Control*: The system is protected against cheating, hacking, or other forms of manipulation from users.

6.2.1. Using the Gameful Design Heuristics

Similar to previous heuristic UX evaluation methods, gamification heuristics should be used by experts to identify gaps in a gameful system's design. Experts should consider each guideline to evaluate whether it is adequately implemented into the system's design. We recommend the evaluation to be conducted by three to five examiners because prior studies with usability heuristics have shown that the returns from a few evaluators are better than with a single evaluator, but they begin to decrease as more than five evaluators are added [240,244,245].

When applying the heuristics, the evaluators should be concerned with identifying if the system has implemented motivational affordances for each one of the heuristic guidelines and assessed its potential to elicit the intended effect, which is motivating users to engage with the application. The evaluation is focused on observing the presence or absence of the motivational affordances and, if the evaluator has enough expertise, in evaluating their quality. However, it does not aim to observe or analyze the actual user experience, which is highly dependent on the users themselves in addition to the system. Therefore, this method cannot evaluate the user experience; its goal is to evaluate the system's *potential* to afford a gameful, engaging experience. As we have stated before, the heuristic evaluation should be subsequently validated by user studies to confirm if the observed potential does indeed translate into the expected gameful experiences.

We suggest the following procedure for experts to conduct an evaluation using the gameful design heuristics:

1. First, the evaluator should familiarize themselves with the application to be analyzed and its main features.
2. For each heuristic, the evaluator should first read the general guideline and observe the application, identifying and noting what the application does to implement this guideline. Next, they should read the questions associated with the heuristic and answer them to identify possible gaps in the application's design.

It is important to note that the questions associated with each heuristic act as guidelines to facilitate the evaluation process. They are not intended to represent every aspect related to a particular heuristic. Therefore, it is important that the evaluator also thinks beyond the suggested questions and considers other issues that might be present in the application regarding each heuristic. The evaluation should be focused on identifying the gaps in the application's design, meaning which guidelines/heuristic are not adequately implemented by the system. Nevertheless, it is useful to write down what the application does well to implement each guideline, because this will assist designers to avoid losing good existing solutions in future design iterations.

After evaluating all the dimensions, a count of the number of issues identified in each dimension can help identify which motivational issues (from the heuristics) require more attention in improving the system's potential to afford an engaging user experience.

6.2.2. Turning the Evaluation Results into Actionable Design

We created the gameful design heuristics to serve as an evaluation method. Thus, this method does not provide the means to turn the identified issues into actionable design ideas to improve the application's design. Instead, we suggest that the results from the evaluation should be used to inform a gameful design method, which can then provide the tools to implement new design ideas for each one of the dimensions where gaps were identified. The methods used to inform the heuristics development (see Table 6-2) are adequate for this goal because they make it easy to map the dimensions where gaps are identified to design elements' categories suggested by these gameful design methods.

6.3 Evaluation

We conducted a summative study with five UX or HCI experts to evaluate the Gameful Design Heuristics.

We asked participants to evaluate two online gameful applications: Habitica and Termling.

Habitica[5] is an online gameful task-management application, which helps users keep track and remain motivated to achieve their goals. Users can create three types of goals: *habits* (long-

[5] http://habitica.com/, last accessed July 2019.

term goals that will give experience points when completed if they are positive, or will damage the user's health if they are negative), *dailies* (activities that the user wants to complete in a repeatable fashion), and to-dos (one-time tasks that give points and disappear when completed). Habitica features a character progression inspired by role-playing games. Thus, users are represented by a virtual character (avatar) that can be leveled up and customized as points are earned. Moreover, users also earn "gold" as they complete goals, which can be used to exchange for virtual or real-life rewards. Users can also collect pets and mounts to further customize their character. Finally, users can band together in parties to complete difficult quests, so they motivate each other to accomplish their own goals. Habitica was chosen for this experiment because it is a well rounded gameful application, with several game elements applied to afford a good user experience.

Termling[6] was a free gameful learning tool that helped motivate learners to study vocabulary words. It used a customizable avatar system to motivate students: as more vocabulary words were studied, the user earned rewards to further equip and customize their character. Termling was the second application chosen for this experiment because it was a very simple gameful application, with just a few game elements. Therefore, it was expected that the design of Termling would satisfy only a few of the gameful design heuristics, thus giving evaluators many opportunities to identify issues and potential improvements.

Three participants (P3, P4, P5) were recruited to evaluate using the heuristics and the remaining two (P1, P2) without it, enabling us to compare how many motivational design issues were found by experts with and without the heuristics. Furthermore, three participants (P2, P3, P4) had a solid expertise in gamification or games, whereas two (P1, P5) were knowledgeable in UX or HCI, but did not have a solid background in gamification. This enabled us to assess if prior gamification expertise would influence the evaluators' ability to identify motivational design issues.

6.3.1. Participants

We initially invited 18 experts in UX, HCI, or gamification to participate in the study. Potential participants were selected from the authors' acquaintances and from previous project collaborators. The criterion was that potential participants should have an expertise either in gamification or games (including design practice or research experience) or in using other UX or HCI methods to evaluate interactive digital applications. Potential participants were contacted by email or in person. No compensation was provided for participation.

From the 18 invited participants, 10 initially agreed to participate and were sent the instructions; of which only five participants completed the procedures (likely because of scheduling difficulties and the lack of compensation). Of these five, two participants completed the evaluation of Habitica only. However, we decided to include their feedback in the study anyway. Therefore, we collected five evaluations for Habitica, but only three for Termling. Table 6-6 summarizes the demographics for the participants.

[6] http://www.termling.com/, last accessed December 2017 (not available anymore at the time of publication of this thesis).

Table 6-6. Participant demographics.

#	Gender	Role	Gamification expertise?	Has studied gamification before?	Used heuristics?
P1	Male	Graduate Student (HCI)	No	Yes (4 months)	No
P2	Male	Creative Director	Yes	Yes (3 years)	No
P3	Female	Professor (HCI)	Yes	Yes	Yes
P4	Male	Creative Lead	Yes	Yes	Yes
P5	Female	Graphic Designer	No	No	Yes

6.3.2. Procedure

Initially, participants read and signed a consent form and filled out a short demographic information form (see Table 6-6). Next, the instructions to evaluate the two applications were sent out. Since both applications were free and available online, participants were instructed to create a free account to test them. We instructed participants P1 and P2 to carry out the evaluation without the gameful design heuristics and participants P3, P4, and P5 to use the heuristics. Assignment to experimental conditions was not random because we needed to ensure that we had participants with and without gamification expertise in both conditions (with and without the heuristics).

The instructions for P1 and P2 are included in Appendix B and contained a one-page summarized introduction about gamification and motivation, followed by instructions requesting them to reflect about the applications' design and motivational affordances, try to understand how they afford intrinsic and extrinsic motivation, and then list any issue they identified related to the motivational affordances or lack of them.

Participants P3, P4, and P5 received the information included in Appendix C, which contained the same introduction about gamification and motivation, followed by an introduction to the gameful design heuristics, and instructions that asked them to reflect about the applications and identify motivational issues, but using the gameful design heuristics. A complete copy of the gameful design heuristics was attached to guide them during the evaluation (see Appendix A), including the full list of heuristics with all the accompanying questions to guide the evaluation. The heuristics were formatted as a fillable form, which offered an additional column where participants could take notes about the issues observed in the applications.

After receiving the instructions, participants could conduct their evaluations at their own pace and discretion; they were not supervised by the researchers. After completing the evaluation, participants emailed the forms back to the researchers.

6.3.3. Results

Table 6-7 shows the number of issues found in the two evaluated applications by the participants. Overall, participants who used the gameful design heuristics identified more issues than those who did not use any heuristics.

Table 6-7. Number of issues found by participants in the study.

	Habitica					Termling				
Participant	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
Used heuristics?	No	No	Yes	Yes	Yes	No	No	-	Yes	-
I1. Meaning	1	3	0	0	0	0	2	-	1	-
I2. Information and Reflection	0	0	1	0	1	0	0	-	1	-
I3. Increasing Challenge	0	0	1	0	0	0	0	-	1	-
I4. Onboarding	2	1	1	1	1	1	3	-	1	-
I5. Self-challenge	0	0	0	0	0	0	0	-	0	-
I6. Progressive Goals	0	0	0	1	1	0	0	-	1	-
I7. Achievement	0	0	1	0	0	0	1	-	1	-
I8. Choice	0	0	2	1	0	0	0	-	2	-
I9. Self-expression	1	0	0	0	0	1	2	-	0	-
I10. Freedom	0	0	0	0	1	0	0	-	1	-
I11. Social Interaction	0	1	2	0	0	0	1	-	0	-
I12. Social Cooperation	0	0	1	0	1	0	0	-	0	-
I13. Social Competition	0	0	0	1	0	0	0	-	2	-
I14. Fairness	0	0	0	1	0	0	0	-	0	-
I15. Narrative	0	0	1	2	0	0	0	-	1	-
I16. Perceived Fun	1	0	0	1	0	0	0	-	1	-
E1. Ownership	0	0	0	0	0	0	0	-	1	-
E2. Rewards	1	0	0	0	0	1	0	-	1	-
E3. Virtual Economy	1	0	0	2	0	0	0	-	2	-
E4. Scarcity	0	0	0	0	0	0	1	-	0	-
E5. Loss Avoidance	0	1	0	1	1	0	1	-	1	-
C1. Clear & Immediate Feedback	0	0	0	0	1	1	0	-	1	-
C2. Actionable Feedback	0	0	0	0	0	0	0	-	1	-
C3. Graspable Progress	0	0	0	1	1	0	0	-	1	-
C4. Varied Challenges	0	1	1	1	1	0	1	-	0	-
C5. Varied Rewards	0	1	1	1	1	0	0	-	1	-
C6. Innovation	0	0	0	0	0	0	0	-	2	-
C7. Disruption Control	0	0	0	2	0	0	0	-	0	-
Total motivational issues	7	8	12	16	10	4	12	-	24	-
Other issues (usability, bugs, etc.)	3	2	-	-	-	4	2	-	-	-

The number of issues identified by the participant who had no prior gamification expertise and used the heuristics (P5) was just slightly higher than the participants who did not use the heuristics (P1 and P2), whether they had gamification expertise or not. However, it is noteworthy that the heuristics helped P5 identify issues in more dimensions than did P1 and P2: while P5 identified issues in 10 different dimensions for Habitica, P1's and P2's issues were concentrated in only 6 dimensions. Moreover, congruent to our intentions, the heuristics helped evaluators focus their analyses on the motivational affordances instead of other usability issues or bugs. This is demonstrated by the fact that P1 and P2 both reported some issues that were not related with the motivational affordances at all (e.g., usability issues or bugs), whereas P3, P4, and P5 only reported motivational issues.

Additionally, it was noted that participants who had prior gamification expertise and used the gameful design heuristics could identify approximately twice as many motivational issues as the participant who also had gamification expertise but did not use the heuristics. In comparison, P3 found 12 and P4 found 16 motivational issues in Habitica, whereas P2 found only eight. In Termling, P4 found 24 motivational issues while P2 found only 12.

In summary, the results provided the following evidence:

- A participant who had no prior gamification expertise, but used the gameful design heuristics, could find as many motivational issues as participants who did not use the heuristics (with or without prior gamification expertise), but in a broader range of motivational dimensions;
- Participants who had prior gamification expertise and used the gameful design heuristics could find twice as many motivational issues than participants who did not use the heuristics or did not have prior expertise;
- Using the gameful design heuristics helped participants focus their analyses on the motivational issues, avoiding any distraction with other types of problems, such as issues with usability or bugs.

6.4 Discussion

We have created a set of 28 gameful design heuristics aimed at enabling experts to evaluate a gameful system to identify design gaps. Our heuristics are based on prior motivational theories and gameful design methods. We deliberately decided to create a new set of heuristics specific to gameful design, rather than extending the existing heuristics for game design. Thus, in our assessment, none of the existing game design heuristics were adequate to evaluate gameful applications. By deriving our set of heuristics from common dimensions of motivational affordances employed by different gameful design methods, we have presented a novel and comprehensive approach that encompasses a broad range of motivational affordances. Furthermore, to enable expert evaluation., the heuristics are written in a concise form, together with supportive questions for reflection.

Our study with five UX and HCI experts provided empirical evidence that:

- gameful design heuristics can help UX evaluators who are not familiar with gamification to evaluate a gameful system at least as well as a gamification expert who does not use the heuristics; and
- gameful design heuristics can greatly improve the ability of gamification experts to perform an heuristic evaluation, leading them to find twice as many issues as they would find without the heuristics.

The implications of our findings for gameful design are twofold. First, we provide evidence that evaluation of gameful applications without a support tool is subjective; therefore, even gamification experts might miss important issues when relying only on their expertise. A probable reason for this is the complexity of gameful design and the number of different motivational dimensions involved. Second, we demonstrate that usage of the gameful design heuristics can significantly improve the results of heuristic evaluations conducted both by gamification experts and non-experts. Considering that gameful design still suffers from difficulties in reproducing successful results of some studies and that several results have reported mixed results [120,306], our work sheds light on one of the probable causes for this. Consequently, the gameful design heuristics represent an important instrument, which can be used by researchers and designers to improve the chances of building effective gameful applications.

Nevertheless, the study was limited by the small sample size. Thus, although these initial results seem promising, future studies with more participants will be needed to support the findings in this study. Additionally, even though the proposed method was meant to be generic enough to work in any heuristic evaluation of gameful applications, future studies will need to collect data from diverse usage scenarios to investigate if adaptations are needed for specific purposes.

Moreover, future studies should assess if the use of the gameful design heuristics instead of a more open evaluation procedure may have any unintended effect on the quality of the evaluation. For example, in our study, the evaluators who used the gameful design heuristics did not pay attention to issues of usability, whereas the evaluators who did not use the heuristics also noticed some usability problems. For the goals of the study, we considered it to be a positive outcome because we asked participants to focus on motivational issues. However, future assessments of the heuristic evaluation procedure we propose should observe if this could be detrimental in any way (e.g., making evaluators ignore other types of issues not covered by the heuristics) and propose strategies to mitigate the problem (e.g., by also asking evaluators to freely look for additional issues after checking the heuristics).

Furthermore, our study did not allow us to collect enough evidence to verify the rate of decrease of new issues found as more evaluators carry out the assessment of a system. Therefore, we are currently relying on evidence from studies of heuristic evaluation of usability, which identified that three to five evaluators make an optimal team size, after which the returns begin to decrease with the addition of more evaluators. However, future work will need to collect evidence about the effectiveness of different sizes of evaluation teams specifically using the gameful design heuristics, to verify if the recommended team size will remain the same as usability heuristic evaluation or if a different number should be recommended for heuristic evaluation of gameful design.

6.5 Conclusion

Our work contributes to the HCI field and to gameful design research and practice by presenting a novel evaluation tool for gameful applications. The suggested method fulfills a need for evaluation tools specific to gameful design. As such, we expect it to be of use to both researchers and practitioners who design and evaluate gameful applications, whether in research studies or in industry applications.

Chapter 7 A Platform for the Study of Personalized Gameful Design

The previous chapters introduced a method that can be used to design personalized gameful systems. However, to advance the scholarship of personalized gamification, researchers will also need to evaluate how users interact with personalized gameful systems and how different personalization approaches affect their performance and experience with the system. Therefore, this chapter is dedicated to the design, implementation, and pilot evaluation of a software platform for the study of personalized gameful design.

The platform was designed as a customizable system that uses a variety of gameful design elements implemented around a central task. For our pilot study, it was an image classification task, but it can be modified according to the needs of each specific study. These gameful design elements can be activated or deactivated by the researcher or the user, allowing experiments to be conducted in which participants interact with different sets of elements. Researchers can then compare the user experience and performance between different conditions.

In the following subsections, we first describe the design and implementation of the platform. Then, we describe a pilot study with 50 participants who used a customizable version of the platform where they could select the gameful design elements that they wanted to use. Results show that users understand the gamification customization task and can select their preferred elements. They also provide insights into how frequently each element is selected. Finally, we discuss how this platform can be used for future studies related to personalized gamification.

7.1 Platform Design

The target application is to enable users to carry out a simple, repetitive task, while at the same time interacting with gameful design elements that would help them gauge their progress and improve their engagement with the task. The choice of a simple, repetitive task was necessary because the user should not feel too absorbed with it. Moreover, the task should be simple enough that participants could quickly understand how to complete it, so they could begin quickly interacting with the system. Finally, it should be a quick task, which could be completed in a few seconds, so we could ask participants to do it several times. This repetition of a microtask creates an adequate condition to use gamification to increase the user's motivation to complete it, as the use of external incentives is more likely to increase performance without hindering intrinsic motivation [51]. Considering these aspects, the task we chose is image classification. Each microtask consists in listing all the classification tags that the participant can think of for a stock image. Stock images were randomly downloaded from Pexels[7] (which provides stock photos free for any usage) and made available as classification tasks in the platform.

[7] https://www.pexels.com

Figure 7-1 shows an example of an image classification task in the platform, without any gameful design element attached to it.

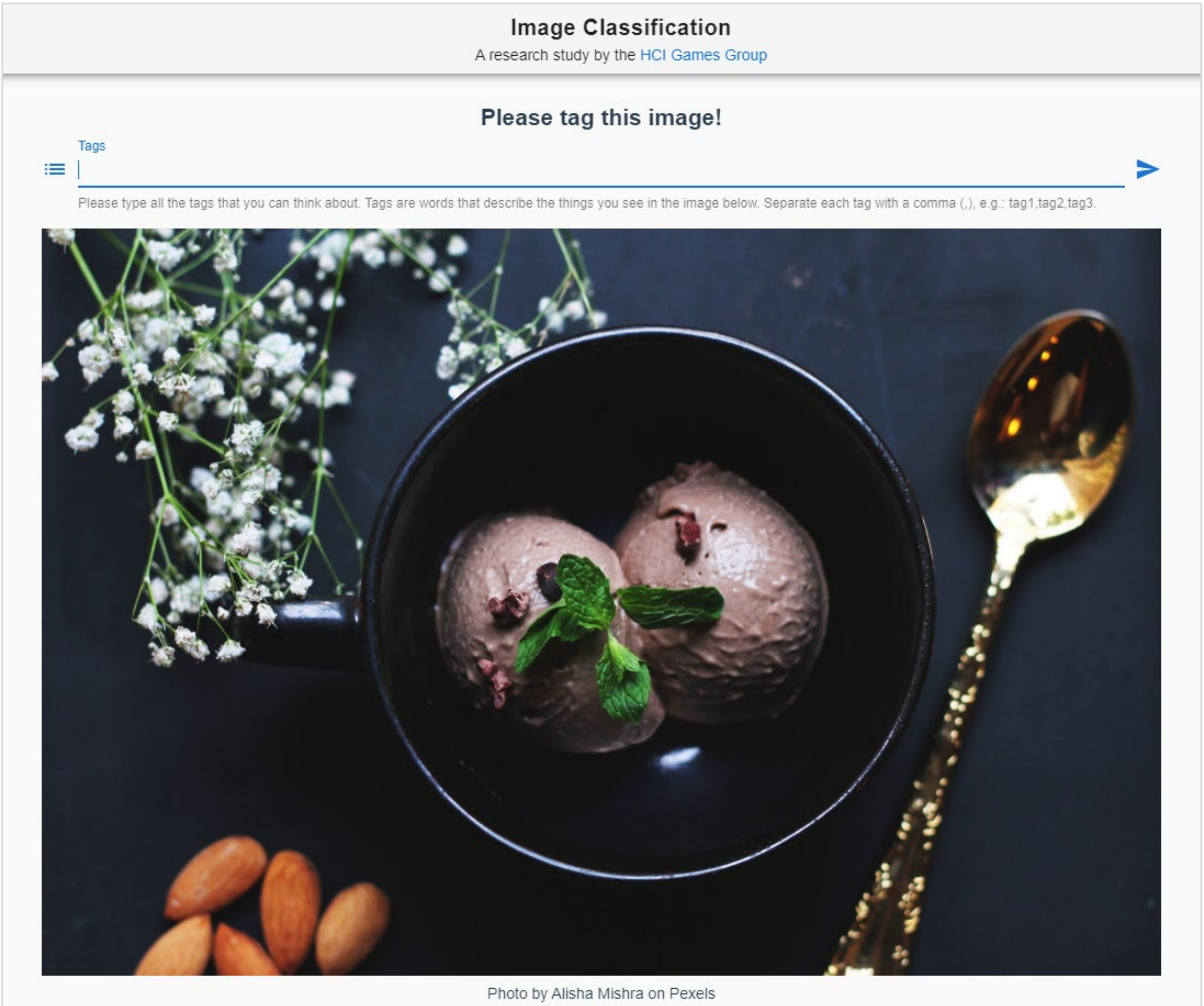


Figure 7-1. The image classification task used in the personalized gamification platform.

The use of classification microtasks was already reported on previous studies of customizable gamification [9,183]. Therefore, this is an interesting type of task to allow for comparisons with previous results. Moreover, these tasks are similar to brainstorming tasks, which have also been used in previous empirical studies of gamification [176] because they have been found to provide a good opportunity to investigate task performance in relation to goal setting. By combining these two types of tasks in our study, we can implement gameful design elements that motivate participants on two levels: (1) to complete more microtasks and (2) to perform better in each task by listing a higher number of tags.

It is important to note that this classification task is not the main goal of the platform, it is merely a device to build the gameful experience of the user around it, allowing the researcher to study gameful experiences. Future researchers could also replace the task with another one if they find something that is more suited to their needs.

7.1.1. Gameful Design Elements

Following the method for personalized gameful design outlined in Chapter 3, we selected gameful design elements for our platform that would be appealing to users with different preferences, based on the Hexad user types framework (see Chapter 4) and the classification of gameful design elements (see Chapter 5). Thus, we looked at the groups of elements (Table 5-2) and selected two elements from each group that would work best together with image classification task. The following gameful design elements were selected to be included in the platform:

Table 7-1. Gameful design elements selected for the platform for the study of personalized gameful design.

Group	Element	Design
Progression	Levels	Users level up as they complete tasks and earn points
	Progress feedback	The system shows how much the user is progressing relative to the total number of tasks that can be completed
Immersion	Narrative	A story will be told as the user progresses through the tasks
	Easter Eggs	Entering some combinations of tags will unlock Easter Eggs
Altruism	Gifting	Users can send gifts with points to other users
	Moderating role	After writing tags for an image, the user can act as a moderator by checking a list of tags given by other people and flagging those tags unrelated to the image
Incentive	Badges	Users earn badges as they complete tasks, which show in their profile and are visible by others
	Unlockable content	Users can unlock customization options for their avatar
Socialization	Leaderboards	Users can see how they compare to others in a leaderboard
	Teams	Users can team up with others for challenges with unique rewards
Risk/Reward	Challenges	Users receive challenges related to the number of tasks to complete and the number of tags in each task
	Chance	After each completed task, the amount of points received will be decided by luck
Assistance	Power-ups	A power-up boost the number of points received by the user for a limited time or number of tasks
	Glowing choice	Users can ask for hints regarding the tags for an image if they run out of ideas

The elements listed in Table 7-1 were designed to work independently from each other. Therefore, any element can be activated or deactivated in the software and the activated elements will work even if other elements are not present. This allows researchers to manipulate the elements for different participants (or allow the participant to customize them) to foster different gameful experiences.

In addition, three features were implemented to support the gameful elements: points, avatars, and customization. Points are used by the following elements: levels, to decide when the user should level up; gifting, so that users can send gifts of points to each other; unlockable content, so users can spend points to unlock additional avatars; leaderboards, which allow users to compare the amount of points they earned with other users; chance, which applies a random modifier to the amount of points earned after each task; and power-ups, which apply a fixed modifier to the amount of points earned. Points are automatically enabled in the platform when any of these elements are enabled, otherwise they are disabled.

An avatar can be selected by the user to represent them in the menus and leaderboards. It is always possible to select an avatar, but the available options are limited unless the game element unlockable content is enabled. Customization allows the user to select what gameful design elements they want to use while interacting with the platform. Customization can be enabled or disabled by the researcher to create different research conditions. In our pilot study, customization was enabled for all participants.

7.2 Platform Implementation

The software design described in the previous section was implemented for a pilot study.

7.2.1. Technology

The platform was implemented as a single-page web application using the Vue.js[8] JavaScript framework (v. 2.6.10, Evan You, 2019). The user interface followed Material Design[9] (a collection of visual design guidelines published by Google) and was implemented using the Vuetify[10] component framework (v. 1.5.12, Vuetify, LLC, 2019). All data is stored on a Firebase[11] real-time database server operated by Google and data access was implemented using the Firebase Web API (v. 5.10.0, Google, 2019).

7.2.2. Images

For classification tasks, 50 images were randomly selected from the website Pexels. The criterion for image selection was that they should be aesthetically pleasing (as subjectively evaluated by the researcher) and show neutral content (not offensive or controversial), such as animals, places, people, or food. A database of images is included in the software implementation, containing the image files, title, author name, and list of tags provided for the image on Pexels.

7.2.3. User Interface

[8] https://vuejs.org/
[9] https://material.io/
[10] https://vuetifyjs.com/
[11] https://firebase.google.com/

The user interface is composed of two parts: the menu area and the main area (see Figure 7-2). The menu area provides access to the different parts of the system. The main area is occupied by the task currently being carried out. By default, this is the image classification task, but the user can use the menu to switch to administrative tasks (such as verifying their own profile or the study information) or game-related tasks (such as seeing the leaderboard or managing gifts, badges, or challenges). The menu area is fully collapsible. On large screens, it is open by default and appears side by side with the main area. (see Figure 7-2). On small screens (such as mobile devices), it is collapsed by default and overlaps the main area when it is open (see Figure 7-3).

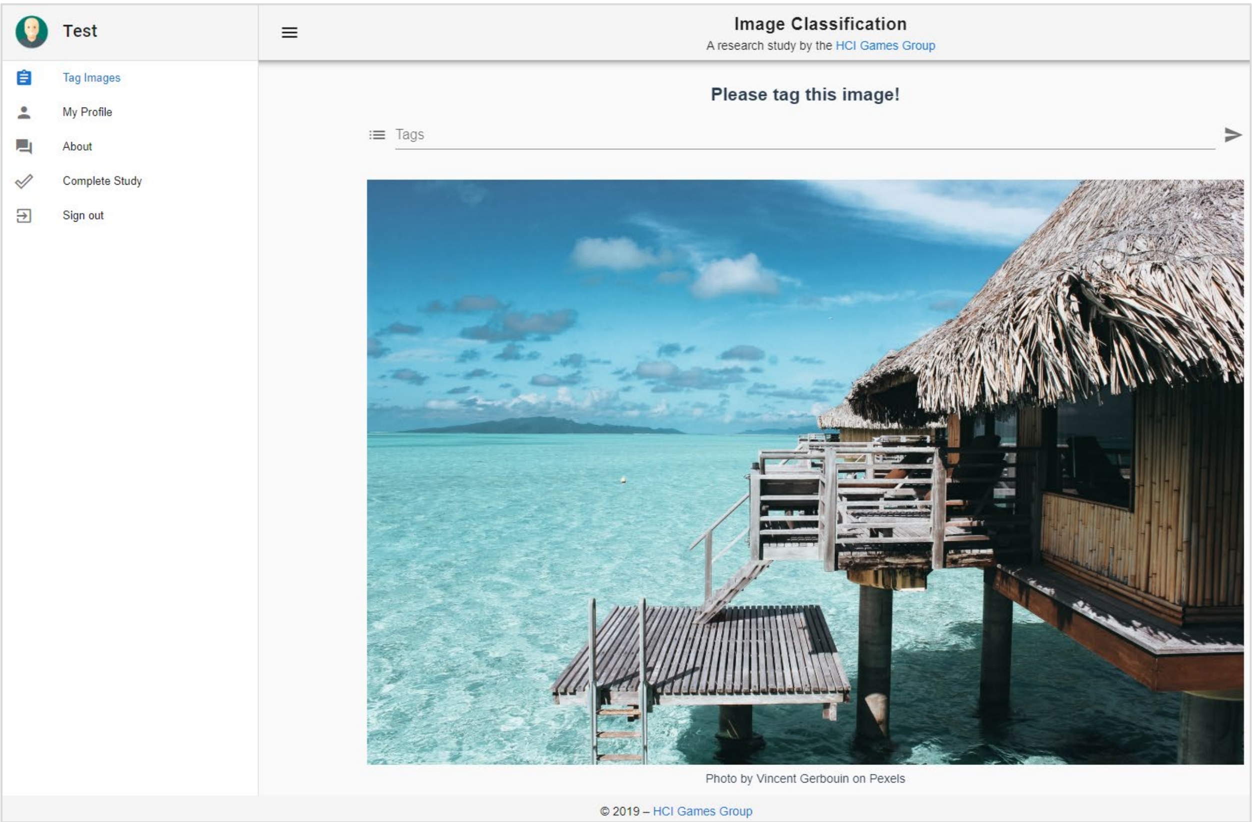
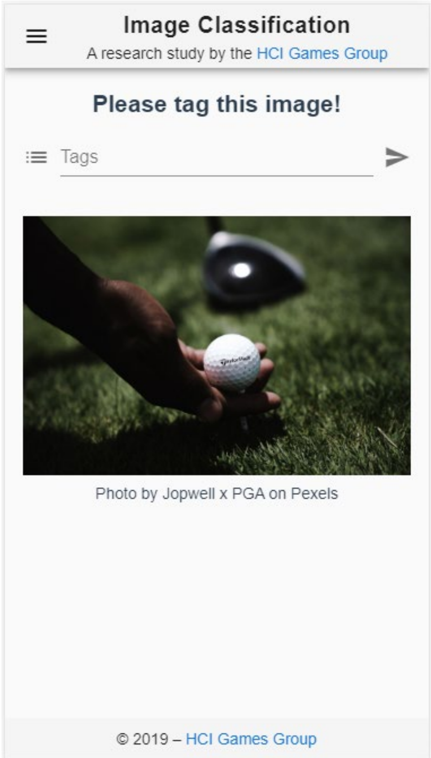


Figure 7-2. Main user interface with the menu on the left and the main area on the right.

7.2.4. Fixed Features

7.2.4.1. Avatar

The game element *avatar* was implemented as a fixed element, so it is always active no matter what the customization options are. The user can select an avatar during the initial registration process and can change it at any time in the *Profile* menu option. There are 18 standard avatar options (see Figure 7-4), unless unlockable content is enabled (see Section 7.2.5.6). The avatar will always be shown beside the user nickname in the menu, leaderboards, and gift UI.



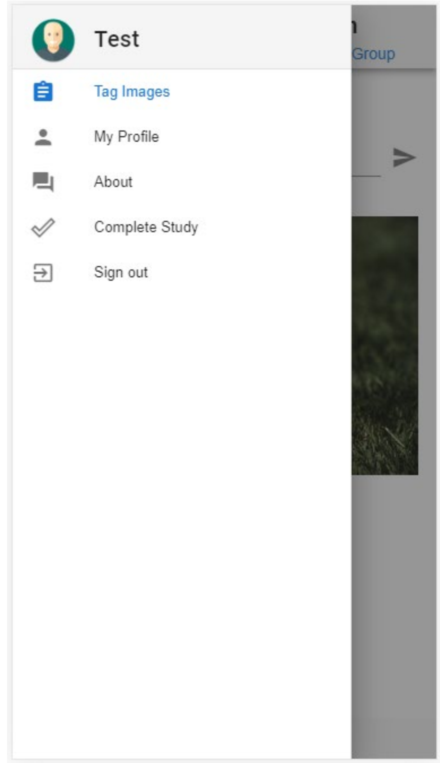


Figure 7-3. Main user interface (small screen layout) with the menu collapsed (left) or opened (right).

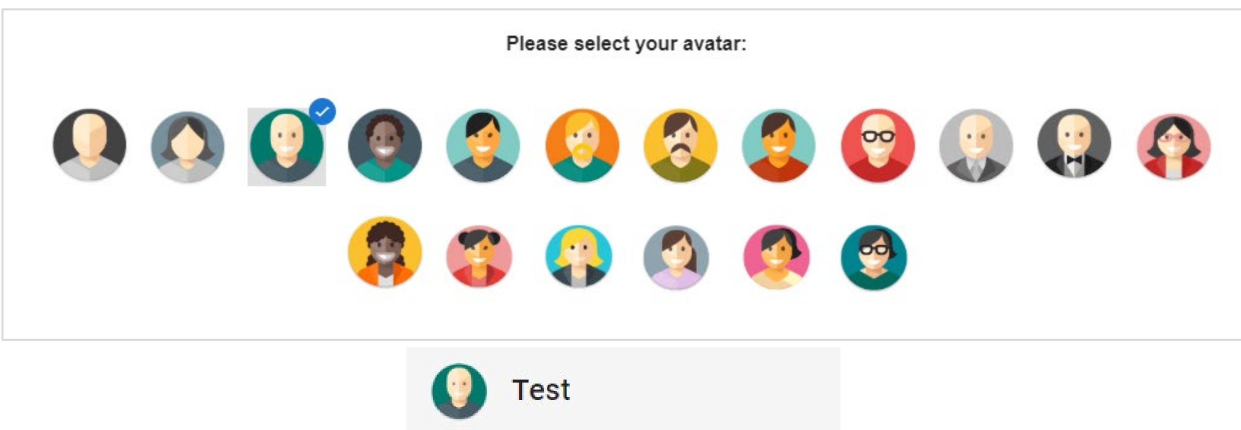


Figure 7-4. At the top, selection of the normally available avatars. At the bottom, detail of the menu with the selected avatar beside the user's nickname.

7.2.4.2. Customization

This feature allows the user to customize their experience by selecting the gameful design elements that they want to use, as explained in Section 3.2.2.1. This feature can be enabled by the researchers or not, allowing them to create different conditions for comparison in the experiment. Figure 7-5 shows how the customization options are presented to the user. This interface is presented right after the registration process, before the user begins classifying images.

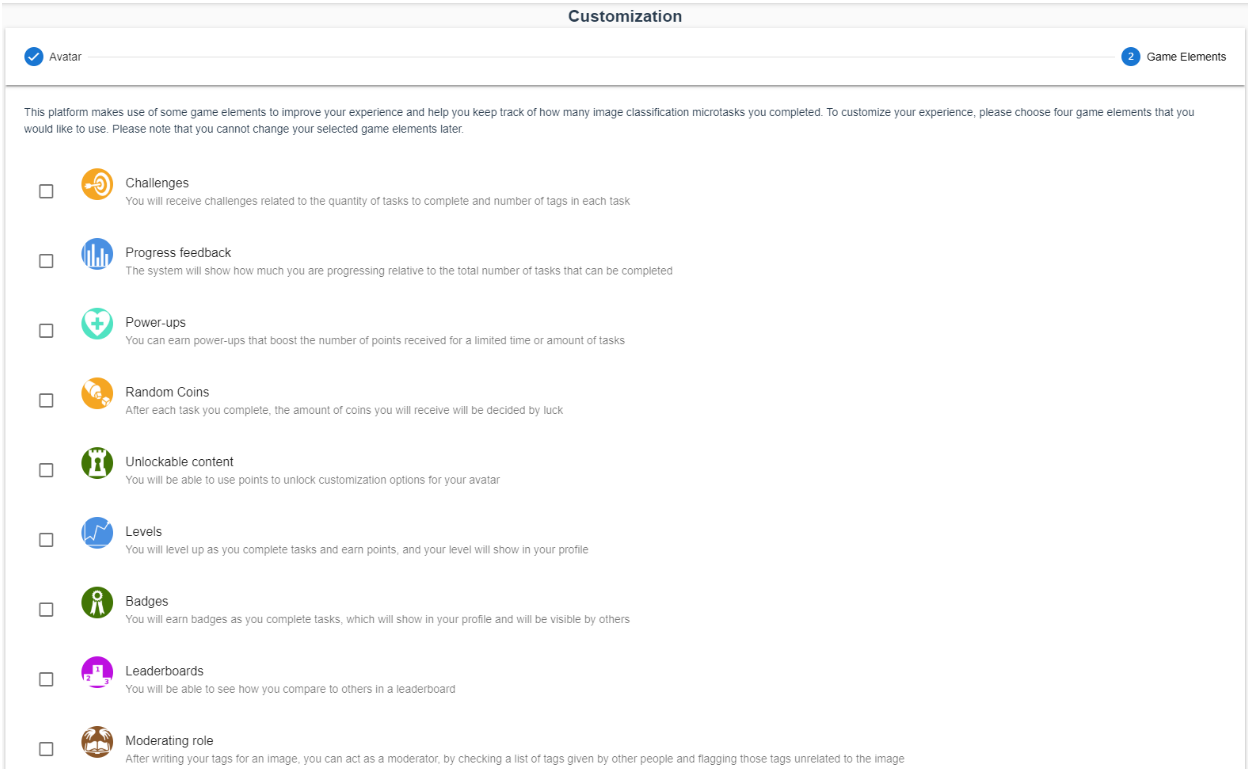


Figure 7-5. Customization of gameful design elements by the user.

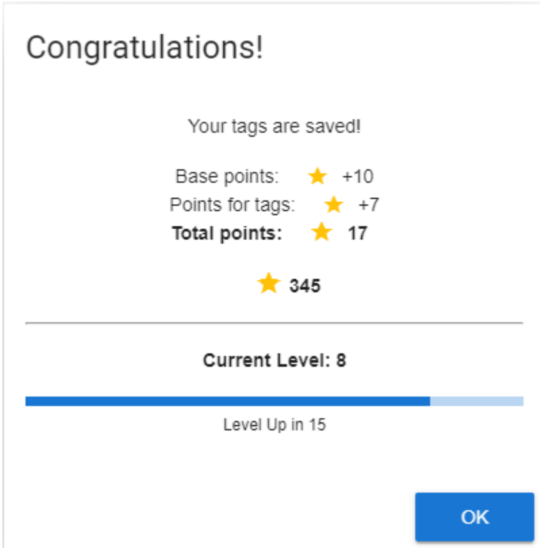
7.2.4.3. Points and Coins

As explained in the previous subsection, the use of points is activated automatically by the software if any of the following gameful elements is in use: levels, gifting, unlockable content, leaderboards, chance, and power-ups. After submitting the tags for an image, the user earns 10 points for the image completion, plus one additional point per tag submitted for the image. This amount can be further modified by chance or power-ups, which will be explained shortly. Furthermore, if unlockable content is enabled, users also earn virtual coins at the same moment and at the same rate that they earn points. The difference is that points only add up, whereas virtual coins can be spent to unlock avatars, and can thus decrease over time.

The amount of points earned after each image is classified is shown in a popup dialog. Additionally, the total amount of points the user has is always visible in the menu area when the use of points is enabled (see Figure 7-6).

7.2.5. Gameful Design Elements

In the version implemented for the pilot study, the following gameful design elements from Table 7-1 were implemented: levels, progress feedback, gifting, moderating role, badges, unlockable content, leaderboards, challenges, chance, power-ups, avatar, and customization. The following elements may be implemented as future work: narrative, Easter Eggs, teams, and glowing choice.



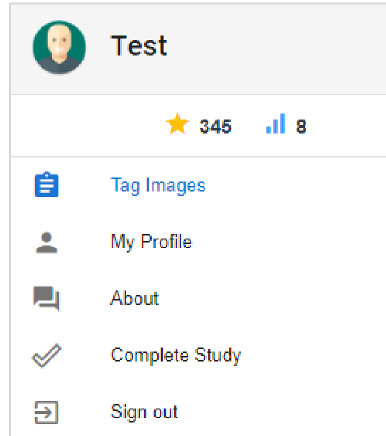


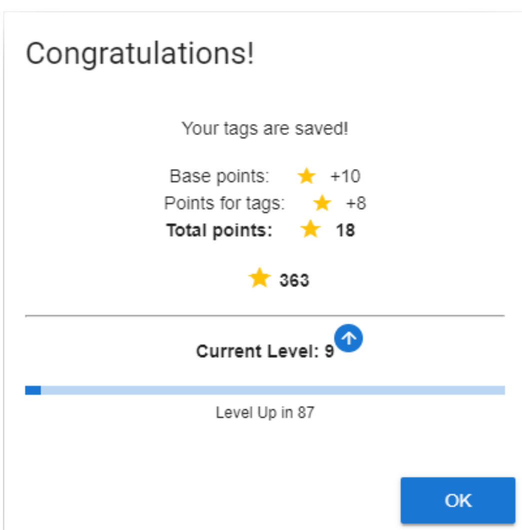
Figure 7-6. Popup dialog showing points earned after an image classification task (left) and total points shown in the menu (right, beside the star icon).

Next, we will describe the implementation and mechanics of each gameful design element.

7.2.5.1. Levels

When levels are enabled, the user will level up based on the total amount of points that they have accumulated. To level up from level A to level B, $10 \times A$ more points are needed.

The current level of the user is showed in the popup dialog after each image is classified, with an up arrow indicating when level up occurs. In addition, a progress bar shows information about the amount of points needed for the next level up. The current level is always shown in the menu area when the use of levels is enabled (see Figure 7-7).



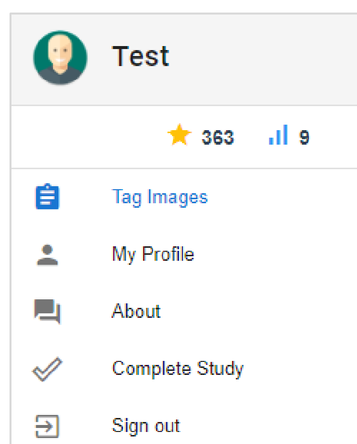


Figure 7-7. Popup dialog showing level up after an image classification task (left) and current level shown in the menu (right, beside the histogram icon).

7.2.5.2. Progress Feedback

When progress feedback is enabled, a progress bar is shown after an image classification task is completed informing how many images the user has already classified and how many images are there in total. The same information is shown in condensed format in the menu (see Figure 7-8).

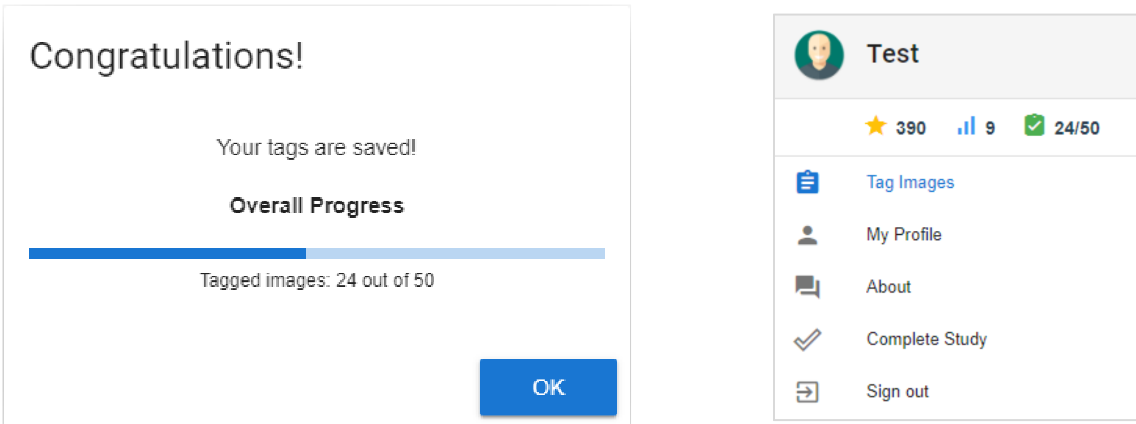


Figure 7-8. Popup dialog showing progress feedback after an image classification task (left) and progress feedback in the menu (right, beside the checkmark icon).

7.2.5.3. Gifting

The user interface for gifts appears in the main area and has two tabs: Receive and Send (see Figure 7-9). Each user can send a gift once per day to each other user, in the value of 10% of the amount of points that the sender currently has. Received gifts keep pending reception until they are claimed by the recipient. Upon reception, the amount of points in the gift is added to the total points of the user who received it.

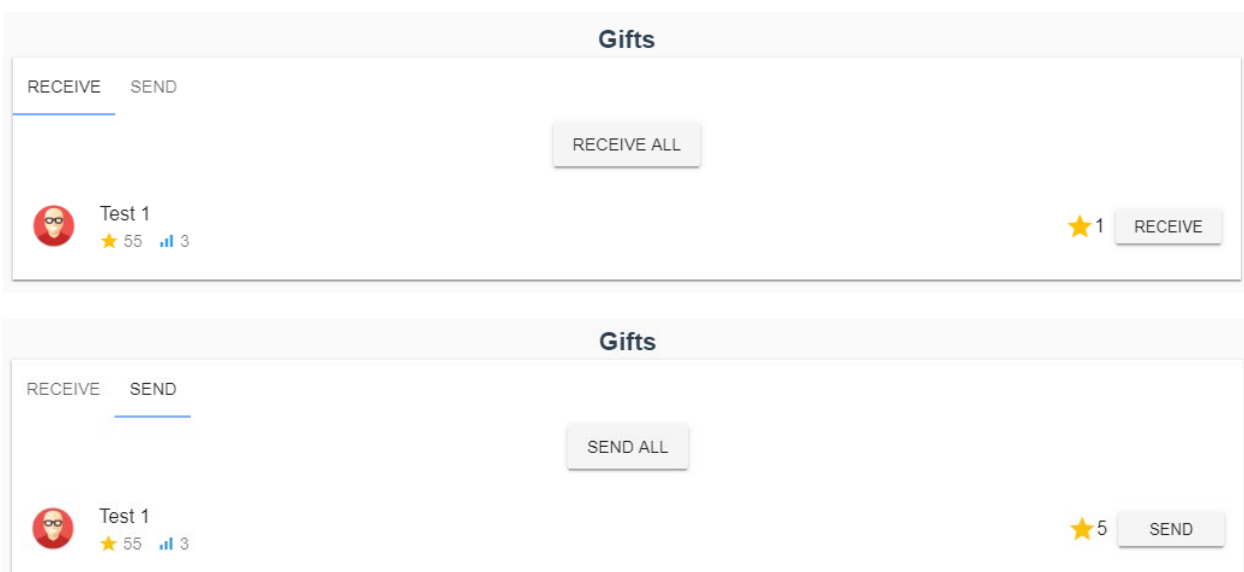


Figure 7-9. Details of the tabs for git reception (top) and sending (bottom). In the left, the UI shows the other user who is receiving or sending the gift ("Test 1"), and by the star icon, the amount of points in the gift.

7.2.5.4. Moderating Role

If the element *moderating role* was enabled, an additional popup is shown after each image classification confirmation. It asks if 10 tags from a list are related to the image just classified (see Figure 7-10). In this pilot, the tags shown are not actually the tags provided by other users, even though users are led to believe that they are. Instead, they are tags chosen from those already provided for the images on Pexels. This was done to avoid the risk of showing offensive or inappropriate content in the platform: if one user entered inappropriate content as tags, and this was shown to other user asking for moderation, it would pose an ethics concern since our platform is supposed to be clean of offensive, inappropriate, of controversial content. To show a list of tags that could be related to the image or not, the software joins the list of tags that belongs to the image with the list of tags from another one of the other 49 images in the system, chosen randomly. From the union set of tags, 10 are then chosen randomly. Thus, the 10 tags shown to the user will typically contain a few tags that belong to the image they just tagged, as well as some tags that came from another image and thus do not correspond to the image they just tagged. This was done so the user always had some tags to agree with and some to disagree with, so they feel that they are doing real moderation work. As with the tags provided by the user, the results of the moderation are not really important (but they could be in a real image classification study). They only serve as a means to create a gameful experience.

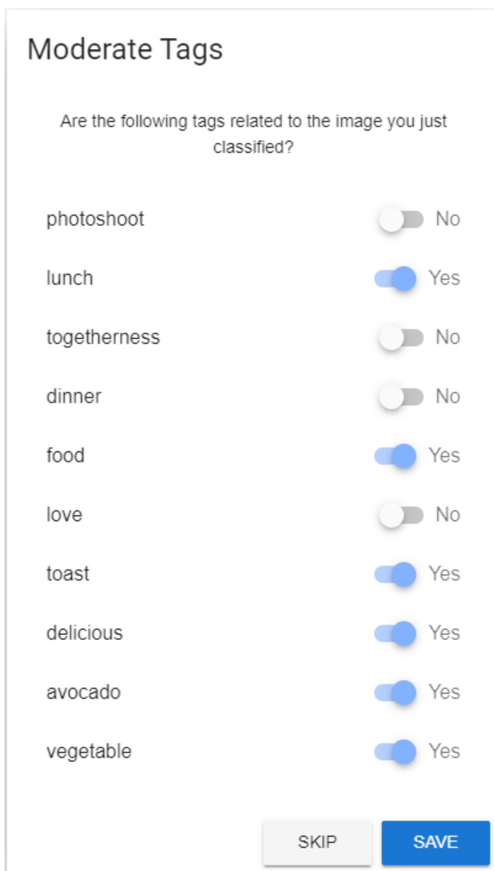


Figure 7-10. Popup dialog asking the user to moderate 10 tags.

7.2.5.5. Badges

The user interface for badges appears in the main area and shows all the badges that can be obtained in the system (see Figure 7-11 to see a list of available badges). Badges are unlocked automatically once the conditions are satisfied. For example, the first badge is unlocked after the user classified 10 images. At any moment, the user can select one of the unlocked badges to use in their profile. Then, the image of the selected badge will appear beside the user nickname wherever it appears (see bottom part of Figure 7-11).

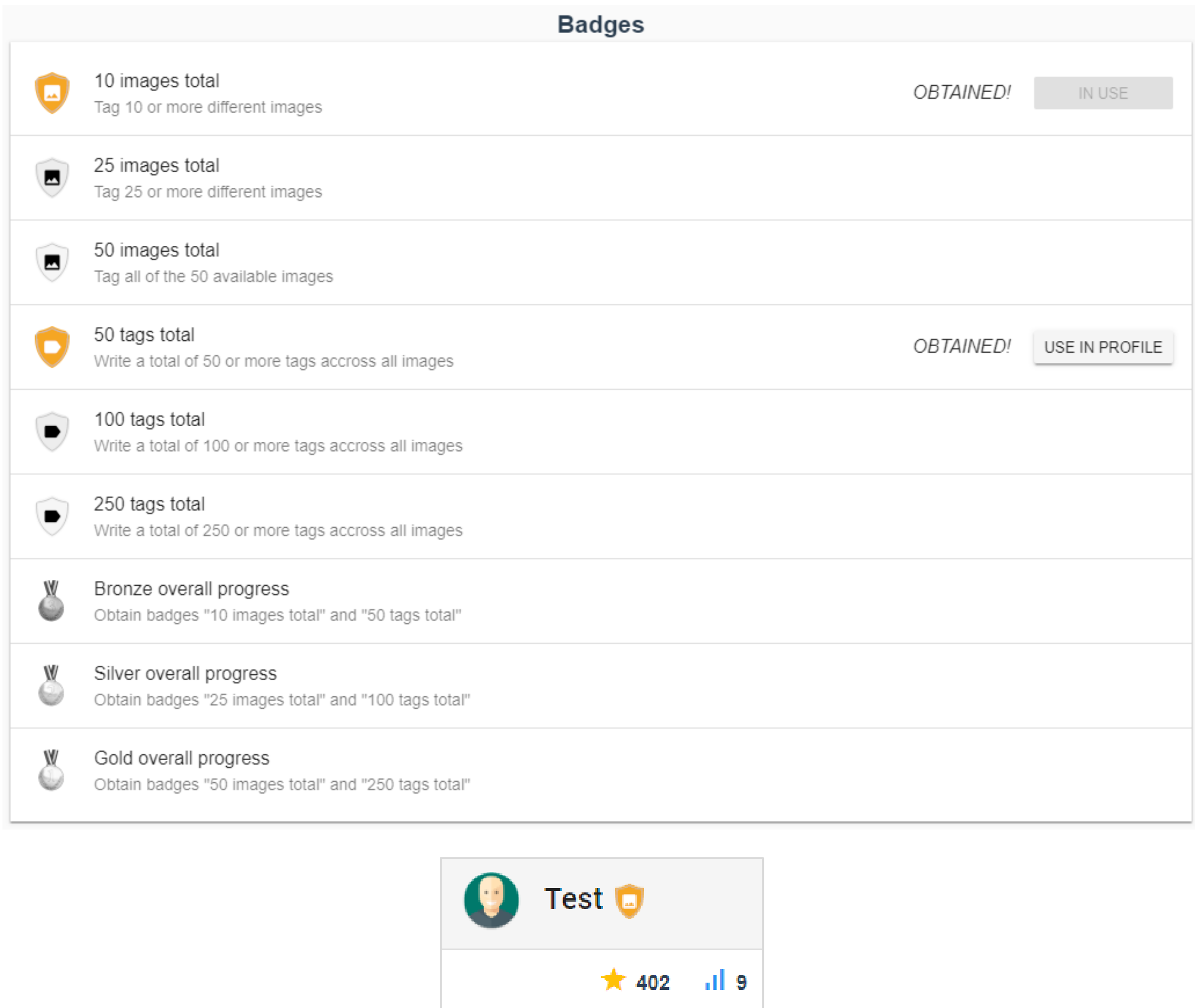


Figure 7-11. At the top, the user interface showing all the badges obtainable in the system, and an example with a couple of badges already unlocked for the user. At the bottom, detail of the menu showing the selected badge beside the user's nickname.

7.2.5.6. Unlockable Content

If unlockable content is enabled, then several locked avatars are added to the list of avatars available for selection. Otherwise, only the free avatars are shown. The user first selects the avatar when they register into the system, and this selection can be modified at any time in the user profile.

The platform always offers 18 free avatars and 92 additional locked avatars are offered only if unlockable content is enabled (see Figure 7-12). If the user selects a locked avatar, a popup dialog prompts them to spend virtual coins to unlock it (see Figure 7-13). Avatars cost 100 or 200 virtual coins to unlock. As mentioned before, users earn virtual coins at the same moment and at the same rate that they earn points. When unlockable avatars are enabled, the current amount of virtual coins available is also always shown in the menu area (see Figure 7-13).

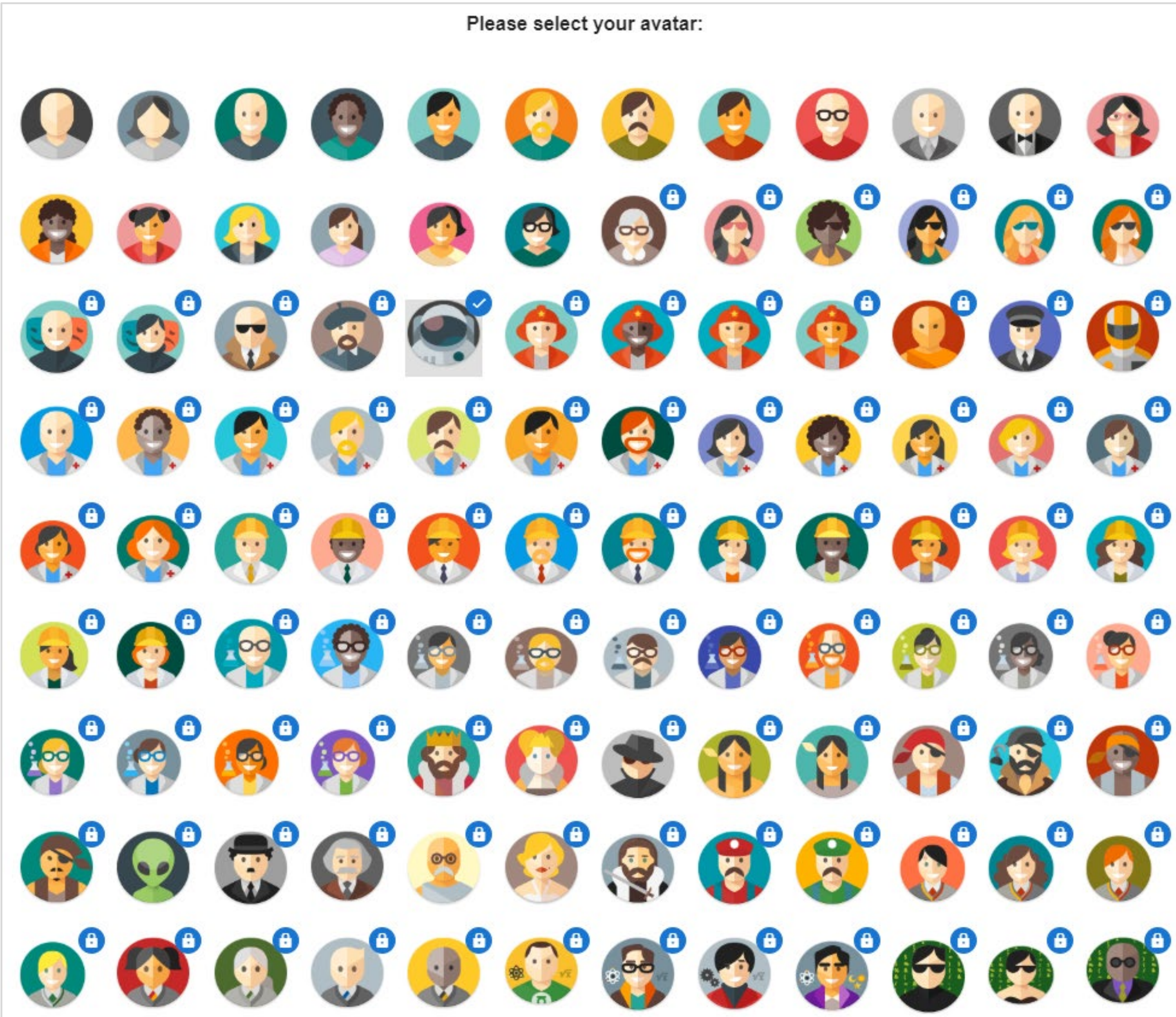


Figure 7-12. Selection of available avatars with unlockable content. The avatars with the lock icon are initially locked and can be unlocked by the user by paying with virtual coins.

7.2.5.7. Leaderboards

The leaderboard appears in the main area when selected in the menu (see Figure 7-14). This interface displays a table that lists all the users that have opted to use leaderboards, ordered by the total amount of points earned by each user so far.

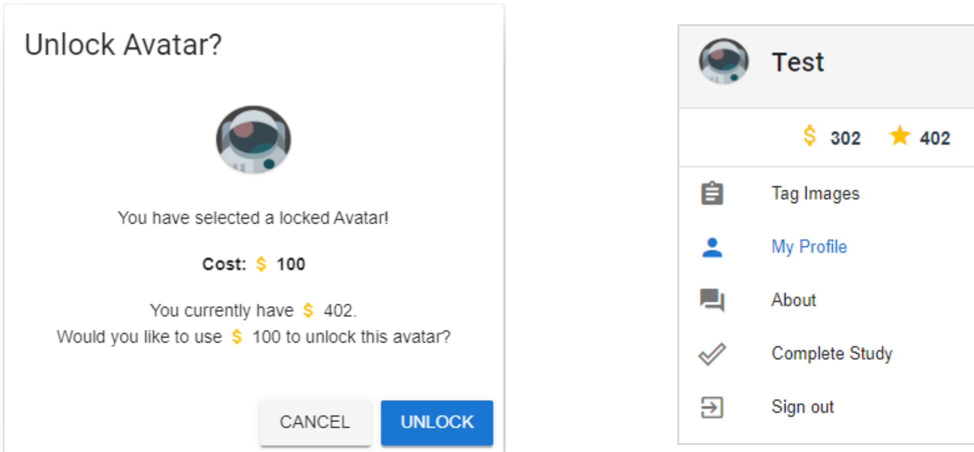


Figure 7-13. On the left, popup dialog prompting the user to spend virtual coins to unlock an avatar. On the right, menu area with an unlocked avatar displayed beside the user's nickname and the amount of virtual coins available displayed beside the money icon.

Figure 7-14. A leaderboard with four users. User "Test" is in the lead.

7.2.5.8. Challenges

The user interface for challenges appears in the main area and shows all the challenges that can be completed in the system (see Figure 7-15). When the user completes a challenge, they earn points according to the difficulty of the challenge. The system detects if any challenge was completed after each image classification is saved. Completed challenges become claimable in the challenges' user interface. The user must then open the interface and click the *Claim* button to receive the corresponding points (see Figure 7-15).

7.2.5.9. Chance

If chance is enabled, then the amount of points earned by the user after classifying each image is multiplied by one of the following values: 1, 2, 3, 4, 5, 1/2, 1/3, 1/4, or 1/5, all with equal probability. When chance is enabled, the popup dialog that appears after an image is classified is modified to show the multiplier applied and the total amount of points earned after the multiplier (see Figure 7-16). In case of multipliers lower than one, the dialog shows a division instead of a multiplication (e.g., ÷ 2 is shown instead of × 1/2).

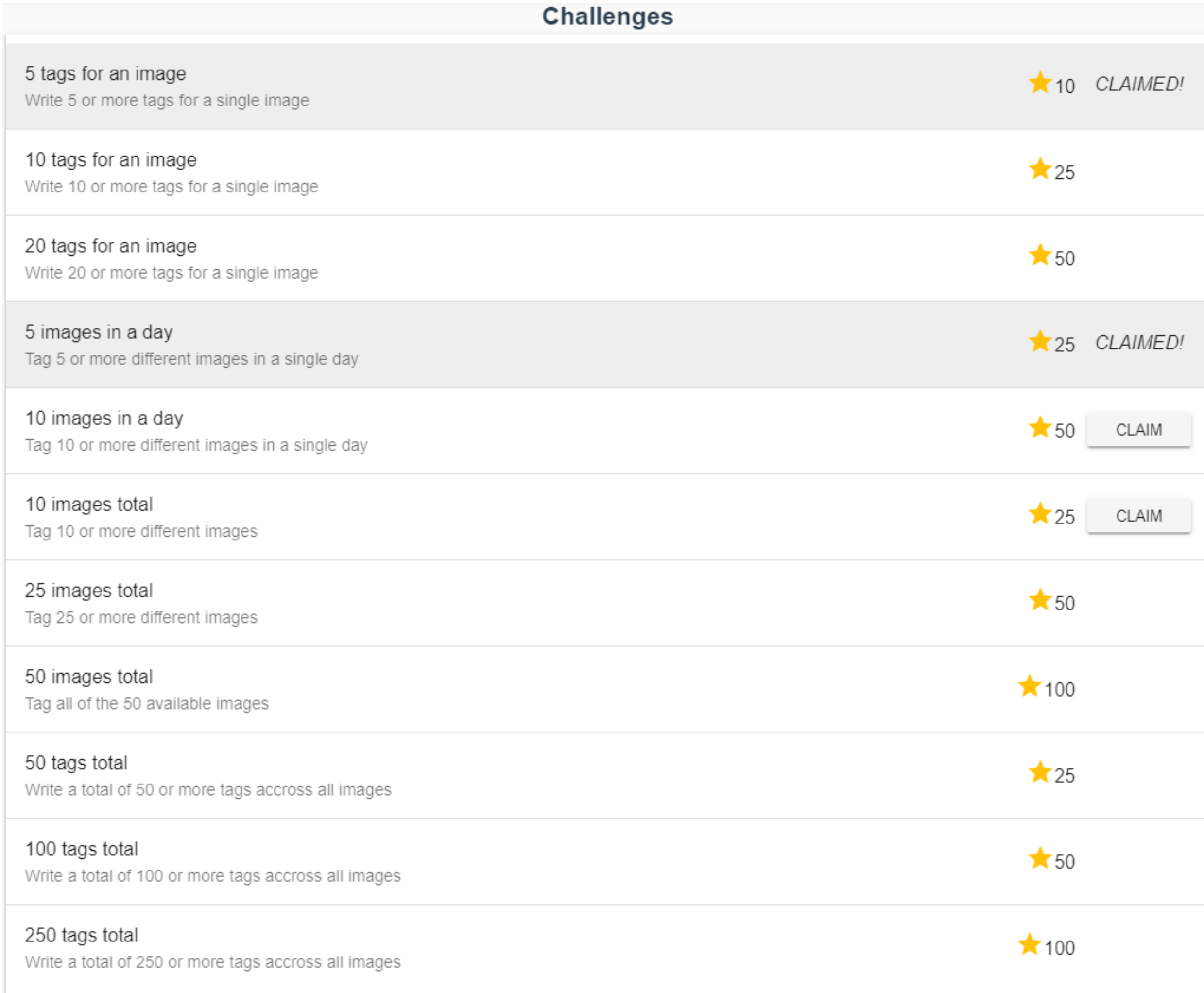


Figure 7-15. The user interface showing all the challenges in the system, and an example with a few challenges already completed and claimed for the user.

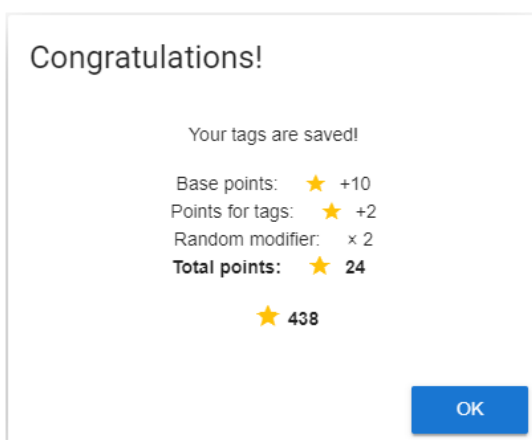


Figure 7-16. The popup dialog showing a ×2 multiplier, displayed as “Random modifier”.

7.2.5.10. Power-ups

When power-ups are enabled, there is a 30% chance that a power-up is earned after each image classification (see Figure 7-17, left). The available power-ups are “5x2” (doubles the amount of points earned for the next 5 images tagged), “5x3” (triples the amount of points earned for the next 5 images tagged), “10x2” (doubles the amount of points earned for the next 10 images tagged), and “10x3” (triples the amount of points earned for the next 10 images tagged). If a power-up is earned, one of the four types is randomly selected with equal probability. All the earned power-ups are stored in an inventory, which can be accessed by clicking on the *Power Ups* button that appears by the *Tags* text-field during image classification. Clicking on this button opens a dialog that lists all the power-ups in the inventory and allows the user to activate one of them (see Figure 7-18). After a power-up is activated, its effect is applied to all the images classified (doubling or tripling the amount of points earned) until it runs out, according to the type of power-up used (see Figure 7-17, right).

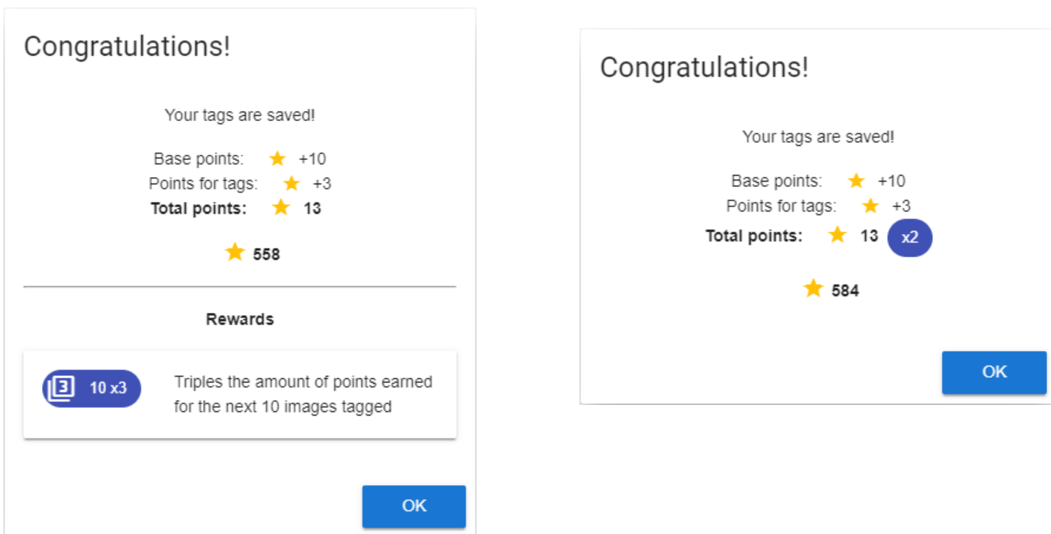


Figure 7-17. On the left, the popup dialog showing a power-up earned after tagging an image. On the right, the multiplier provided by a power-up shown as “× 2” by the total points earned.

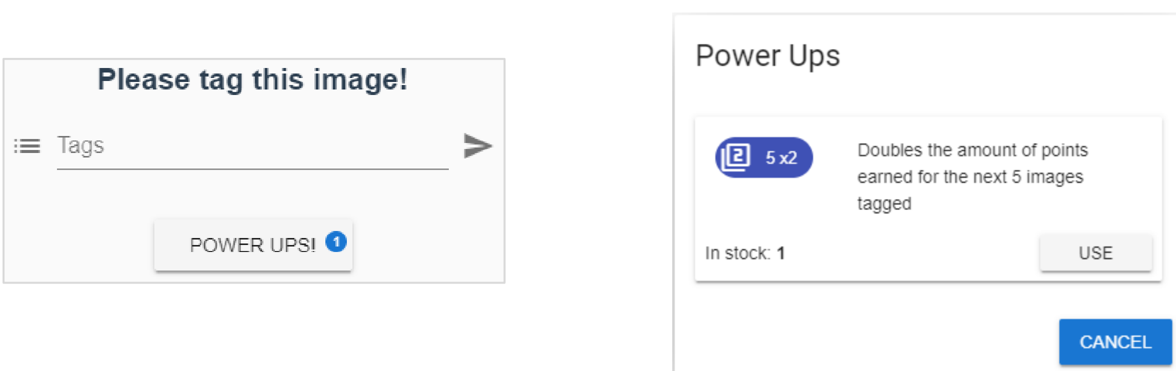


Figure 7-18. On the left, detail of the *Power Ups* button showing below the text field for image tagging. On the right, popup dialog showing the inventory of currently owned power ups.

7.3 Pilot Study

We conducted a pilot study to gather participants' impressions regarding the experience of customizing the gameful design elements in the platform. Participants chose four elements between the available choices, then they interacted with the platform freely to classify up to 50 images. After, we gathered qualitative feedback about their experience. The results of this study focus on which gameful design elements were selected by participants and a qualitative analysis of their impressions.

7.3.1. Participants

We recruited participants through Amazon's Mechanical Turk, which is being increasingly used for HCI experiments [41]. The guidelines for ethical recruitment of participants using this platform published by the University of Waterloo Office of Research Ethics were followed. We recruited a total of 50 participants split into two batches: 10 participants on 24 April 2019 and the remaining 40 participants on 25 April 2019. The first small batch was used to test if the platform was working properly and if the workers were able to understand and complete the task. Since no problems were identified, we proceeded with the recruitment of the remaining participants on the following day.

In both batches, participants were required to have a HIT (high intelligence task) approval rate greater than 97% and number of HITs approved higher than 5,000. This was done to ensure that only workers with a good history in the platform accepted our task. The HIT description on Mechanical Turk contained a brief description of the image classification task without mentioning the gameful elements and a link to the application described in the previous section. Participants were informed that the estimated duration of the task was between 30 minutes and 1 hour and were paid a fixed amount of \$ 5.00 (five American dollars) after completion of the task. This remuneration was paid to all participants who submitted a completion code for the HIT, even if they did not complete all the steps of the study procedure, congruent to the ethical participant recruitment guidelines.

After verifying the answers submitted by the 50 participants, all of them completed the procedure until the end and appeared to have completed the study with attention since all provided meaningful answers to the qualitative questions. Therefore, all answers were included in the analysis. The sample contained answers from 23 women and 27 men, with ages varying from 22 to 64 years old (M = 34.1, SD = 9.2). They spent an average of 24.2 minutes on the platform (SD = 20.5), tagged 27.3 images on average (SD = 18.9) with a total of 120.8 tags on average (SD = 97.3), and earned a total of 801 points on average (SD = 750). Participants were distributed geographically as follows: 43 from the United States, 4 from India, 2 from Italy, and 1 from Panama. Participants' scores in the Hexad user types followed a similar distribution as other reports (see Chapter 4), with the following means and standard deviations: Achiever: 22.8 (3.4); Player: 22.7 (3.1); Philanthropist: 22.3 (3.0); Free Spirit: 21.8 (3.3); Socialiser: 19.6 (4.7); and Disruptor: 13.9 (5.3).

7.3.2. Procedure

After following the link to the application, participants had to read and accept the informed consent letter. It described the image tagging tasks and framed the study as image classification research, without mentioning that we were actually studying gameful design elements. This deception was done to ensure that participants would interact naturally with the gameful elements without any bias that could be caused by the knowledge of the focus of the study.

Following the informed consent, participants answered a short demographic information form (gender, age, country, Hexad user types scale [323], and Big-5 personality traits scale [283]). Next, they were invited to customize their profile by selecting a nickname and an avatar. The nickname served to identify them in the software without giving away their real identity. Finally, they were asked to select four game elements among the nine available options. All the game elements described in the previous section were offered, except for gifting because in this pilot participants would only interact with the platform for a few minutes. It would not make sense that they would be allowed to send a gift per day to other participants if they would not be interacting with the platform for more than one day, and they could not go back to receive the gifts once they completed their participation. The reason we asked them to select four gameful elements (as opposed to letting them select all or none, for example) was so we could later ask about the experience of making this selection.

After completing the demographic questions and customization options, participants were left to interact with the platform freely. Logically, the image tagging tasks were the focus point of the platform, and participants could complete as many of them as they wanted up to the limit of 50 available images. During this period, participants could also interact with the features provided by the four gameful design elements that they selected.

When they felt they had tagged enough images, participants clicked the option *Complete Study* in the menu. At this point, they were asked to complete a questionnaire that included the Intrinsic Motivation Inventory (IMI; [210]) and the following questions. All were presented as a free-text entry, except the rating (Q2), which also included a 5-point Likert scale.

- **Q1**: Overall, how do you describe your experience with the image classification activities you just completed?
- **Q2**: How do you describe the experience of selecting game elements to customize the platform for you? (Likert scale with *very negative*, *negative*, *neutral*, *positive*, and *very positive*, in addition to the free-text answer)
- **Q3**: Were you satisfied with the selection of game elements provided by the system? Why?
- **Q4**: Were you able to select game elements that matched your preferences? Why?
- **Q5**: How much do you feel that the selection of game elements you used to customize the platform for you influenced your enjoyment of the image classification tasks? Why?

After completing the post-study questionnaire, participants were them presented with a post-study information letter and additional consent form. This additional information letter was needed to debrief participants about the deception used in the study. Thus, the letter explained that participants were initially told that we were interested in the tags to help us develop image classification systems; however, we were actually interested in studying their experience with the gameful design elements in the platform. It also explained that this was done to avoid bias in the participant's interaction with the game elements and their responses about their experiences. Participants were them given the chance to accept or to decline having their study data used after knowing the real purpose of the study and were instructed to contact the researchers by email if they had any question about the deception employed in the study. These procedures followed the guidelines for ethical participant recruitment established by the Office of Research Ethics at the University of Waterloo. All 50 participants agreed to have their data used after learning the real purpose of the study and none of them contacted the researchers to ask for clarification. Upon completion of this last step, the software then generated a completion code that participants used to complete the HIT on Mechanical Turk.

7.3.3. Results

7.3.3.1. Exploratory Quantitative Analyses

Progress feedback was the game element that was selected more often by participants: 36 times. It was followed by levels (30), power-ups (30), leaderboards (23), chance (23), badges (20), unlockable content (16), and challenges (16). Moderating role was selected less often: only 6 times.

To verify if the participants' age, gender, user types, or personality traits had any significant influence on their game element choices, we carried out several splits of the dataset according to whether the participant selected a specific element or not. For example, we compared participants who selected progress feedback with those who did not select it, participants who selected levels with those who did not select it, and so on.

There were no significant associations between the participants' selection of game elements and their ages (Mann-Whitney U test) and gender (Fisher's exact test).

The user types and personality trait scores were not generally significant predictors of game element selection. However, there were a few significant differences in scores for some of the game elements, as shown in Table 7-2. According to these statistics, participants who chose challenges scored lower in conscientiousness; participants who chose unlockable content scored higher in the user type achiever and in emotional stability; participants who chose leaderboards scored lower in conscientiousness; participants who chose levels scored higher in the user type achiever and in openness to experiences; and participants who chose progress feedback scored lower in the user types socialiser and achiever, as well as emotional stability.

Table 7-2. Significant differences in user types and personality trait scores between game element choices.

		Mean (SD)		Mann-Whitney U Test Mean rank			
Element	**Score**	**No**	**Yes**	**No**	**Yes**	**U**	**p**
Challenges	Conscientiousness	5.84 (0.88)	5.16 (1.01)	28.46	19.22	171.500	.032
Unlockables	Achiever	5.57 (0.77)	6.01 (0.97)	22.65	31.56	369.000	.042
Unlockables	Emotional Stability	4.49 (1.57)	5.47 (1.84)	22.15	32.62	386.000	.017
Leaderboards	Conscientiousness	5.87 (0.99)	5.33 (0.89)	29.61	20.67	199.500	.026
Levels	Achiever	5.39 (0.89)	5.92 (0.77)	20.28	28.98	404.500	.037
Levels	Openness	4.67 (1.37)	5.52 (1.09)	20.10	29.10	408.000	.031
Progress F.	Socialiser	5.54 (1.12)	4.66 (1.13)	33.75	22.29	136.500	.012
Progress F.	Achiever	6.01 (1.01)	5.59 (0.77)	32.25	22.88	157.500	.040
Progress F.	Emotional Stability	5.79 (1.33)	4.42 (1.70)	34.68	21.93	123.500	.005

Note. No = the game element was not selected by the participant; Yes = the game element was selected by the participant. All combinations of user type with game element and personality trait with game element were tested, but only the significant ones ($p < .05$) are shown.

Regarding the participants' performance in the image classification task (measured by the total amount of pointes they earned, number of images tagged, total tags entered, and time spent in the platform), it seemed to have been affected if they selected challenges, badges, unlockable content, or progress feedback (see Table 7-3). Using challenges increased the number of images tagged; using badges decreased the number of points earned and images tagged; using unlockable content decreased the number of points earned, images tagged, and tags entered; and using progress feedback improved all performance measures. Selection of any of the remaining game elements (levels, moderating role, leaderboards, chance, and power-ups) did not significantly affect participants' performances.

Table 7-3. Significant differences in participant performance according to their game element choices.

		Mean (SD)		Mann-Whitney U Test Mean rank			
Element	**Measure**	**No**	**Yes**	**No**	**Yes**	**U**	**p**
Challenges	Images tagged	23.4 (18.3)	36.1 (17.7)	22.32	31.07	346.000	.043
Badges	Total points	1030 (878)	469 (297)	28.40	20.08	191.500	.045
Badges	Images tagged	31.9 (19.5)	20.6 (16.3)	28.36	20.12	192.500	.042
Unlockables	Total points	993 (807)	405 (403)	29.67	15.38	110.000	.001
Unlockables	Images tagged	31.7 (18.3)	18.1 (17.1)	28.52	17.75	148.000	.011
Unlockables	Total tags	138.9 (101.7)	83.4 (77.9)	28.14	18.53	160.500	.027
Progress F.	Total points	321 (185)	993 (805)	14.57	29.17	391.000	.001
Progress F.	Images tagged	11.7 (7.2)	33.5 (18.6)	13.71	29.51	403.000	<.001
Progress F.	Total tags	59.4 (45.3)	145.3 (102.1)	14.96	29.01	385.500	.002
Progress F.	Time spent	19.8 (25.6)	25.9 (18.2)	18.29	28.31	353.000	.029

Note. No = the game element was not selected by the participant; Yes = the game element was selected by the participant. All performance measures (points, images, tags, and time spent) were compared for all game elements, but only the significant ones ($p < .05$) are shown.

Considering participants' scores in the Intrinsic Motivation Inventory (all items scored in a 7-point Likert scale with 4.0 as the neutral score), they were generally interested in and enjoyed the task (M = 4.97, SD = 1.33), felt competent in the task (M = 5.49, SD = 0.92), felt that they put effort into the task (M = 5.72, SD = 0.91), did not feel pressured or tense while completing the tasks (M = 2.20, SD = 1.04), felt that they had choice regarding the execution of the tasks (M = 5.08, SD = 1.35), felt that the tasks had value and importance (M = 4.81, SD = 1.25), and felt neutral in regards to the relatedness with other participants (M = 4.11, SD = 0.99).

Comparing the IMI scores between different game element choices, they were only significantly influenced when participants selected levels or progress feedback (see Table 7-4). Selecting levels increased participants' perceived interest/enjoyment, competence, and effort, and decreased their perceived pressure/tension. On the other hand, selecting progress feedback decreased participants' perceived effort into the task, even though their performance actually improved, as discussed before.

Table 7-4. Significant differences in intrinsic motivation scores between game element choices.

				Mann-Whitney U Test			
		Mean (SD)		Mean rank			
Element	**Score**	**No**	**Yes**	**No**	**Yes**	**U**	**p**
Levels	Interest/Enjoyment	4.54 (1.37)	5.25 (1.24)	19.9	29.2	412.000	.026
Levels	Competence	5.21 (0.90)	5.68 (0.90)	20.08	19.12	408.500	.030
Levels	Effort	5.31 (1.13)	5.99 (0.63)	19.48	29.52	420.500	.016
Levels	Pressure/Tension	2.67 (1.18)	1.89 (0.82)	31.42	21.55	181.500	.018
Progress F.	Effort	6.21 (0.29)	5.52 (1.00)	33.82	22.26	135.500	.011

Note. No = the game element was not selected by the participant; Yes = the game element was selected by the participant. All combinations of intrinsic motivation scores with game elements were tested, but only the significant ones ($p < .05$) are shown.

7.3.3.2. Qualitative Analyses

We analyzed the answers to the five qualitative questions using thematic analysis. The first author coded the answers in two ways: first, classifying the response into a positive, neutral, or negative feeling; second, by identifying main themes in each answer. Table 7-5 presents the results of the analyses for each question, as well as some quotes that exemplify participants' responses.

Table 7-5. Qualitative (thematic) analyses of participants' reports of their experiences.

Sentiments	**Main Themes**	**Quotes**
Q1: *Overall, how do you describe your experience with the image classification activities you just completed?*		
Positive: 34 times	Fun: 11 times Enjoyable: 8 times Interesting: 7 times	"I thought it was fun because I got to earn points and power up bonuses. it was like a game. I would do more of it." (P7)

		“I would describe the image classification as enjoyable. Tagging the images was fun, but, allowing the use of game elements made the experience even better. It motivated me to keep going and to tag more images.” (P13) “I enjoyed it and I liked getting to seem my progress. I enjoyed earning points and it motivated me to keep doing more than I would have to see how far I could get.” (P35)
Neutral: 9 times	Descriptions of the task	
Negative: 7 times	Boring, Tedious	
Q2: *How do you describe the experience of selecting game elements to customize the platform for you?*		
Very positive: 18 times Positive: 18 times	Fun: 6 times Motivation: 6 times Control: 5 times Good personalization or customization: 4 times	“I liked that I had some control over my experience with choosing the game elements. Made for a better experience overall.” (P14) “I liked it, I could choose the elements I believed to be more motivating, it was pretty straightforward.” (P19) “I like that. I had fun experimenting and wanted to try the other ones. It feels like you get a really great deal of customization and freedom getting to choose what elements you want. You get to decide your degree of interactivity and that’s pretty cool.” (P35)
Neutral: 8 times		
Negative: 1 time	Not useful Meaningless No impact on the task	
Q3: *Were you satisfied with the selection of game elements provided by the system? Why?*		
Positive: 42 times	Variety of elements: 14 times Good customization: 6 times	“Yes, there were a lot of choices. I would have chosen more, but we were limited to four.” (P40) “Yes, I had enough to choose from and I was able to easily pick the things I knew would motivate me.” (P41) “Yes, I think there was enough variety offered in the game elements that I could find enough elements that matched my interests or at least seemed somewhat suitable and somewhat enjoyable to pick and to eventually use. It seemed like a good mix of things to me.” (P2)

Neutral: 6 times	Not interested in the elements No difference for the experience	
Negative: 2 times	Did not like the elements Did not want them	
Q4: *Were you able to select game elements that matched your preferences? Why?*		
Positive: 39 times	Variety of elements: 7 times Good fit: 6 times Good match: 3 times	"I think so, there was enough variety and I was able to find elements that I've used in other previous games and that somewhat match my personality characteristics I guess." (P2) "The game elements were most definitely satisfying. Allows me to do things such as 'level up' as well as giving me boost for finishing the tagging of a photo motivated me to keep going and made the experience more enjoyable in the long run." (P13) "Yes because there was a wide enough variety of options in order for me to find ones that matched my preferences so that I would have an enjoyable experience." (P35)
Neutral: 5 times	No difference for the experience	
Negative: 3 times	Did not like the elements Would prefer monetary bonus	
Q5: *How much do you feel that the selection of game elements you used to customize the platform for you influenced your enjoyment of the image classification tasks? Why?*		
Positive: 39 times	Enjoyable: 5 times Good goals: 4 times Rewards: 4 times Levels: 4 times Progress feedback: 3 times Challenges: 2 times Felt like a game: 4 times	"I feel like it did because I felt like I kind of created my own game that was perfect for me and so it felt like I was in control and added to my enjoyment." (P7) "I feel like it influenced me to complete all 50 classifications. Seeing my progress really motivated me." (P10) "It's always nice when you have the option to customize your experience. Most of the time we're stuck with whatever the developer thinks is necessary, and that leads to a lot of clutter more times than not." (P40)
No influence: 11 times	No impact in the experience	

7.3.4. Discussion

In general, participants were able to understand and complete the gamification customization process and enjoyed selecting the game elements for their experience. Summarizing the results of the qualitative analyses for all questions, around 80% of participants expressed a positive experience, 10% expressed a negative experience, and 10% were neutral. However, it is difficult to understand how much of their perceived experiences are due to the use of gamification per se, and how much are specifically due to the possibility of customizing the experience. Even so, some of the answers highlight how participants enjoyed the variety of elements offered and the perceived control over their own experience, which shows that at least part of the participants definitively appreciated the customization options. Participants who expressed neutral or negative experiences seem to have preferred no gamification at all, rather than having an issue with the customization options.

Looking at the frequency that each element was selected by participants, some are used more often than others. The elements selected more often are related to tracking progress (progress feedback and levels) or improving performance in the game (power-ups). Progress feedback was selected so often (36 times) and helped increase participant performance so much that it probably should be a fixed element for this platform rather than being left as a customization option.

From the results of this pilot study, it is not clear what factors influenced participants' selection of specific elements. Although some significant differences were observed, we conducted several pairwise comparisons between user types and game elements, as well as personality traits and game elements, increasing the chances of a Type I error. Therefore, the results should not be overstated. Moreover, the significant differences in the user types and personality trait scores for some game elements do not generally correspond to what would be expected from previous studies. For example, it is unexpected that the Achiever scores for participants who selected progress feedback are lower than for those who did not select it. On the other hand, correlations that were expected because they were observed in previous studies did not occur this time, such as the Socialiser scores not being significantly different for participants who selected leaderboards or not. One possible explanation for these differences is that on a specific task there is an influence of context that is not considered by the generic Hexad user types scale, which asks users about their experiences in general without a specific application in mind. However, when participants reached the customization task, they were specifically instructed to select elements that would be used with the image classification task. Some participants mentioned that they selected elements that they thought would help them in the task. This suggests that the usefulness of game design elements for a specific task may be more important than someone's generic preferences when it comes to customizing their experience. Future studies could specifically ask participants to explain why they selected each element to further investigate the reasons behind choices of gameful design elements.

Regarding participant performance in the image classification task, it is noteworthy that some game element choices significantly influenced performance. Using progress feedback and challenges improved performance, whereas badges and unlockable content decreased their performance. This result may be related to the way that the elements were implemented in this context. Challenges and progress feedback helped participants gauge their progress and feel motivated to complete more tasks. On the other hand, badges and unlockable content had little impact in the participants' experiences because they only modified how the participant appeared in their own profile (which is probably not very motivating per se) or in the leaderboard (which in this case probably did not make much difference for motivation anyway, due to the low level of interaction between participants). This means that when considering personalization options, gamification designers need to be aware of the context and test the impact that different gameful design elements will have on the users' performances. Some elements may have to be avoided in specific contexts if they are likely to decrease the users' performance in the task.

7.3.4.1. Limitations and Future Work

This study was a pilot that demonstrated the application of the method for personalized gameful design and the possibility of conducting future studies to obtain more detailed insights into how personalization and customization may affect the user's experience and performance. Even so, we were already able to derive some interesting takeaways, such as the popularity of each gameful design element in participants' choices.

The design and development of this customizable gameful platform opens the possibility for the execution of several different types of studies to investigate specific aspects of personalized gamification. For example, future research can create experimental conditions with different levels or types of personalization or customization, such as no personalization at all (only fixed game elements), full customization (letting participants freely select elements), customization with recommendations (suggesting elements that participants may enjoy, based on their profile), or full personalization (automatically selecting elements for participants without letting them choose). This will allow us to better understand how different types of personalization/customization may affect user experience and performance.

Another type of study that can be conducted in the future is to better understand the reasons behind participants' selection of different gameful design elements. This may be achieved by asking participants to explicitly explain why they chose each element. It will also be interesting to vary the context of gamification by replacing the image classification task with a different one. For example, tasks that require skill, such as doing some mathematical calculation, or creative tasks, such as writing short stories, could be interesting variations. This will allow researchers to study if a different context or type of task may change how participants perceive and select game elements for their experience.

The fact that participants in the pilot were paid Mechanical Turk workers may also have influenced the results because ultimately their goal was to complete their participation quickly to earn the remuneration. Future studies can also explore different recruitment methods that allow participants to have more freedom in deciding to volunteer for the study and interact with the platform for a longer period (over the course of a few days instead of just a few minutes). This will potentially modify the context of the gameful experience and may result in different motivations for choosing specific gameful design elements.

7.4 Conclusion

This chapter described a customizable gameful platform that we designed and developed specifically for the goal of being able to carry out various studies to investigate different aspects of personalized gamification. It features several gameful design elements built around a main instrumental task, enabling researchers to observe and study the gameful experience of participants carrying out the instrumental task. The platform is flexible and allows researchers to independently modify the instrumental task that is used, the game elements that are offered, and the level and type of personalization or customization that is allowed. This allows researchers to generate different experimental conditions to study a broad range of research questions.

We also conducted a pilot study that demonstrated the viability of the platform to conduct experimental studies. Our results show that participants can understand, carry out, and comment about the gamification customization task. The pilot study also provided initial insights into the practical aspects of personalized gamification, such as the influence of different game element selections on the participants' performance and the potential role of context as an important factor for determining how users select game elements.

The availability of this platform for the gamification research community will open new possibilities in the study of personalized gamification.

Chapter 8 Conclusion

Personalization of gameful digital systems is a promising approach, which allows designers to create applications that are more effective in helping users achieve their goals, such as learning about certain topics or receiving support for attitude or behaviour change, while also creating a better user experience.

This thesis provides theoretical and practical contributions to help researchers understand the characteristics of people and how they perceive and interact with gameful design elements. We operationalize this with new design and evaluation methodologies to help designers create personalized gameful systems. Additionally, we introduce a digital platform for the execution of experimental studies to investigate specific aspects of personalized gamification.

8.1 Contributions

Chapter 3 introduced a formal definition of *personalized gameful design* as "the tailoring of the gameful design elements by the providers to the users based on knowledge about them, to boost the achievement of the goals of the gameful system." Then, we presented a novel design method in three steps to personalize gameful interactive systems: (1) classification of user preferences, (2) classification and selection of gameful design elements, and (3) heuristic evaluation of the design. This method presents clear guidelines and specific categories of gameful design elements that are more likely to be enjoyable by each type of user. We believe this will help designers effectively build personalized gameful systems. Moreover, we showed how these three steps can be integrated into the existing gameful design methods.

This section summarizes our contributions: the development of the three steps of the personalized gameful design method and the creation of a platform for the study of personalized gamification.

8.1.1. Classification of User Preferences

Chapter 4 evaluated the Hexad Gamification User Types Scale in English and Spanish, showing that its structural validity is acceptable through reliability analysis and factor analysis. This means that the Hexad user types scale is suitable for investigating the effects of gamification or developing guidelines and methods for personalized gameful design. The validated version of the scale (listed in Table 4-24) consists on 24 items, four per user type, which can used to calculate an individual's Hexad profile. This profile consists on an average score for each one of the six user types: *philanthropist*, *socialiser*, *free spirit*, *achiever*, *player*, and *disruptor*. These scores can be used to verify if the effects of gameful interventions or methods are moderated by the user types, or by practitioners to design applications that are personalized to the preferences of individual users.

8.1.2. Classification of Gameful Design Elements

Chapter 5 presented a new conceptual framework for classifying gameful design elements based on participants' self-reported preferences. Specifically, our model classifies gameful design elements in eight groups, which are further organized into three categories: *individual motivations* (immersion and progression); *external motivations* (risk/reward, customization, and incentives); and *social motivations* (socialization, altruism, and assistance).

This contribution is important to HCI and gamification because it presents the first conceptual framework of design elements constructed in the specific context of gameful design and based on user preferences. Gamification researchers and practitioners have relied until now on models that were created in the context of games, assuming they would be generalizable to gamification without empirical evidence. Our work enables future studies and industry applications to be built upon a model empirically constructed and validated specifically for gamification. Furthermore, our classification of gameful design elements contributes to the gameful design practice by helping designers better understand the potential effect of each element on user enjoyment, enabling them to make more informed design decisions.

8.1.3. Heuristic Evaluation of Gameful Design

Chapter 6 introduced a new set of guidelines for heuristic evaluation of gameful design in interactive systems. Our model contains a set of 28 gameful design heuristics, which are based on prior motivational theories and gameful design methods. They are organized into 12 dimensions of motivational affordances: *purpose and meaning*, *challenge and competence*, *completeness and mastery*, *autonomy*, *relatedness*, *immersion*, *ownership and rewards*, *scarcity*, *loss avoidance*, *feedback*, *unnpredictability*, and *change and disruption*. The aim of our inspection tool is to enable a UX expert to conduct a heuristic evaluation of a gameful application, even if they do not have a background in gameful design or motivational psychology. Thus, the evaluation can be conducted by an independent quality control team who can provide useful feedback for the design team. Our method fulfills a need for evaluation tools specific to gameful design. As such, we expect it to be of use to both researchers and practitioners who design and evaluate gameful applications. Using a tool to conduct a heuristic evaluation of gameful design can potentially help decrease part of the cost and time for the creation of gameful interactive systems.

8.1.4. A Platform for the Study of Personalized Gameful Design

Chapter 7 described the design, implementation, and pilot evaluation of a software platform for the study of personalized gameful design. It integrates nine gameful design elements built around a main instrumental task, enabling researchers to observe and study the gameful experience of participants. The platform is flexible so the instrumental task can be changed, game elements can be added or removed, and the level and type of personalization or customization can be controlled. This tool allows researchers to generate different experimental conditions to study a broad range of research questions.

We believe this platform will open new possibilities in the study of personalized gamification, by allowing researchers to conduct many experimental studies over a shorter period.

8.2 Impact of This Work

Sections of this thesis have already been published and have already significantly impacted gamification research and practice. The Hexad user types scale has been used in dozens of studies, related to diverse topics such as gameful design (e.g., [181,183]), persuasive technologies (e.g., [268]), or education (e.g., [228]). As of June 2019, our two main publications about the Hexad scale [323,329] have been cited 119 times[12]. Our scale was also made available by Marczewski on his website[13] and has been completed by more than 22,000 people. Our work on the classification of gameful design elements [324] has already been cited 26 times and has earned the recognition of gamification practitioners by receiving the Outstanding Gamification Research 2017 award[14] organized by the Gamification Europe conference. Our Gameful Design Heuristics [322] have been cited 20 times and have been taught to HCI researchers and practitioners in two courses that we presented at CHI 2017 [331] and CHI 2018 [332].

8.3 Limitations and Future Work

This thesis develops tools to understand user preferences and gameful design elements, to design personalized gameful systems, and to evaluate the design. However, work is still needed to better understand how users behave in practice when interacting with tailored gameful systems or how different contexts influence the user experience, such as different application domains or different types of tasks or systems.

8.3.1. Classification of User Preferences

The studies that we conducted in Chapter 4 to validate the Hexad user types and its measurement scale relied on participants' self-reported responses and did not consider any particular context or application domain. Therefore, future studies will need to observe user behaviour and preferences in different gameful systems to understand how these characteristics may change in specific scenarios and if they correspond to the scores obtained from self-reported preferences. It is possible that user type scores for a user when interacting with a particular system may change over time, as the user becomes familiar and skilled with different features of the system. Therefore, the user types scale and practical observations of behaviour should be tested and compared between different contexts, application domains, types of tasks, and the user's expertise level. This will allow researchers to understand how well user preferences for different gameful design elements or interaction styles remain similar in different contexts, and how their preferences differ depending on what type of activity they are doing when interacting with a gameful system.

[12] According to Google Scholar.
[13] https://www.gamified.uk/UserTypeTest2016/user-type-test.php
[14] https://gamification-europe.com/awards/

8.3.2. Classification of Gameful Design Elements

Similarly, the studies we conducted to classify gameful design elements relied on participants' self-reported preferences and without considering any particular context or application domain. These studies allowed us to create an initial conceptual framework of people's preferences for different gameful design elements, which can be used by designers to create gameful systems that can be personalized. However, we expect that the proposed classification of gameful design elements may be improved in the future, as more studies observe real user behaviour instead of just asking them to self-report their preferences. Thus, future research will need to investigate if participants still demonstrate the same types of preferences when they are interacting with a real gameful system. Moreover, the influence of context or application domain that we mentioned in the previous section should also be tested in this case, to understand if participants may prefer different gameful design elements (or combinations of those) depending on the kind of activity that they are doing during a gameful experience. It can be expected that the refinement of the proposed classification of gameful design elements, based on actual user observation and considering actual contexts and domains, will help designers be even more accurate in future personalized gameful design efforts than what they can be by using the version of the classification proposed in this thesis. Nonetheless, this thesis provides a valuable starting point, so designers can already begin constructing personalized gameful systems, which researchers can then further study to progressively improve the classification framework.

Furthermore, our study employed a general description of each gameful design element, which seemed the most generic way to understand each element based on our literature review. However, each one of the elements studied can be designed and implemented in different ways or combined with other elements to create different user experiences. Therefore, it may be necessary to continue studying how different implementations of the same gameful design element may influence the way that users perceive it and, consequently, their preferences for different elements.

8.3.3. Evaluation of Gameful Design

Our Gameful Design Heuristics were already used to evaluate small existing gameful systems or to evaluate the planned design of small systems, like reported in Section 6.3. But we did not test its application to larger systems. Thus, it would also be interesting to study its usefulness in helping designers evaluate larger projects. Similarly, we have seen the Gameful Design Heuristics employed by small teams, with only one designer and a few evaluators. It would also be interesting to observe how the heuristics would be used by a larger team composed of several designers and evaluators.

Heuristic evaluation is only one type of method to evaluate digital interactive systems. In future work, researchers can explore different methods that could be employed to help evaluate the gameful experience of users and how it is afforded by the system. An example of an alternate tool is the scale to measure gameful experience proposed by Landers et al. [179] as future research. This could help understand how users are interacting with the implemented motivational affordances.

8.3.4. Empirical Studies of Gameful Systems and Experiences

The customizable gameful platform that we developed can help researchers conduct many different experimental studies to investigate specific aspects of personalized gamification. For example, empirical studies can observe user behaviour in different gamified conditions and with different tasks and goals to acquire a better understanding of user preferences.

Moreover, studies can compare control conditions that do not use personalization (e.g., when game elements are fixed by the developer and cannot be modified during the user experience) with different types of tailored systems to understand the effects of personalization on user experience and performance. In addition, different types of personalization and customization could be compared to measure their effect on experience and performance. For example, it is possible to compare types of partial tailoring, in which some elements are fixed but some can be adjusted, with full tailoring, in which all gameful elements can be fully adjusted. Another useful comparison would be between system-initiated personalization, in which the system automatically adjusts the game elements, and user-initiated customization, in which the user is free to adjust their experience.

Furthermore, as mentioned in section 8.3.1, user preferences may change over time, as the user's expertise within a system evolves. Therefore, the tailoring of gameful design elements for a user should not be static but evolve over time as well. If a system lets the user customize their experience, this can be accomplished by simply letting the user change their settings at any time. However, if the system employs automatic personalization, then the user's preferences will need to be constantly re-evaluated, and the selection of gameful design elements will need to be constantly modified to reflect new preferences. Nonetheless, because all studies of personalized gamification conducted so far were over short periods, there is no empirical knowledge yet as to how user preferences may change over time. Thus, future studies over longer periods should keep track of user preferences over time and try to find out if there are any patterns regarding how this happens for groups of users. If this kind of patterns can be identified, it would help designers create gameful systems in the future that will be able to better adapt to user preferences over time.

8.3.5. Recommender Systems for Personalized Gamification

It is important to note that currently, our models rely on statistical averages and correlations, rather than individualized preferences. For example, the partial significant correlation we found between Free Spirit scores and Immersion gameful design elements means that if we look at several individuals with high Free Spirit scores, together, they will tend to also have a high preference for Immersion elements. But it does not guarantee that any single individual with high Free Spirit scores will also have high preference for Immersion elements. Therefore, while our models of user preferences and gameful design elements are useful for designing systems that afford diverse gameful experiences, they should be used with caution for automatic personalization of gameful systems. Currently, the models of user preferences can be used as an initial hint for the system to try and infer individual user preferences; however, more sophisticated mechanisms will need to be developed to increase the accuracy of the predictions.

One family of algorithms that can be used to identify individual user preferences with more accuracy is that of recommender systems. They can analyze all the interactions of the user with the system to gather knowledge specific to each user, instead of relying only on models based on statistical averages. Nevertheless, in this work, we did not explore the implementation of recommendation algorithms to suggest or even automatically tailor the user experience according to parameters learned by the algorithm by analyzing the interactions of many users with a gameful system. Our customizable gameful platform can also help with this type of research by allowing the creation of different experimental conditions for data collection, since the use of recommendation algorithms generally requires the use of large datasets to train the model before it can generate useful recommendations. These data sets can then be generated by logging participants' interactions with our platform.

8.4 A Word on the Ethics of Personalized Gameful Design

As Section 2.1.9 demonstrated, the debate on the ethics of gamification is timely and important. Logically, it also encompasses the practice of personalized gameful design as proposed in this thesis. Although a comprehensive study of the ethics of personalized gameful design is not part of the scope of this thesis, I would like to briefly address the matter by expressing how I would like the methods introduced here to be used.

As expressed by González Pecotche [109:252] in the inspirational quote included in the front matter of this thesis, my desire after producing the knowledge contained in this thesis, and making it available to the world, is that it will be used to make future generations happier. González Pecotche also expresses that whoever acquires knowledge should not receive it selfishly and should be responsible for making good use of it in benefit of humanity [109–111]. Therefore, it is my hope that whoever receives the knowledge that I deposit in this thesis will use it ethically and in benefit of humanity.

Based on the frameworks and codes of conduct for ethical gamification reviewed in Section 2.1.9, this non-comprehensive list suggests some of the ways by which personalized gameful design can be practiced ethically:

- Being honest with clients and users, giving them realistic expectations, and never collecting information dishonestly;
- Taking into consideration the legal and social expectations of the communities that will be involved with the system;
- Avoiding practicing illegal or unethical activities, such as exploiting or manipulating users;
- Being open and transparent about the system, informing clients and users what data is being collected and how it is being used, and encouraging free access to information;
- Never sharing personal information without consent;
- Never persuading anyone to do anything that they would not be willing to do otherwise;

- Never thwarting the choice and autonomy of anyone involved with the gamification;
- Always providing the best service and experience possible;
- Always respecting all persons and the environment and avoiding any type of discrimination;
- Attempting to anticipate the potential consequences and outcomes of the gameful system and ensuring that they will not cause any harm;
- Designing systems to help people flourish, improve their wellbeing, cultivate their virtues, and live the good life.

Future research will need to keep investigating the potential positive and negative effects of gamification and when, how, and why they occur, to refine and expand the list above with definitive guidelines for ethical personalized gameful design.

8.5 Final Remarks

This thesis defined *personalized gameful design* and proposed a method that will help designers create gameful systems that can be tailored to the preferences of each user. Our personalized gameful design method is based on classifying user preferences, classifying gameful design elements according to user preferences and selecting those that are more adequate for each user, and evaluating the motivational potential of the design by using our gameful design heuristics.

Moreover, we designed and implemented a customizable gamification platform that can be used by ourselves and other researchers to conduct empirical studies to continue deepening our understanding of the user experience with gameful systems. This will allow us to continue refining our personalized gameful design method as we acquire more knowledge about how personalization or customization affect the user experience.

The ethical concerns related with gamification are important and precautions are necessary to avoid causing unintended negative consequences. Nonetheless, gamification can potentially lead to valuable positive outcomes. Empirical results have already shown that when correctly used, gamification can be a tool to improve employee motivation, improve student motivation and learning, help patients learn about health concerns and adhere to treatment plans, help scientists gather more help from the community to solve complex issues, or increase citizens' engagement with their community, among many other positive outcomes that have been already demonstrated by gamification researchers and practitioners.

We expect that personalized gamification will be even more effective in helping users achieve these positive outcomes than one-size-fits-all gamification, since the preferences of each user will be taken into consideration.

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Appendix A Gameful Design Heuristics

Intrinsic Motivation Heuristics

This category includes affordances related to the three psychological needs introduced by SDT [296] (competence, autonomy, and relatedness), as well as purpose and meaning, which facilitate internalization as suggested by SDT, and immersion as suggested by [298].

Purpose and Meaning

Affordances aimed at helping users identify a meaningful goal that will be achieved through the system and can benefit the users themselves or other people.

OCT	Epic Meaning and Calling	**HEX**	Philanthropist	**SUP**	Epic Win
REC	Information and Reflection				

Name	Description	Questions
I1. Meaning	The system clearly helps users identify a meaningful contribution (to themselves or to others).	- Does the system provide enough context for the user to understand the benefits (to themselves or to others) of what they are doing?
I2. Information and Reflection	The system provides information and opportunities for reflection towards self-improvement.	- Does the system provide information that allows the user to reflect on their real-life achievements and how to improve themselves outside of the system?

Challenge and Competence

Affordances aimed at helping users satisfy their intrinsic need of competence through accomplishing difficult challenges or goals.

OCT	Development and Accomplishment	**MDL**	Challenge lenses and Intrinsic rewards	**HEX**	Achiever
KEG	Competence: Challenge	**SUP**	Challenge yourself and Battle the bad guys	**REC**	Engagement

Name	Description	Questions
I3. Increasing Challenge	The system offers challenges that grow with the user's skill.	- Does the system present challenges in a way that motivates the user to tackle them? - Is the difficulty of the challenges adjusted to the user's ability and skill? - Do the challenges' difficulty increase over time?
I4. Onboarding	The system offers initial challenges for newcomers that help them learn how it works.	- Does the system present an initial tutorial or explanation of the first steps the user should take? - Is the tutorial or initial explanation challenging and fun?

I5. Self-challenge	The system helps users discover or create new challenges to test themselves.	- Does the system offer features to allow the user to create their own challenges?

Completeness and Mastery

Affordances aimed at helping users satisfy their intrinsic need of competence by completing series of tasks or collecting virtual achievements.

OCT	Development and Accomplishment	**MDL**	Goal lenses, Action lenses, and Intrinsic rewards	**HEX**	Achiever
KEG	Competence: Achievements	**SUP**	Seek out and complete quests		

Name	Description	Questions
I6. Progressive Goals	The system always presents the next goals users can pursue that are immediately achievable.	- Does the system always present a new goal right after the user completes the current goal? - Are the suggested new goals immediately achievable (adequate to the user's ability and skill)? - Are the suggested new goals always a bit more difficult than the previous?
I7. Achievement	The system lets users keeps track of their achievements or advancements.	- Does the system allow the user to keep track of their achievements and/or completed goals? - Is the achievement tracking meaningful, i.e., does it help the user understand which new abilities or skills were acquired after each achievement or what rewards were awarded?

Autonomy and Creativity

Affordances aimed at helping users satisfy their intrinsic need of autonomy by offering meaningful choices and opportunities for self-expression.

OCT	Empowerment of Creativity and Feedback	**MDL**	Object lenses and Intrinsic rewards	**HEX**	Free Spirit
KEG	Autonomy	**REC**	Play and Choice		

Name	Description	Questions
I8. Choice	The system provides users with choices on what to do or how to do something, which are interesting but also limited in scope according to each user's capacity.	- Does the system let the user freely choose their goals and tasks? - Does the system offer multiple paths for achieving similar results? - Does the system present choices that are adequate for the user's ability and skills (i.e. don't present too many choices at the beginning when the user does not understand all the choices)?

		- Does the system clearly inform the user about the available choices and their consequences?
I9. Self-expression	The system lets users express themselves or create new content.	- Does the system let the user create new content for themselves or other users? - Does the system let the user express themselves (e.g. avatars, personalized pages, status messages, etc.)?
I10. Freedom	The system lets users experiment with new or different paths without fear or serious consequences.	- Does the system offer multiple paths for achieving similar results? - Does the system let the user experiment with different paths without fear or serious consequences (e.g. they can go back and follow another path if the experiment does not work)?

Relatedness

Affordances aimed at helping users satisfy their intrinsic need of relatedness through social interaction, usually with other users.

OCT	Social Influence and Relatedness	**MDL**	Intrinsic rewards	**HEX**	Socialiser
KEG	Relatedness	**SUP**	Recruit your allies	**REC**	Engagement

Name	Description	Questions
I11. Social Interaction	The system lets users connect and interact socially.	- Does the system offer means for the user to interact with other users? - Are social interactions meaningful for the application, i.e., do they help users achieve their goals?
I12. Social Cooperation	The system offers the opportunity of users working together towards achieving common goals.	- Does the system offer means for users to work together towards achieving common goals? - Are users adequately rewarded proportionally to the effort they invested in the collaborative work?
I13. Social Competition	The system lets users compare themselves with others or challenge other users.	- Does the system offer means for users to compare themselves with others? - Does the system offer means for users to compete or challenge other users?
I14. Fairness	The system offers similar opportunities of success and progression for everyone and means for newcomers to feel motivated even when comparing themselves with veterans.	- Is progression in the system balanced and fair, i.e., do all users have equal chance of achievement if they put the same effort and time into the system? - Do the system offer means for newcomers to progress at their own pace without feeling diminished by the progress of other users that are already ahead of them?

Immersion

Affordances aimed at immersing users into the system to improve their aesthetic experience, usually by means of a theme, narrative, or story, which can be real or fictional.

KEG	Perceived Fun	**SUP**	Adopt a secret identity	**REC**	Exposition

Name	Description	Questions
I15. Narrative	The system offers users a meaningful narrative or story with which they can relate to.	- Does the system feature a theme or story that provides an aesthetic experience? - Is the theme or story meaningful and connected to the users' goals? - Is the theme or story clearly explained?
I16. Perceived Fun	The system affords users the possibility of interacting with and being part of the story (easy fun).	- Does the system allow the user to interact with and influence the story? - Does the way a user influences the story also extend its influence to other users?

Extrinsic Motivation Heuristics

This category includes affordances that provide an outcome or value separated from the activity itself as suggested by SDT [296] and Octalysis [53]: ownership and rewards, scarcity, and loss avoidance.

Ownership and Rewards

Affordances aimed at motivating users through extrinsic rewards or possession of real or virtual goods. Ownership is different from competence when acquiring goods is perceived by the user as the reason for interacting with the system, instead of feeling competent.

OCT	Ownership and Possession	**MDL**	Intrinsic rewards	**HEX**	Player
KEG	Extrinsic motivation	**SUP**	Collect and activate power-ups		

Name	Description	Questions
E1. Ownership	The system lets users own virtual goods or build an individual profile over time, which can be developed by continued use of the system and with which users can relate to.	- Does the system feature an individual profile that the user can evolve over time? - Does the system let users own virtual goods? - Are the user profile and/or virtual goods meaningful and useful to the user? - Is progression of the user profile or acquisition of virtual goods a result of the user's progression in the system?
E2. Rewards	The system offers incentive rewards for interaction and continued use, which are valuable to users and proportional to the amount of effort invested.	- Does the system reward the user for completing tasks or progressing in their goals? - Does the system reward the user for continued use?

		- Are rewards proportional to the amount of effort, time, and dedication that the user put into the system? - Are the rewards meaningful and useful for the user?
E3. Virtual Economy	The system lets users exchange the result of their efforts with in-system or outside rewards.	- Does the system let the user exchange their rewards or possessions with other users? - Does the system let the user exchange their rewards or possessions for other virtual goods? - Does the system let the user exchange their rewards or possessions for outside (real-life) rewards?

Scarcity

Affordances aimed at motivating users through feelings of status or exclusivity by means of acquisition of difficult or rare rewards, goods, or achievements.

OCT	Scarcity and Impatience

Name	Description	Questions
E4. Scarcity	The system offers interesting features or rewards that are rare or difficult to obtain.	- Does the system offer rewards or virtual goods that are rare or difficult to obtain? - Does the system limit certain features only to users with certain accomplishments? - Does the system let users display the rare or difficult goods or rewards that they have obtained? - Is the difficulty of obtaining such rare goods or rewards proportional to the amount of effort and time invested into the system?

Loss Avoidance

Affordances aimed at leading users to act with urgency, by creating situations in which they could lose acquired or potential rewards, goods, or achievements if they do not act immediately.

OCT	Loss and Avoidance

Name	Description	Questions
E5. Loss Avoidance	The system creates urgency through possible losses unless users act immediately.	- Does the system feature timed tasks, which make the user lose an opportunity if they are not completed in time? - Does the user feel they are going to lose something unless they keep using the system continually (e.g. rewards for

		continued use, information, social connections, etc.)? - Does the system make the user feel that they should keep using the system due to the amount of time or effort already invested?

Context-Dependent Heuristics

This category includes the feedback, unpredictability, and disruption affordances, which can afford either intrinsic or extrinsic motivation, depending on contextual factors such as the kind and the user's personal perception regarding the task at hand.

Feedback

Affordances aimed at informing users of their progress and the next available actions or challenges.

OCT	Empowerment of Creativity and Feedback	**MDL**	Feedback lenses

Name	Description	Questions
C1. Clear and Immediate Feedback	The systems always inform users immediately of any changes or accomplishments in an easy and graspable way.	- Does the system immediately inform the user when any change in status occur? - Does the system immediately inform the user when any task is completed or any goal is achieved? - Is the feedback always clear and understandable? - Does the feedback always explain exactly what has happened and which action caused it?
C2. Actionable Feedback	The system always informs users the next available actions and improvements available.	- Does the system immediately inform the user what are the next available actions after any task is completed or any goal is achieved? - Does the system always inform how the next available actions are connected to the completed action?
C3. Graspable Progress	Feedback always tells users where they stand and what is the path ahead for progression.	- Does the system always clearly inform the user where they stand in progression and possessions? - Does the system immediately inform which is the next step in progression that can be achieved and how to achieve it? - Does the system always inform which are the obtainable rewards or virtual goods and how to obtain them?

Unpredictability

Affordances aimed at surprising users with variable tasks, challenges, feedback, or rewards.

OCT	Unpredictability and Curiosity	**MDL**	Varied challenge, Varied feedback, and Secrets	**HEX**	Free Spirit
REC	Play				

Name	Description	Questions
C4. Varied Challenges	The system offers unexpected variability in the challenges or tasks presented to the user.	- Does the system feature any unexpected variability in the tasks or goals that can be completed (e.g. by randomly suggesting a different goal)?
C5. Varied Rewards	The system offers unexpected variability in the rewards that are offered to the user.	- Does the system award unexpected rewards for achievements or progression (e.g. by partly randomizing the rewards obtained for a completed task or goal)? - Does the user feel they can influence their chance of getting better random rewards?

Change and Disruption

Affordances aimed at engaging users with disruptive tendencies by allowing them to help improve the system, in a positive rather than destructive way.

HEX	Disruptor

Name	Description	Questions
C6. Innovation	The system lets users contribute with ideas, content, plugins, or modifications aimed at improving, enhancing, or extending the system itself.	- Does the system let the user create new content for themselves or other users? - Can the system be modified by the user in any way (e.g. by changing the system directly or through plugins or mods)? - Can the users contribute with ideas or suggestions? - Can the users influence in the system's evolution (e.g. by voting in their preferred new features)?
C7. Disruption Control	The system is protected against cheating, hacking, or other forms of manipulation from users.	- Is the system protected against cheating? - Is the system protected against hacking? - Does the system protect users from harassment from other users? - Does the system limit the user's ability to gain unfair advantages over other users by any means?

Legend

OCT Octalysis Framework [53]

MDL Motivational Design Lenses [75]

KEG Kaleidoscope of Effective Gamification [150]

HEX Hexad User Types [198, 329]

SUP SuperBetter [217]

REC RECIPE for Meaningful Gamification [239]

Appendix B Instructions for Participants Without the Gameful Design Heuristics

Introduction

Gamification

User experience (UX) is a field within Human-Computer Interaction (HCI) that studies the whole experience of a user with a product, system, or service. UX focuses on issues such as usability, ergonomics, cognitive load, and affective experiences. However, in the last years, there is a particular growing interest in understanding users' motivation to use a product, system, or service. This interest is spawned by observable low engagement rates: it is not enough to have a useful system; one needs to also motivate and engage users in it.

One possible solution to this comes from the field of study called *gamification* or *gameful design*. Gamification is defined in HCI as "*the use of game design elements in non-game contexts*" [77]. Gamification and gameful design both frame the same set of phenomena from different points of view: the design strategy of using game design elements to afford gameful experiences (gamification) or the design goal of designing for gamefulness using game design elements (gameful design) [77]. Thus, in the context of this work, both terms can be used interchangeably.

Some gameful design frameworks and methods have been suggested [75] with prescriptive guidelines on augmenting an application with *motivational affordances*. Motivational affordances are properties added to an object, which allow its users to experience the satisfaction of their psychological needs. In gameful design, motivational affordances are often used to facilitate intrinsic and extrinsic motivations as advocated by self-determination theory [296]. Thus, motivational affordances that support the user's feelings of competence, autonomy, and relatedness are often used to facilitate intrinsic motivation, whereas rewards are often used to facilitate extrinsic motivation.

Motivation

Self-determination theory (SDT) [296] is a construct of human motivation and personality that seeks to understand what facilitates and hinders human motivation. In summary, SDT posits that humans may be intrinsically or extrinsically motivated to carry out a task. Intrinsic motivation occurs when the task itself is inherently enjoyable enough to motivate the individual into engaging in it. Extrinsic motivation occurs when the individual engages in the task while seeking a separate external outcome from it. In more detail, SDT further divides extrinsic motivation into four levels that range from totally external motivation to increasing degrees of internalization tending toward intrinsic motivation: external regulation, introjected regulation, identified regulation, integrated regulation. Moreover, SDT posits that there are three psychological needs that when satisfied allow humans function optimally: autonomy, competence, and relatedness. When satisfied, these psychological needs also support intrinsic motivation and facilitate integration of external motivation. For this reason, many gameful design frameworks are based on adding properties (motivational affordances) to the system aimed at supporting the user's feeling of autonomy, competence, and relatedness. Furthermore, tangible or intangible rewards are often offered as a means of supporting the user's extrinsic motivation. Cerasoli et al. [51] showed that intrinsic motivation is a stronger predictor of performance in qualitative tasks whereas extrinsic motivation is a stronger predictor in quantitative tasks. Thus, combining intrinsic and extrinsic motivations can lead to improved performance.

Instructions

Please follow the following steps for evaluating each App:

1. Select the first application (from the two apps provided for review).
2. Reflect about the application's design and the motivational affordances within the app. Try to understand how they foster intrinsic and extrinsic motivation (using rewards or feelings of autonomy, competence, and relatedness).
3. Based on these reflections, list any issue you can observe in the application related to the motivational affordances (or lack of them).
4. If you encounter any issue, you can further reflect about what design elements could be added to improve the application.
5. After listing all the issues, evaluate the list of design ideas to choose the best ones.
6. Once this procedure is completed for the first app, select the second app and follow through steps 2-5.

Please note that you should not spend more than one hour testing and evaluating each application.

If you decide to search for any additional resources to learn about gamification or gameful design besides this document to guide your assessment (e.g. blogs, papers, courses, etc.), please take note of all the resources you have used and submit a complete list together with your evaluations (list of issues and suggestions for each app).

Sample Issue Format

To evaluate the applications, you are being asked to write a list of the issues you encounter (with optional suggestions for improvement). Issues should be written in a concise format describing the problem encountered. For example, an issue related with usability could be described in the following format:

> *The error messages are not clear enough and do not explain how the user might correct the problem* (required issue description). *Suggestion: change the error messages to include a suggested corrective action (e.g. try again after a few minutes or contact customer support)* (optional suggestion for improvement).

Use a similar format to list issues related with gamification or motivation (not usability) that you encounter in the apps.

Applications for Evaluation

For the purpose of this study, we ask that you evaluate the following applications. Both applications are free. You can create a free account using the application website to better evaluate it.

- Habitica - https://habitica.com/
- Termling - http://www.termling.com/

Contact

If you have any questions, please contact one of the researchers responsible for this study.

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Appendix C Instructions for Participants With the Gameful Design Heuristics

Introduction

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Gameful Design Heuristics

Although many gameful design methods have emerged recently, designers still lack standard evaluation methods for evaluating gameful design. For other established areas of UX, heuristic evaluation methods are commonly used [242]. In usability engineering, heuristics are general principles or broad usability guidelines that have been used to design and evaluate interactive systems. Heuristic evaluation, in the context of usability, is the use of said principles as a usability inspection method by experts to identify usability problems in an existing design as part of an iterative design process [242]. These are fast and inexpensive tools that can be used to identify and address design issues early in a project. These are not meant to replace user tests, but rather add to the set of evaluation tools: while heuristic evaluation can be applied early in a project, user tests are conducted later to find issues that could not be captured before.

The *Gameful Design Heuristics* are a new set of guidelines for heuristic evaluation of gameful design in interactive systems. It is the first tool of its kind focused specifically on evaluating gameful design through the lens of intrinsic and extrinsic motivational affordances. This set of heuristics is aimed at enabling evaluators to identify gaps in a gameful system's design. It was constructed based on an examination of several gameful design frameworks and methods that feature a classification of motivational affordances in different dimensions, which were used as a theoretical background to devise our heuristics. The gameful design frameworks that contributed with dimensions of motivational affordances to the *Gameful Design Heuristics* were (the acronyms in brackets refer to entries in the References section):

- *Octalysis*, by Yu-kai Chou [53]
- *Motivational Design Lenses*, by Sebastian Deterding [75]
- *The Kaleidoscope of Effective Gamification*, by Dennis Kappen and Lennart Nacke [150]
- *HEXAD*, by Andrzej Marczewski [198, 329]
- *Super Better*, by Jane McGonigal [217]
- *RECIPE for Meaningful Gamification*, by Scott Nicholson [239]

After reviewing and comparing these frameworks, we identified twelve common dimensions of motivational affordances, which were based on the theories of intrinsic and extrinsic motivation [296] and behavioural economics, as well as the authors' experiences. Prior research on motivation [296] enabled categorization of the twelve dimensions into *intrinsic*, *extrinsic*, and *context* *dependent* motivational categories. Next, we built our set of gamification heuristics by identifying adequate guidelines for each of the twelve identified dimensions and based this categorization to highlight the different uses of intrinsic and extrinsic motivators. The twelve dimensions of the *Gameful Design Heuristics* are shown in Table 1.

Category	Dimensions
Intrinsic Motivation	Purpose and Meaning, Challenge and Competence, Completeness and Mastery, Autonomy and Creativity, Relatedness, and Immersion
Extrinsic Motivation	Ownership and Rewards, Scarcity, and Loss Avoidance
Context-Dependent	Feedback, Unpredictability, and Change and Disruption

Table 1: Twelve Dimensions of the Gameful Design Heuristics

Instructions

The *Gameful Design Heuristics* should be used during the design or evaluation of gameful applications. Please follow the following steps for evaluating each App with each heuristic:

1. Select the first application (from the two apps provided for review).
2. Reflect about the application's design and the motivational affordances within the app.
3. Review the list of heuristics provided for review. Note that the heuristics are identified with unique code numbers.
4. Select the first heuristic from the list. As an example, choose the *heuristic* associated with *meaning* (I1) from the list of intrinsic motivation heuristics.
5. Based on this specific heuristic, list any issue you can observe in the application related to the heuristic's description. The suggested sample questions provided beside the heuristic (column 3) can help you reflect on the application design for this heuristic. While the question is provided as a sample, it is not comprehensive. You are invited to think about other questions that relate to the heuristic being used (e.g. *meaning*).
6. If you encounter any issue, you can further reflect about what design elements could be added to improve the application.
7. Once you are satisfied with the first heuristic, select the next heuristic and follow through steps 3-6
8. Keep repeating the steps until you have completed reviewing all heuristics.
9. Please notate key successes or discrepancies for each heuristic in a separate comment section. These notes will be useful in the interview phase of the study.
10. After completing all heuristics, evaluate the list of design ideas to choose the best ones.
11. Once this procedure is completed for the first app, select the second app and follow through steps 2-10.

Please note that you should not spend more than one hour testing and evaluating each application.

If you decide to search for any additional resources to learn about gamification or gameful design besides this document to guide your assessment (e.g. blogs, papers, courses, etc.), please take note of all the resources you have used and submit a complete list together with your evaluations (list of issues and suggestions for each app).

Sample Issue Format

To evaluate the applications, you are being asked to write a list of the issues you encounter (with optional suggestions for improvement). Issues should be written in a concise format describing the problem encountered. For example, an issue related with usability could be described in the following format:

> *The error messages are not clear enough and do not explain how the user might correct the problem* (required issue description). *Suggestion: change the error messages to include a suggested corrective action (e.g. try again after a few minutes or contact customer support)* (optional suggestion for improvement).

Use a similar format to list issues related with gamification or motivation (not usability) that you encounter in the apps.

Applications for Evaluation

For the purpose of this study, we ask that you evaluate the following applications. Both applications are free. You can create a free account using the application website to better evaluate it.

- Habitica - https://habitica.com/
- Termling - http://www.termling.com/

Contact

If you have any questions, please contact one of the researchers responsible for this study.

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