FEDERAL UNIVERSITY OF ALAGOAS

COMPUTER SCIENCE INSTITUTE

POSTGRADUATE PROGRAM OF COMPUTER SCIENCE

MASTER THESIS

TAILORING GAMIFIED VIRTUAL LEARNING ENVIRONMENTS BASED ON GAMER TYPES

MASTER STUDENT

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Master thesis presented as partial requirement to obtain the master's degree by the post-graduation program in Computer Science of the Federal University of Alagoas.

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-

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ABSTRACT

In the last years, is notorious the growing use of different digital technologies in many different fields, with highlight for, social networks, marketing, health, and education. In the field of education, specially, studies have highlighted the use of different digital technologies in order to provide different educational resources, such as educational games, intelligent tutoring systems, virtual learning environments, and others. In order to create better virtual learning environments, a plethora of studies have been using game design elements to design these systems, aiming to increase students' concentration, motivation, flow experience, and others, creating the named gamified virtual learning environments. However, besides these plenty of studies, recent researches are showing that in some case, the use of gamification can cause the opposite effects, because the students are motivated or demotivated for different gamification elements according to their gamer type, for instance, some students can be more motivated for specific gamification elements and demotivated for others gamification elements. Thus, one of the main contemporary challenges in this field is to provide gamified virtual learning environments tailored according to students' gamer types. This master thesis aims to propose a process and architecture to tailor gamified virtual learning environments based on the students' gamer type. The process and architecture proposed were created based on the Orji' guideline that associate the best persuasive strategies for each *BrainHex* gamer types and were designed through the Empirically-Based Technology Transfer methodology. A real gamified virtual learning environment was tailored based on our proposal and was evaluated through an empirical experiment with 125 elementary students in order to comparatively evaluate the tailored and the counter-tailored versions of the system in terms of students' concentration and flow experience. The main results indicate that are not significant difference of gamer types in terms of concentration and flow experience in some of gamer types, and, for some gamer types the tailored system was more effective, however, in some specific cases, the flow experience and concentration was larger in the counter-tailored version of the system, surprising and contradicting the expectation of recent important theoretical studies of this field. So, after our main experiment, we also conducted a second empirical experiment, in order to identify the better gamification element to motivate each gamer type. This experiment was conducted with 111 Brazilians students and the results confirm that students have different preferences about each gamification element and classified the better gamification elements to each gamer type. Finally, we provided a guideline to tailor gamified virtual learning environments based on our process and architecture and a second guideline with the better, neuter and worse gamification elements to motivate each gamer type.

Key-words: gamification; gamer types; persuasive technology strategies; virtual learning environments; tailoring educational systems.

RESUMO

Nos últimos anos, é notório o crescente uso das diferentes tecnologias digitais em diferentes campos de pesquisa, com destaque para redes sociais, marketing, ciências da saúde e educação. No domínio da educação, especialmente, recentes estudos têm destacado o uso de diferentes tecnologias digitais para fornecer diferentes recursos educacionais, como jogos educacionais, sistemas tutores inteligentes, ambientes virtuais de aprendizagem e outros. Para criar melhores ambientes virtuais de aprendizagem, uma grande quantidade de estudos tem usado elementos de design de jogos para projetar esses sistemas, com o objetivo de aumentar a concentração, motivação, experiência de fluxo e outros, criando os ambientes de virtuais de aprendizagem gamificados. No entanto, pesquisas recentes mostram que, em alguns casos, o uso da gamificação pode causar efeitos opostos do proposto, isso porque os estudantes são motivados ou desmotivados por diferentes elementos de gamificação de acordo com seu perfil, por exemplo, alguns estudantes podem ser melhores motivados por elementos específicos de gamificação e desmotivados por outros elementos de gamificação. Assim, um dos principais desafios contemporâneos neste domínio de pesquisa é fornecer ambientes de virtuais de aprendizagem gamificados adaptados de acordo com os tipos de perfil dos estudantes. Esta dissertação de mestrado tem como objetivo propor um processo e uma arquitetura para adaptar ambientes virtuais de aprendizagem gamificados com base no tipo de jogador do estudante. O processo e a arquitetura propostos foram criados com base nas diretrizes de Orji, que associam as melhores estratégias persuasivas para cada tipo de jogador identificados pelo *BrainHex* e foram criadas através da metodologia de Transferência de Tecnologia com base em um estudo empírico. Um ambiente virtual de aprendizagem gamificado foi adaptado com base em nossa proposta e foi avaliado através de um experimento empírico com 125 estudantes de ensino básico, a fim de analisar comparativamente as versões personalizadas e não personalizads do sistema em termos de concentração e experiência de fluxo. Os principais resultados indicam que não houve diferença significativa entre alguns dos tipos de jogadores em termos de concentração e experiência de fluxo, e, para alguns tipos de jogadores, o sistema personalizado foi mais efetivo, no entanto, em alguns casos específicos, a experiência de fluxo e a concentração foram maiores na versão não personalizada do sistema, surpreendendo e contradizendo a expectativa de recentes estudos teóricos importantes deste domínio. Assim, após o nosso experimento principal, também realizamos um segundo experimento empírico, para identificar os melhores elementos de gamificação para motivar cada tipo de jogador. Este experimento foi conduzido com 111 estudantes brasileiros e os resultados confirmam que os alunos têm diferentes preferências sobre cada elemento de jogo e classificaram os melhores elementos de gamificação para cada tipo de jogador. Finalmente, fornecemos um guideline para adaptar ambientes virtuaus de aprendizagem gamificados com base em nosso processo e arquitetura e um segundo guideline destacando quais os melhores elemenos de gamfiicação para motivar cada tipo de jogador.

Palavras-chave: gamificação; tipos de jogadores; estratégias de tecnologia persuasivas; ambientes virtuais de aprendizagem; adaptação de sistemas educacionais.

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1. Introduction

In the last years, the emergence of different digital technologies has been used in different fields, such as social networks (Adaji and Vassileva 2016), movies (Wu and Chen 2015), health (Orji *et al*. 2013), and educational fields (Connolly *et al*. 2012, Bittencourt *et al*. 2009, Dascalu *et al*. 2015 and others), drawing the attention of academics and practitioners. In the educational field, several studies have been used the digital technologies with many different goals, such as improving the concentration, engagement and flow of the students (Hamari *et al*. 2016), providing recommendation of educational resources to the students (Holanda *et al*. 2012) and offering an adaptive system (Masthoff and Vassileva 2015). These studies have brought different challenges and opportunities to the industry and to the Computer and Education community (C&E), with a preference for design educational environments capable of providing personalized learning to the students, according to their personal characteristics and preferences (Masthoff and Vassileva 2015, Busch *et al*. 2016 and Ciocarlan *et al*. 2017).

1.1. Motivation and Contextualization

Commonly, many different digital technologies have been used in the educational field (*e.g*. educational games (Connolly *et al*. 2012), intelligent tutoring systems (Woolf 2010 and Paiva *et al*. 2015), adaptive hypermedia systems (Brusilovsky and Maybury 2002) and virtual learning environments (Dillenbourg (2002), Kerimbayev (2015) and Santana *et al*. 2016), to solve big notorious challenges in this field (*eg*. student's evasion, frustration, demotivation, among others).

In order to provide educational resources to the students in different geographical contexts with distinct educational goals, a growing plethora of studies have been developing and evaluating different kinds of virtual learning environments (VLEs), such as using recommended agents based on the students' learning styles (Dascalu *et al*. 2015), or measuring the students’ experience in this kind of system (Janßen *et al*. 2016). These studies have highlighted the VLEs as one of the most important types of educational systems, capable of helping students and teachers in different perspectives, including allowing students to learn any content in different time zones and geographical locations, allowing students to work in a collaborative way and to receive only specific contents according to their individual needs (*i.e*. Challco et al. 2015, Dascalu *et al*. 2015 and Paiva *et al*. 2015).

Besides, the VLEs represent an important way to provide solutions to very important educational problems (*i.e*. students' evasion, disengagement and demotivation). Recent studies showed contradictory results regarding the efficacy of these systems, such as students' evasion and demotivation during the virtual course (Alencar *et al*. 2015, Pedro *et al*. 2015 and Paiva et al. 2016), making room for a new research in this field.

In order to begin to solve the problem of students' evasion, disengagement and demotivation in the VLEs, recent researches have used game and gamification elements associated with its activities, in order to decrease students' evasion, frustration and demotivation, as well as to improve student's concentration, engagement, and learning in the VLEs (*e.g*. Fedena (2016), Dokeos (2016), and Paiva *et al*. (2015)). These studies are implementing and evaluating the use of gamification in the VLEs, raising the concept of gamified VLEs.

Recent results have shown that these systems are capable of offering different ways for the students to perform the educational activities associated with game design elements (Hamari *et al*. 2014) and also that gamified VLEs could provide a number of benefits to students, *i.e*.: increasing student's motivation (Cózar-Gutiérrez and Sáez-López 2016) and increasing student's performance and learning (Nah *et al*. 2014 and Pedro *et al*. 2015).

However, similar studies are showing that, in many cases, the use of gamification in an educational context (especially gamified VLEs) doesn't always improve the students' motivation, engagement, and learning (Hamari *et al*. 2014, Orji *et al*. 2014 and Orji *et al*. 2017), bringing the attention of the community for the need of more deep researches, especially in order to identify when and how the use of gamification is really effective to improve the students' satisfaction with the system and to propose solutions to provide better gamification.

1.2. Research Problem

More recent studies in the field of gamified VLEs, conducted since early 2013, also have shown contradictory results, pointing to the fact that sometimes gamified VLEs improve the students' motivation, engagement and learning, but sometimes the same system doesn't improve or even in some cases decrease the students' motivation, engagement and learning, causing frustrations, demotivation or disengagement of the students (Orji *et al*. 2014, Wu and Chen 2015 and Orji *et al*. 2017). Studies conducted in the last years (*e.g*. Orji *et al*. (2013), Monterrat *et al*. (2014) and Alhathli *et al*. (2017)) have highlighted that this situation occurs because often students that use the gamified VLEs have different behavior, expectations, and needs, and are encouraged in different ways (Paiva *et al*. 2015 and Masthoff and Vassileva 2015).

In gamified VLEs, it is important to considerate that the students have different gamer types, so they are more motivated or less motivated in different ways, according to their gamer type and the gamification elements (gamification) used in the system (Orji *et al*. 2014, Monterrat *et al*. 2015 and Masthoff and Vassileva 2015). For instance, if a student is competitive, it is more likely that he prefers to earn points and compete in missions. However, the same student might be demotivated to participate in collaborative or interactive activities, needing to participate in specific activities, associated with their preference or gamer type.

Thus, depending on the approach used in these systems, the final results can be harmful to the students' motivation, engagement, flow experience and such (Bateman and Nacke (2010), Yee (2006), and Orji *et al*. (2014)). According to these studies, if the system provides the same gamification elements to all participants (*one-size fits all* approach), without considering their individual characteristics (*e.g*. gamer type) it might generate both a positive effect on some students and a negative effect on others.

Highlighting this problem, according to a recent systematic literature review conducted by Nah *et al*. (2014), most of the gamified VLEs created have provided different gamification elements to students, such as points, badges, trophies, ranking, and so on. However, unfortunately, these systems are using the *one-size fits all* approach or *monolithic group* (Orji *et al*. 2014), which may become harmful to students. In other words, because of the use of the same gamification elements to all of the students, this has to cause the opposite effect that is intended for this kind of system. This problem highlights the recent big challenge presented by Orji *et al*. (2014), Monterrat *et al*. (2015), Masthoff and Vassileva (2015) and others, of creating tailored systems, based on the students' needs and preferences, to create educational systems, based on the students' gamer type.

Few recent studies have conducted researches to solve this problem. These studies are generally conducted to provide theoretical relationships between various personality types and traits, as well as outlined player typologies that currently exist, or to provide toolboxes to better inform the design of gamified systems and specifically target users in a more internally engaging and motivating way (Ferro *et al*. 2013). Other recent important advances are the identification of the best persuasive strategies associated to each gamer type, and the development of a guideline to tailor gamified VLEs based on the students' gamer types (Orji *et al*. 2014) (more details in the Related Works section).

Besides these recent advances, this field has many open challenges and gaps to be solved. Most of the studies conducted in the last years were made in different fields other then the educational (*i.e*. specific studies for marketing or health sciences), creating a gap in the field, as well as opening an opportunity to conduct similar studies in the area. Recent studies identified which are the best persuasive strategies associated to each gamer type. Another big challenge in this field is to provide a process and structure for the gamification designers being able to implement gamified VLEs, tailoring it and taking as basis the students' gamer types, using the best game design element to each student gamer type.

1.3. Research Goals

Based on the recent challenges to provide adapted VLEs for each student (Orji *et al*. (2014), Monterrat *et al*. (2015), Masthoff and Vassileva (2015)) this master thesis aims to propose a process and structure capable of tailoring general gamified VLEs according to the students' gamer types, as well as tailoring and evaluating empirically a real gamified VLE based on the process and structure proposed, in order to present a specific guideline to tailor gamified VLEs based on students' gamer type.

1.4. Scope Definition

The process and structure to create gamified VLEs proposed in this study take into account the seven different *BrainHex* gamer types (seeker, survivor, daredevil, mastermind, conqueror, achiever, and socializer). The proposal was developed based on Orji's guidelines that define which are the best persuasive strategies to each gamer type. The associations of the best gamification elements to each gamer type were also founded through Orji' study. Some specific gamification elements can only be implemented in specific types of gamified system. The process and structure proposed are directly applicable to create the gamification system design, based on the students' gamer type, independent of the pedagogical system and the gamification framework used to implement the system.

The process and architecture proposed are designed to be used by gamification designers during the process of system design, where the gamification designers can use our approach to provide a personalized gamification design model to the system. Our proposal can also be used during the system implementation, to guide the programmers and designers to create the system gamification (in systems originally implemented without personalization). The study was conducted following the Empirically-Based Technology Transfer methodology (Gorschek *et al*. 2006), considering the 5th step (academic validation).

1.5. Research Contributions

The main contributions of this master thesis are found in the field of C&E, more specifically in the gamified VLEs domain, providing a process and structure to create gamified VLEs based on the students' gamer types. We also developed a gamified VLE, personalized with the gamer types based on our process and structure, conducting an empirical validation with elementary students, analyzing the students' concentration and flow experience in the tailored and in the counter-tailored version of the system. Based on our results, we also provided a guideline to create a new gamified VLSs and a guideline to tailor/modify pre-existent gamified VLEs.

We also provided a Portuguese version of the *BrainHex* player model. The *BrainHex* version in Portuguese language was used in our experiment and was later available online for the community. We aim to use the results obtained through the Portuguese version of *BrainHex* to identify an overview of Brazilians players.

Our study provided two different systematic literature reviews (SLR): the first in the gamer types area applied to computers and education (C&E) and its results were used to identify a general view of the empirical studies in this domain, identify our main related works and make important decisions (*i.e*. choose the player model used in this study), and the second SLR in the field of Flow Theory applied to C&E, and its main results were used to make important decisions regarding our experiment, such as choosing the flow model and the flow state scale used in our empirical experiment.

Finally, our study also identified the best gamification elements (considering the ten gamification elements most used in the field of C&E (Nah *et al*. 2015)) to motivate each *BrainHex* gamer type and provided a specific guideline with the best gamification elements to tailor Gamified VLEs based on students' gamer types.

1.6. Methodology

This research has the goal to solve an industrial problem, perceived in different companies that implement and offer educational systems. So, as showed before, studies conducted in these systems have showed that students are motivated in different ways on gamified VLEs, according to their gamer type, and this kind of system needs to provide different gamification elements, according to the students' gamer types, in order to motivate and engage these students.

To provide a robust methodology, it was adopted the *Empirically-Based Technology Transfer* model (Gorschek *et al*. 2006). This methodology provides a structure to develop solutions to different problems identified in the industrial context, as well as validating the solution statically and dynamically in an industrial and academic context.

1.6.1. Empirically-Based Technology Transfer

Software engineering is an applied research area that has the objective of performing researches on industrially relevant issues. It is in many cases insufficient to perform only academic research on engineering requirements or software testing with the motivation of these areas challenging the industry (Wohlin *et al*. 2012).

Software engineering is preferably conducted jointly by academical and industrial contexts to enable knowledge exchanging in any direction, transferring new methods, technologies, and tools from academical contexts to industrial ones. In this sense, the Empirically-Based Technology Transfer methodology is composed of seven steps, begining with the problem identification (industry) and ending in the evaluation (academy and industry). This methodology was documented and presented by Gorschek *et al*. (2006) and developed based on a long-term collaborative venture. **Figure 1** shows the general view of the Empirically-Based Technology Transfer methodology.

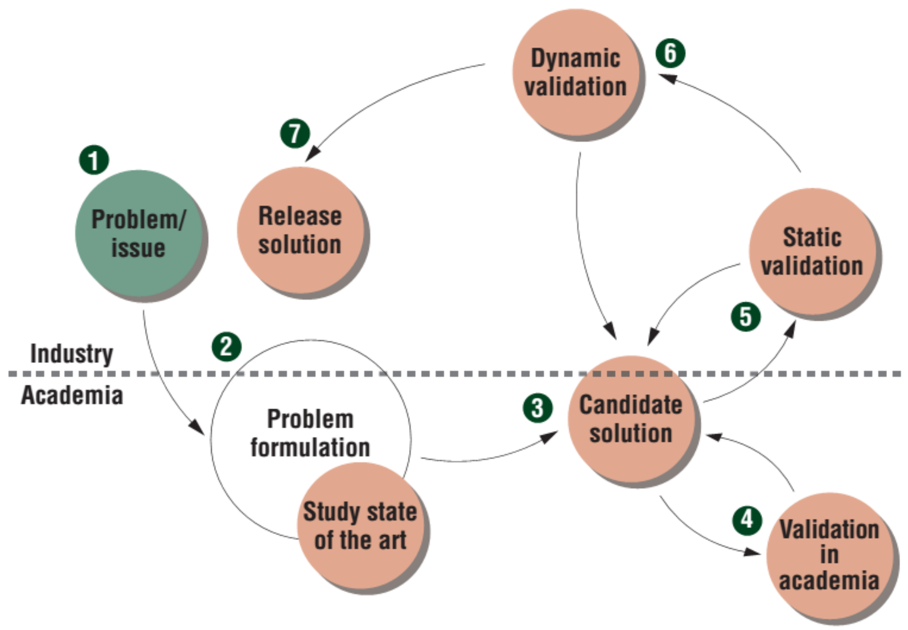


Figure 1 - Empirically-Based Technology Transfer methodology

- **Identification of industrial problem/issue**: The first step is to identify current challenges in a specific industrial context, which implies that the researcher is together with the industrial partner(s). The identification of challenges may be done using, for example, surveys or interviews. In our case, the problem was identified through a research review of recent challenges in the field of study (see Research Problem section for a comprehensive review).
- **Problem formulation**: Based on the identified challenge(s), the challenge should be formulated as a research problem and research questions should be specified. If several different challenges are identified then there is the need to prioritize one of them to be addressed. Furthermore, a main contact person for the chosen challenge should be identified. In this study, the problem formulation was conducted in partnership with academic professionals (Ph.D. with expertise in the field of study),

as well as industry professionals (CEO and gamification designer with expertise in the field of study) (see Research Problem section for a comprehensive review).

- **Candidate solution**: Based on available approaches and the actual needs, a candidate solution is developed, which may include tailoring current processes, methods, technologies, and tools used in the company. The solution is preferably developed in close collaboration with the industrial partner(s) so that the applicability can be continuously ensured. In our research, the candidate solution is developed based on the Orji' guideline, in collaboration with the industrial partner, representatives of a real gamified VLE used to implement the candidate solution (see Implementation section for a comprehensive review).
- **Academical validation**: The first validation of the proposed solution is preferably conducted in an academical environment to minimize the risk, *i.e.*, an off-line validation. In many cases, this may be conducted as an experiment or as a case study of a student project. In our study, the academical validation will be conducted with 100 high performance students, using the candidate solution in a lab environment, and conducting an empirical evaluation in terms of usability, engagement, motivation, and flow experience (see Experiment section (Validation in Academy) for a comprehensive review).
- **Static validation**: In the static validation, industry representatives evaluate the candidate solution offline. This may be done through a presentation of the candidate solution followed by either an interview of different industry representatives with preferably indifferently affected roles or joint workshops. In our work, the static validation will be conducted with industry representatives of the real gamified VLE (*MyTutor*), involved in the initial process assessment (step 1): CEO, interface designers, gamification designers, and product managers. The feedback of industry representatives will be collected through structured voice recording and solution presentation through a seminar (see Experiment (Static Validation) section for a comprehensive review).
- **Dynamic validation**: Once the new solution passes the static validation and there are an agreement and a commitment to implement the new solution, it will be time to move on to the dynamic validation. This is preferably done as a pilot evaluation. To know how to exactly conduct the validation depends on the type of solution. The new

solution may be used in a project, sub project or in parts of a system, or for a specific activity. In our project, the dynamic validation will be conducted only after the previews steps are concluded, and will be made by an empirical experiment in real scenario, to compare the tailored system with the counter-tailored system, with high school students, in terms of usability, engagement, motivation, and flow experience (this phase, as well as the next steps, is not part of the scope of this master thesis).

- **Release solution**: A generic solution must be tailored to each unique situation. There is the need to ensure that any research solution is properly handed over to an industrial company and that this company has sufficient support in terms of training and potential tool support.
- **Closing remark**: It is interesting to note that the industry representatives are primarily interested in the specific tailoring of their environment, while from a researcher's perspective it’s a case for the generic solution. Thus, the collaborative partners may have different main focuses, but in the end they both benefit from the joint effort. The industrial partner gets a solution to an identified challenge and the researchers can evaluate a research result in a real industrial environment.

For a comprehensive review, see Gorschek *et al*. (2006) and Wohlin *et al*. (2012).

2. Background

This section presents the main topics addressed in this study, which is: Computers and Education, Virtual Learning Environments, Gamification, Gamer Types, Persuasive Technologies Strategies and Flow Theory.

2.1. Computers and Education: A Review of Important Topics

The application of Digital Information and Communication Technologies (DICT) in education has been receiving an increasing interest and is gradually becoming leitmotiv for the teaching-learning process (Terry (2008) and Santos *et al*. (2015)). In the last years, several countries have adapted their educational approaches in order to promote and support the use of computer-supported educational technologies in physical and virtual learning contexts (*e.g.* Admiraal *et al.* 2011, Santos *et al.* 2014 and Andrade *et al.* 2014).

In this context, Bittencourt *et al*. (2015) presented a series of contemporary key themes related to C&E, a subfield of the DICT on education, for instance: Virtual Learning Environment (VLE), Web-based Learning, Web-based Education, Collaborative Learning, Adaptive Hypermedia, Intelligent Tutoring System (ITS), Distance Education and Educational Games.

Jonassen and Land (2012), highlight that VLEs are an important mechanism capable of supporting students in different scenarios. Boisvert (2000) also points out about the importance of web-based learning, highlighting that this kind of system can improve the student's learning and provide individual educational learning spaces. Another relevant theme is semantic web-based education. Bittencourt *et al*. (2009) highlight the semantic web-based education importance in order to design educational systems capable of meeting the contemporary educational demands (*e.g.*, interoperability between educational systems, querying and reasoning and so on). Complementarily, Steenbergen-Hu, and Cooper (2014) highlight ITSs' results in the education as an example of the success of the application of C&E to provide individualized learning.

Moreover, another prolific research topic on C&E is collaborative learning on the web. According to Roberts (2009), these educational systems are capable of integrating students in different social contexts, time period, and educational experience has a unique impact on individual learning through collaborative means. Collaborative learning techniques are pervasive on distance education, students who are not physically present at a school (Bozkurt *et al*. 2015).

In the last years, several courses, in different educational levels and target to different student's profile have been created based on these techniques. Lastly, Admiraal *et al*. (2011) suggest the use of games in the education. According to these authors, game-based learning is a promising possibility for C&E, especially, considering a large number of works that showed positive results of game-based learning in several educational scenarios. In this context, Connolly *et al*. (2012) point out several positive situations of games in education, as well as various challenges in the game application in this scenario.

2.2. Virtual Learning Environments

In the last decades, Virtual Learning Environments (VLE) have been formed with an important contribution of C&E, especially in order to provide to students and professors, an environment capable of offering different educational resources and different collaborative learning spaces. VLE was defined by Dillenbourg (2002) as a concept that includes several interesting features that justify the use of a specific label. Dillenbourg (2002) points out several topics presented in a VLE:

- A VLE is a designed information space;
- A VLE is a social space: educational interactions occur in the environment, turning spaces into places;
- The virtual space is explicitly represented: the representation of this information/social space can vary from text to 3D immersive worlds;
- Students are not only active but also actors: they co-construct the virtual space;
- VLEs are not restricted to distance education: they also enrich classroom activities;
- VLEs integrate heterogeneous technologies and multiple pedagogical approaches;
- Most virtual environments overlap with physical environments.

Based on this conceptualization, in a year later, Konstantinidis (2003) synthesizes this conceptualization defining VLE as an environment produced from underlying automated rules that allows its users to modify it to some degree. According to Britain and Liber (2004), these systems allow participants to be organized into cohorts, groups, and roles; present resources, activities, and interactions within a course structure; provide for the different stages of assessment; report on participation, and have some level of integration with other institutional systems.

After these works, a series of VLE systems have been implemented and evaluated in the last decades, these systems aim to provide resources to different learning contexts. Table **1** presents some VLEs of different domains, presented to Faruque (2012):

Table 1 - Virtual Learning Environment List

Virtual Learning Environment List	
ATutor	Open Source Web-based Learning Content Management System (LCMS) designed with accessibility and adaptability in mind. (ATutor 2016).
Claroline	A toolkit of Distance Education and collaborative work, provide to institutions create and manage online resources (Claroline 2016).
Dokeos	Toolkit to learning with four components: *Author* in order to implement the educational contents, *LMS* in order to control the interaction with students, *Shop* to sales the Course Syllabus, and *Evaluate* in order to evaluate and certificate the students. (Dokeos 2016).
eFront	Learning management system that provides effective employee training that fits your brand preferences for both, online training and blended learning. (eFront 2016).
Fedena	Open source school management software that has more features than a student information system. (Fedena 2016).
ILIAS	Open source web-based learning management system (LMS). It supports learning content management and tools for collaboration, communication, evaluation, and assessment. (ILIAS 2016).
MeuTutor®	Virtual Learning Environment that provides to professors a space to define and provides different educational resources (videos, hyper texts, questions, quizzes, and others), at the same time, provide to students this resources through activities gamified, the student has the opportunity of study single or in collaboration with others students through student's groups. *MeuTutor®* monitors students' learning in a personalized way, focusing on the quality of teaching and students' performance. (Paiva *et al*. 2015).
Moodle	Open source online courseware platform that runs under all major operating systems. Provides tools for educators to create a virtual classroom via the Internet. (Moodle 2016).
OLAT	Open Source Learning Management System tailored to the needs of Universities and Higher Education institutions. OLAT (2016).

A series of studies about cohorts, groups, and roles as well as how they influence learning have been investigated in the last decade. For instance, Kerimbayev (2015) presents some possibilities and implementation of Virtual Learning Environment and its use in different educational contexts. Kerimbayev (2015) also shows that these systems are as a set of information resources provides complex methodical and technological support of the educational process, educational process management, and also its quality. Nowadays, VLEs represent a multi purpose system, presenting a set of advantages, for instance, mobility and interactivity of training environment, a distance of learning and, existence of information educational resources.

However, several challenges related to the design and application of VLEs have been reported in the literature. Paiva *et al*. (2015) argue that a majority challenge related to the design and implementation of these systems is contributing to students' learning, and especially providing to students specific learning materials, according to their needs and personal characteristics. Thus, providing adaptive support to users during their interaction process in VLEs, is a key challenge concerning the design of this kind of system (Vail *et al*. 2015), especially regarding the complex process for implicit identification of specific features related to the behavior of users.

This study is concerned with to gamified VLEs, in reason of the use of game mechanicals, capable of motivating students toward learning. In this sense, we have to use gamified VLE called *MeuTutor*® (see section *MeuTutor*), this due to this system provides to student's educational resources through activities gamified, as well as provide to professor organize and to distribute activities in according to their Course Syllabus.

2.3. Gamification

Throughout history, many have championed the use of play, games, and game-inspired design to improve the human condition (Nacke and Deterding 2017). At the same time, during recent years, gamification has become a popular method of enriching information technologies (Morschheuser *et al*. 2017), showing the use of gamification in the most different types of system, with emphasis on educational systems (Hamari *et al*. 2014).

The term "gamification", according to Huotari and Hamari (2016) was first used in 2008, in a blog post by Brett Terrill (2008), describing the word as "taking game mechanics and applying them to other web properties to increase engagement". However, the concept of gamification had commonly adopted from the digital media industry (Deterding *et al*. 2011). The first documented use dates back to 2008 by Paharia (2010), but the term did not see widespread adoption before the second half of 2010 (Deterding *et al*. 2011). Thus, in the field of game studies, gamification can be seen as but one further outgrowth of the repurposing and extension of games beyond entertainment in the private home (Deterding *et al*. 2011).

During the last couple of years, gamification has been a trending topic and a subject of much hype as a means of supporting user engagement and enhancing positive patterns in service use (Hamari *et al*. 2014). Gamification has been researched and discussed in several different contexts, for instance, in the general academic context (*e.g*. Sinha (2012) and Challco *et al*. (2015)), industry (*e.g*. Korolov (2012) and Herger (2014)) and conducting empirical experiments in order to identify the real effects gamification application in the people behavior, learning, and sun on (*e.g*. Hamari (2015) and Santana *et al*. (2016)). More specifically, in the context of academia (main interest of this study), these works have been done, especially in gamification applied to C&E, in order to provide to student's motivation and engagement in learning environments.

The first wave of gamification research has predominantly consisted of (1) definitions, frameworks and taxonomies for gamification and game design elements; (2) technical papers describing systems, designs, and architectures; and (3) effect and user studies of gamified systems (Hamari, Koivisto, & Sarsa, 2014; Seaborn & Fels, 2015). These trends of studies, has pointed many challenges in this field.

Actually, different definitions of gamification have used in the academia; Deterding *et al*. (2011) defines the concept of gamification, as "the use of game design elements in non-game contexts". Werbach (2014), in turn, adopts a designer's point of view and presents a very general definition of gamification as "the process of making activities more game-like", in order to bring academic and practitioner perspectives closer together. Huotari and Hamari (2011) define gamification as a service packaging where a core service is enhanced by a rules-based service system that provides feedback and interaction mechanisms to the user with an aim to facilitate and support the users' overall value creation.

More recently, Huotari and Hamari (2016) update this term proposing a definition for gamification, anchoring gamification in the service marketing literature, as "gamification refers to a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation".

In order to synthesize the terms, Vassileva (2015) address gamification as a term directly related to the concept of games and game mechanics, which has accumulated a number of patterns, rules, and feedbacks that create user engagement, are motivational and can be applied to develop game-like mechanics in any application, including educational environment. Vassileva (2015) describes the most commonly used game mechanics to gamification. We show these game mechanics in Table **2**, summarized by Pedro *et al*. (2015).

Table 2 - Patterns of Game Mechanics

Pattern	Description
Ownership	Allowing the user to own things, such as points, token, badges. It creates loyalty to the system.
Achievements	Providing a virtual or physical representation of having accomplished something that can be easy, difficult, surprising, funny, and accomplished alone or as a group.
Status	Computing and displaying rank or level or a user.
Community collaboration and quests	Posing challenges to the users related to time-limit or competition that can be resolved by working together.

Gamification takes the power of games and applies it to a given context to solve a problem. An important aspect of gamification understanding of what game elements are adequate in each problem and situation. Werbach and Hunter (2012) describe game elements as smaller pieces used to define building blocks that form the integrated gameplay experience. According to the same authors, these game elements are included in the dynamics, mechanics and components categories, as described below and summarized on Figure **2**:

- Game dynamics – the “big picture” aspects of the gamified system that you have to consider and manage but which can never directly enter into the game. For instance, constraints, emotions, narrative, progression, relationships, and personalization.
- Game mechanics – the basic processes that drive the action forward and generate player engagement; For instance, challenges, change, competition, cooperation, feedback, resource, acquisition, rewards, transactions, turns, win states, and profiles.
- Game components – the specific instantiations of mechanics and dynamics. For instance, achievements, badges, collections, leaderboards, levels, notifications, points, progress bars, quests or missions, status, teams, virtual goods, and so on.

Figure 2 - Game elements by Werbach and Hunter (2012)

While no standard conceptualization of gamification exists, most sources agree that gamification is generally defined as the use of game elements and mechanics in non-game contexts and a series of studies have been done in order to research the influence of gamification in the learning of students, especially in computer-based activities. In order to identify studies in Gamification, Hamari *et al*. (2014) conducted a Systematic Literature Review, with aims, identify empirical studies in gamification, as well as a response the question: Does gamification work?

Among the results, two especially are considerate in this work: (*i*) most works about gamification with empirical results, have been from C&E Hamari *et al*. (2014), and (*ii*) all of the studies in education/learning contexts considered the learning outcomes of gamification as mostly positive, for example, in terms of increased motivation and engagement in the learning tasks, as well as enjoyment over them. However, at the same time, the studies pointed to negative outcomes which need to be paid attention to, such as the effects of increased competition, task evaluation difficulties, and design features (Hamari *et al*. 2014).

These results are most important to this study, first to shows the crescent amount of studies done in Gamification applied to C&E, as well as the important positive results of application in the motivation, engagement, and learning of students. Second, these results also show negative outcomes which need to be paid attention, showing that others studies in gamification needed will do, especially, in gamification applied to C&E.

Front of this scenario, Nah *et al*. (2014), conducted a Systematic Literature Review in order to identify studies related to the use of Game Elements/Gamification in education. Thus, based on the review, they identified eight different game design elements that are used extensively in the educational and learning contexts. We show these game design elements in Table **3**.

Table 3 - Gamification elements used in education

Game element	**Description**
Points	The point system functions as a measure of success or achievement. These points may be used as rewards, as a form of investment for further progress towards the goals, or to indicate one's standing. There are different types of points and they vary across games. For example, Experience Points (XP) (*i.e*., points earned by completing tasks) and Steam Points (*i.e*., points that correspond to in-game currency) were used for some of the role-playing games in education (O'Donovan *et al*. 2013). Points can also be considered as credits in an academic environment (Kumar and Khurana 2013).
Levels/Stages	The level system is used in various game designs to give players a sense of progression in the game. Initial levels tend to require less effort and are quicker to achieve, whereas the advanced levels require more effort and skills. Even though levels/stages are a widespread and popular Gamification concept and they serve as a form of rewards for task or assignment completion, students' learning abilities may not progress or improve as a result of leveling (Goehle 2013).
Badges	Badges are recognized as a mark of appreciation or task accomplishment during the process of goal achievement. In order to maintain learners' motivation, the use of badges is helpful for engaging the learners in subsequent learning tasks. Badges are effective in inspiring learners to work towards future goals (O'Donovan 2013). The majority of the student respondents in (Santos *et al*. 2013) survey also felt that badges helped to keep them engaged, especially in the classroom context, and motivate them to carry out future learning tasks.
Leaderboards	The objective of a leaderboard is to keep the learners motivated and create a sense of eagerness to advance their names for the achievements they have accomplished. Leaderboards are used to create a competitive environment among students. A leaderboard is used to display the current levels of high scorers and the overall scores. In order to avoid demotivation for those who are lower ranked, leaderboards usually display the top 5 or 10 scorers only. The survey findings by O'Donovon *et al*. (2013) suggest that leaderboards rank highest in motivating learners.
Prizes and Rewards	The use of prizes has been found to be effective in motivating learners (Brewer *et al*. 2013). The timing and scale of rewards can also affect learner motivation (Raymer 2011). In general, it is better to give multiple small rewards than one big reward. Also, the schedule for giving out rewards should be evenly distributed throughout the learning process. An example of in-game rewards is character upgrades (Raymer 2011). A character upgrade is a way to motivate learners by displaying their progress in the form of characters. It allows others to recognize the amount of effort a learner has spent to reach his or her current level. In order to use character upgrades as a game design element, one must be given a virtual character which allows him or her to upgrade from time-to-time by means of the points or rewards earned (Raymer 2011).
Progress bars	Several researchers (*e.g*. Berkling and Thomas (2013), O'Donovon *et al*. (2013) and Raymer (2011)) have utilized progress bars to gamify education. While badges

	demonstrate achievements towards a particular level/goal, progress bars are used to track and display the overall goal progression. In an educational game, progress bars are used as a display mechanism to motivate people who are close to achieving their educational goal or sub-goals. Progress bars can also encourage them if they are falling behind in their progress.
Storyline	Storyline refers to the narrative or story in the game. Kapp (2012) suggests that a good storyline can help learners to achieve an ideal interest curve, where interest peaks around the beginning and end of the learning process, and to stay motivated throughout the learning process. A storyline also provides a context for learning and problem solving as well as helps to illustrate the applicability of concepts to real-life (O'Donovon *et al*. 2013).
Feedback	The frequency, intensity, and immediacy of feedback are helpful for learner engagement (*i.e*. Berkling and Thomas (2013), Kapp (2012) and Raymer (2011)). The more frequent and immediate the feedback is, the greater the learning effectiveness and learner engagement. Clear and immediate feedback has been shown to be important for attaining the flow state, which is a state of engagement and immersion in an activity (*ie.* Nah *et al*. (2014), Csikszentmihalyi (1990) and Csikszentmihalyi (1997)). Hence, feedback is an important criterion for performance and engagement.

These concepts are important to this study, the gamified VLE *MeuTutor*® used in this work, implement all the concepts presented in the Table **3** (*see section MeuTutor*®), thus, all main gamification elements actually used in education, are considered in the gamified VLE used in our experiment.

2.4. Gamer Types

From recent years, game types have recognized as a big challenge of VLE, that happens because the importance of learning personalization to students in these systems. According to Orji (2014), gamer types represent one way that players differ is in their preferred play styles. Through identification of gamer type in students, it is possible for instance: provide learning materials in according to your game style.

In order to provide an overview of this field, Hamari and Tuunanen (2014) conducted a meta-synthesis about player types, analyzing the main studies conducted in this field until 2012. The study conducted by Hamari and Tuunanen conclude that the field of study in player types is perhaps surprisingly uniform. In summary, the studies could be synthesized into five key dimensions pertaining to motivations of play/orientation of the player: Achievement, Exploration, Sociability, Domination, and Immersion. Additionally, in the relevant literature, notions of how Intense the mode of play, was commonly articulated as continuum or dichotomy between hardcore-ness and casualness were largely present in most of the studies. Most of the player typologies have been built based upon observation within MMOs and other online games.

Hamari and Tuunanen also highlight that one especially interesting further inquiry could be in investigating the feedback loop of how established player typologies affect the design of games and how they further strengthen the common ways to play. This is an important find improving the importance of our study, in order to create personalized systems, based on the user's gamer type. The Table 4 shows a summary of studies addressed in the study of Hamari and Tuunanen. Following, we will explain about the main studies about gamer types, addressed in the meta-synthesis, however, as we know, the meta-synthesis made by Hamari and Tuunanen considers only studies published until 2012, leaving out important recent studies. In this sense, we have deepened the research including new studies conducted in this domain.

Table 4 - Studies on player types by Hamari and Tuunanen (2014)

Authors	**Year**	**Basis**	**Methods**	**Presented Player types**
Whang Chang	2004	Psychographic	Quantitative factor analyses	Single-oriented player, Community-oriented player, off-real world player
Tseng	2010	Psychographic	Quantitative factor analyses	Aggressive gamer, social gamer, Inactive gamer
Yee	2006, 2007, 2012	Psychographic	Quantitative factor analyses	Achievement, social, Immersion (+subconstruts)
Zackariasson *et al*.	2010	Psychographic	Conceptual-analytical	Progress and provocation, Power and domination, Helping and support, Friends and collaboration, Exploration and fantasy, Story and escapism
Stewart	2011	Behavioral Psychographic	Conceptual-analytical	Guarian/Achiever, Rational/Explorer, Idealist/Socializer, Atisan/Killer, Conqueror, Wanderer, Manager, Participant, Hardcore, Casual
Bartle	1996	Behavioral	Qualitative observations and Quantitative factor analyses	Achiever, Explorer, Socializer, Killer
Lazzaro	2004	Behavioral	Conceptual-analytical	Easy fun, Hard fun, Altered States, The people factor

Drachen *et al.*	2009	Behavioral	Quantitative - clustering of game play data	Veteran, Solver, Pacifist, Runner
Ip Jacobs	2005	Behavioral	Quantitative factor analysis	Hardcore gamer, Casual gamer
Kallio *et al.*	2011	Behavioral	Triangulation of quantitative and qualitative data	Social mentalist, Casual mentalist, Committed mentalist
Hamari and Lehdonvirta	2010	Behavioral	Conceptual – analytical combination of qualitative observation and marketing theory	For example character levels and classes
Williams *et al.*	2006	In-game demographic	Triangulation of quantitative and qualitative data	Group centralist, Size of the guild, Type of server, Faction

The first important study conducted in this field was conducted by Bartle (1996), proposing an informal, qualitative model of four player types, Bartle's Model (Bartle's Test) was derivative from Psychology and through a series of questions and an accompanying scoring formula that classifies players. Thus, through Bartle's Model, it is possible to identify four different Player Types: Killers, Achievers, Socializers, and Explorers. Bartle's Model has been implemented in order to be applied in single-player and multiplayer context. Following, we describe each category and synthesize the categories in Figure 3.

- **Achievers** are players that consider the gathering of points their main motivation for playing. They actively seek treasures and values that the game provides;
- **Explorers** are more interested in figuring out how the game world works and like to tinker with game mechanics, possibly trying to expose potential exploits. They engage in discovery and mapping of the game system, structure or topological world;
- **Killers** are very competitive players, interested in imposing themselves onto others and in many cases are motivated to pursue the misery of others if caused by their behavior;
- **Socialisers** are more interested in the social interactions that the game facilitates than the game mechanics itself. They want to get to know the other players, understand their motivations and form relationships with them.

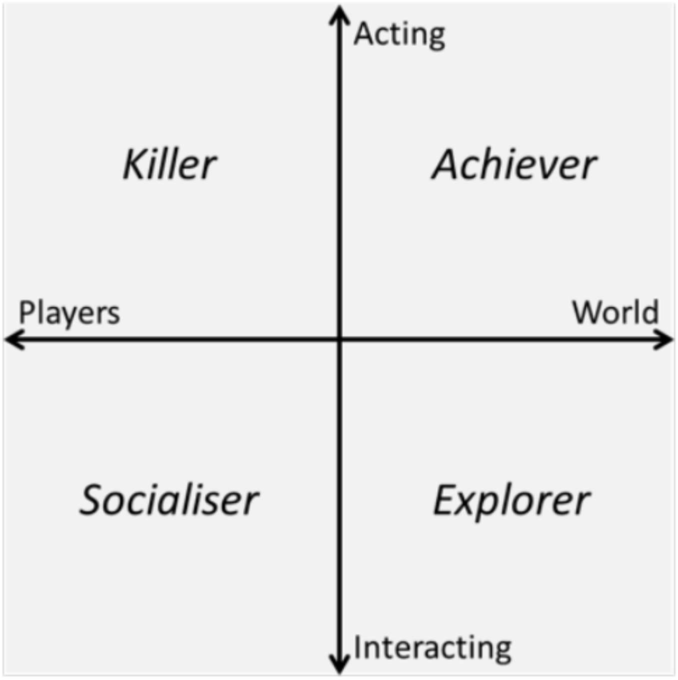


Figure 3 - Bartle's player type axes

Hereafter Yee (2006) recognized that Bartle's Model has constructed on comparisons between specific scenarios, as well as to Yee (2005) has argued that a "component" framework provides more explanatory power than a "category" framework. In this perspective, Yee (2006) propose a new model (Yee's MMORPG user motivations) focused specifically in Massive Multiplayer Online Role-Playing (MMORPG). Yee's MMORPG user motivation aims to measure different motivations of player in acceding and remain in a game. Thus, this model adopts five categories: Achievement, Relationship, Immersion, Escapism, and Manipulation. Following, we describe these categories:

- **Achievement**: measures the desire to become powerful in the context of the virtual environment through achieving goals and amassing powerful items;
- **Escapism**: measures how players are using the virtual world to avoid escape from real-life obligations;
- **Immersion**: measures how much users enjoy being in a fantasy world, the role-play of being someone else and the narrative that evolves from it;
- **Manipulation**: measures how much a player wants to objectify other users and manipulate them for personal gain and satisfaction;

- **Relationship**: measures the desire of users to interact with one another and how willing they are to form meaningful relationships that allow a degree of real-life problem disclosure.

However, models, before discussed, have been several limitations, in the context of big surveys, both approaches are focused to especially contexts and not provide resources to demographical surveys and different Gamer Types. In this context, after Bartle's model, Bateman and Boon (2005) proposed the development of the First Demographic Game Design Model (DGD1). Bateman and Boon (2005) presented findings based upon a set of four play styles supported by the data and also by the methods of statistical analysis used, which had required considerable manipulation to become tractable. These four play styles: Conqueror, Manager, Wanderer, and Participant.

Following up the findings of DGD1, six years after, Bateman et al. (2011) propose the Second Demographic game Design Model (DGD2). The DGD2 has brought news contributions to others studies, for instance, was discovered that women consistently assigned lower scores than men when describing their game playing competencies, the importance of emotions to their play, and their enjoyment of various patterns of play (Nacke *et al*. 2014).

More recently, in her book "*Game Design Workshop: A Playcentric Approach to Creating Innovative Games*", Fullerton (2014) outlines different theoretical types of players based on the agendas and needs when entering a space of play as well as addressing the pleasures of play from the point of view of the player, these players were not empirically evaluated. The player types will be described follows:

- **Competitor**: Plays to best other players, regardless of the game;
- **Explorer**: Curious about the world, loves to go adventuring; seeks outside boundaries - physical or mental;
- **Collector**: Acquires items, trophies, or knowledge; likes to create sets, organize history, etc.;
- **Achiever**: Plays for varying levels of achievement; ladders and levels incentivize the achiever;

- **Joker**: Doesn’t take the game seriously, they play for the fun of playing; there’s a potential for jokers to annoy serious players, but on the other hand, jokers can make the game more social than competitive;
- **Artist**: Driven by creativity, creation, and design;
- **Director**: Loves to be in charge, direct the play;
- **Storyteller**: Loves to create or live in worlds of fantasy and imagination;
- **Performer**: Loves to put on a show for others;
- **Craftsman**: Wants to build, craft, engineer, or puzzle things out.

In the same year, Nacke *et al*. (2014) propose a new Demographic Model, capable of identifying gamer type called *BrainHex*. In according to Nacke et al. (2014) BrainHex is such a top-down approach, taking the inspiration for its archetypes from neurobiological research, previous typology approaches, discussions of patterns of play, and the literature on game emotions. *BrainHex* is the first model capable of identifying seven Gamer Types categories (Seeker, Survivor, Daredevil, Mastermind, Conqueror, Socializer, and Achiever) and classifying the players in class and sub-class related to each other, allowing a more accurate classification. Following we show these categories and Figure **4** shows the *BrainHex* conceptual model.

- **Achiever**: While a Conqueror can be seen as challenge-oriented, the Achiever archetype is more explicitly goal-oriented, motivated by long-term achievements. Achievers, therefore, prefer games amenable to ultimate completion, especially digital RPGs, whose self-adjusting difficulties ensure completion as a result of perseverance (Nacke *et al*. 2014).
- **Conqueror**: Some players aren’t satisfied with winning easily—they want to struggle against adversity. Anger serves to motivate opposition and hence to encourage persistence in the face of challenge, and testosterone may also have an important role in this behavior (irrespective of gender) (Nacke *et al*. 2014).
- **Daredevil**: This play style is all about the thrill of the chase, the excitement of risk taking and generally playing on the edge. The behavior related to this type is focused around thrill seeking, excitement and risk taking, and thus epinephrine, which was already mentioned, can be seen as a reward enhancer (Nacke *et al*. 2014).

- **Mastermind**: A fiendish puzzle that defies solution or a problem that requires strategy to overcome is the essence of fun to this archetype. Whenever players face puzzles or must devise strategies, the decision center of the brain and the close relationship between this and the pleasure center ensures that making good decisions is inherently rewarding (Nacke *et al*. 2014).
- **Seeker**: This archetypal is motivated by interest mechanism, which relates to the part of their brain processing sensory information (i.e., the sensory cortices) and the memory association area (i.e., hippocampus). The Seeker type is curious about the game world and enjoys moments of wonder (Nacke *et al*. 2014).
- **Socialiser**: People are a primary source of enjoyment for players fitting a Socialiser archetype—they like talking to them, they like helping them, they like hanging around with people they trust. The name of this archetype pays tribute to Bartle's Socialisers, verified by Yee's relationship motivation (Nacke *et al*. 2014).
- **Survivor**: While terror is a strongly negative experience, certain people enjoy the intensity of the associated experience, at least within the context of fictional activities such as horror movies and games. The state of arousal associated with epinephrine becomes that of terror as a result of the action of the fear center, which becomes hyperactive when a situation is assessed as frightening (based on prior experience, and certain instinctive aversions). It is not yet clear whether the enjoyment of fear should be assessed in terms of the intensity of the experience of terror itself, or in terms of the relief felt afterward (Nacke *et al*. 2014).

Figure 4 - *BrainHex* conceptual model (BrainHex Blog[1])

BrainHex is of particular interest in our work because it did the union of important past models, as well as, is empirically based and therefore can be validated. The *BrainHex* model acknowledges that the Gamer Types are not mutually exclusive, therefore, scores from each type are summed to find the player's dominant gamer type (primary type) and subtypes Orgi (2014). It is capable to describes each gamer's play style, clearly connects it to the types of gameplay elements that the gamer prefers, and provide sub-class related each gamer's play style.

In according to Orgi (2014), the instrument used to classify participants into Gamer Types does not require them to introspectively choose their Gamer Type from a number of categories. *BrainHex* includes 28 questions about game playing to classify participants into their dominant gamer types. Figure **5** synthesizes these Gamer Topologies and their respective Gamer Types.

[1] Available in: http://blog.brainhex.com/ (Accessed in February 12, 2016).

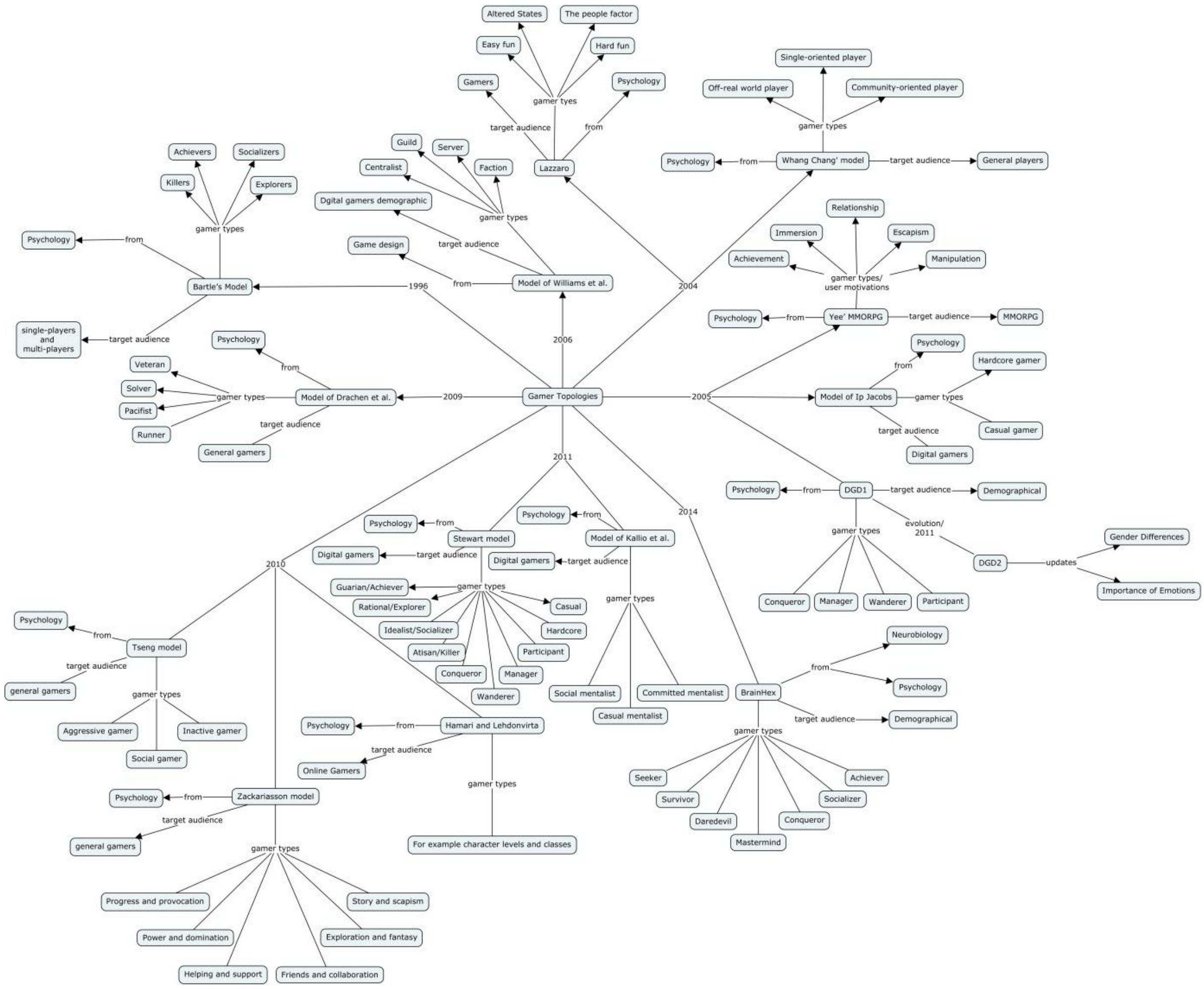


Figure 5 - Gamer Topologies map

2.5. Persuasive Technologies Strategies

In general, the term persuasion is an umbrella term of influence, attempting to influence a person's beliefs, attitudes, intentions, motivations, or behaviors (Seiter and Gass 2010). A plethora of different techniques of persuasion has been used in different contexts, for instance, in sales systems to persuade users to purchase some products (Fautsch 2007) or in the health, science to motivate people to practice sports (Orji *et al*. 2014).

Persuasion began with the Greeks, who emphasized rhetoric and elocution as the highest standard for a successful politician. The first persuasive strategy registered were the trials that held in front of the Greek Assembly, and both the prosecution and the defense rested, as they often do today, on the persuasiveness of the speaker. Besides, over the last 20 years of research in this field, a number of PT strategies have been developed, Orji *et al*. (2014) synthesized the studies conducted in this field in the last 20 years, during these years, some important studies were conducted, for instance, in 2003, Fogg developed seven persuasive tools that can be used to persuade users in different contexts, such as marketing or health or education.

One year after the Fogg's study, Cialdini (2004) also developed six persuasive principles that can verify and applied in different contexts. More recently, Oinas-Kukkonen and Harjumaa (2008) built on Fogg's strategies to develop 28 persuasive system design principles (Table **5**). According to Harjumaa (2009), actually, these strategies are often applied in combinations when incorporated in actual software, in order to provide systems capable of persuading different users.

Table 5 - Persuasive Strategies by Oinas-Kukkonen and Harjumaa (2008)

Primary task support		
Principle	**Example requirement**	**Example implementation**
1. Reduction A system that reduces complex behavior into simple tasks helps users perform the target behavior and it may increase the benefit/cost ratio of a behavior.	The system should reduce the effort that users have in regard to performing their target behavior.	Mobile application for healthier eating habits lists proper food choices at fast food restaurants Toscos *et al*. (2006). The smoking cessation web site provides an interactive test which measures how much money a user will save with quitting.
2. Tunneling Using the system to guide users through a process or experience provides opportunities to persuade along the way.	The system should guide users in the attitude change process by providing means for action that brings closer to the target behavior.	The smoking cessation web site offers information about treatment opportunities after a user has answered an interactive test about how addicted (s)he is on tobacco.
3. Tailoring Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.	The system should provide tailored information for its user groups.	Personal trainer Web site provides different information content for different user groups, e.g. beginners and professionals. Web site for recovering alcoholics presents a user such stories which are close to one's own story.
4. Personalization A system that offers personalized content or services has a greater capability for persuasion.	The system should offer personalized content and services for its users.	Users are able to change the graphical layout of an application or the order of information items at a professional Web site.
5. Self-monitoring A system that helps track one's own performance or status supports in achieving goals.	The system should provide means for users to track their performance or status.	Heart rate monitor presents a user's heart rate and the duration of the exercise. Mobile phone application presents daily step count Consolvo *et al*. (2006).
6. Simulation Systems that provide simulations	The system should provide means for observing the link between the	Before and after pictures of people who have lost weight are presented

can persuade by enabling them to observe immediately the link between the cause and its effect.	cause and effect in regard to their behavior.	on a Web site.
7. Rehearsal A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world.	The system should provide means for rehearsing a target behavior.	A flying simulator.
	Dialogue support	
Principle	**Example requirement**	**Example implementation**
8. Praise By offering praise a system can make users more open to persuasion.	The system should use praise via words, images, symbols, or sounds as a way to give positive feedback for a user.	A mobile application which aims at motivating teenagers to exercise praises user by sending automated text-messages for reaching individual goals Toscos *et al*. (2006).
9. Rewards Systems that reward target may have great persuasive powers.	The system should provide virtual rewards for users in order to give credit for performing the target behavior.	Heart rate monitor gives a user a virtual trophy if they follow their fitness program. The game rewards users by altering media items, such as sounds, background skin, or a user's avatar according to user's performance Sohn and Lee (2007).
10. Reminders If a system reminds users of their target behavior, the users will more likely achieve their goals.	The system should remind users of their target behavior during the use of the system.	Caloric balance monitoring application sends text-messages to their users as daily reminders Lee *et al*. (2006).
11. Suggestion Systems offering suggestions at opportune moments will have greater persuasive powers.	The system should suggest users certain behaviors during the system use process.	Application for healthier eating habits suggests children eat fruits instead of candy at a snack time.
12. Similarity People are more readily persuaded through systems that remind themselves in some meaningful way.	The system should imitate its users in some specific way.	Slang names are used in an application which aims at motivating teenagers to exercise Toscos *et al*. (2006).
13. Liking A system that is visually attractive for its users is likely to be more persuasive.	The system should have a look and feel that appeals to its users.	A web site which aims at encouraging children to take care of their pets properly has pictures of cute animals.
14. Social role If a system adopts a social role, users will more likely use it for persuasive purposes.	The system should adopt a social role.	E-health application has a virtual specialist to support communication between users and health specialists Silva *et al*. (2006).
	System credibility support	
Principle	**Example requirement**	**Example implementation**
15. Trustworthiness A system that is viewed as trustworthy (truthful, fair, and unbiased) will have increased powers of persuasion.	The system should provide information that is truthful, fair and unbiased.	Company Web site provides information related to its products rather than simply providing advertising or marketing information.
16. Expertise A system that is viewed as incorporating expertise (knowledge, experience, and	The system should provide information showing expertise.	Company Web site provides information about their core know-how. Company Web site is updated regularly and there are no dangling

competence) will have increased powers of persuasion.		links or out-of-date information.
17. Surface credibility People make initial assessments of the system credibility based on a firsthand inspection.	The system should have competent look and feel.	There is only a limited number of and a logical reason for ads on a company Web site.
18. Real-world feel A system that highlights people or organization behind its content or services will have more credibility.	The system should provide information on the organization and/or actual people behind its content and services.	Company Web site provides possibilities to contact specific people through sending feedback or asking questions.
19. Authority A system that leverages roles of authority will have enhanced powers of persuasion.	The system should refer to people in the role of authority.	Web site quotes an authority, such as a statement by government health office.
20. Third-party endorsements Third-party endorsements, especially from well-known and respected sources, boost perceptions of system credibility.	The system should provide endorsements from respected sources.	E-shop shows a logo of a certificate which assures that they use secure connections. Web site refers to its reward for high usability.
21. Verifiability Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.	The system should provide means to verify the accuracy of site content via outside sources.	Claims on a Web site are supported by offering links to other web sites.
	Social support	
Principle	**Example requirement**	**Example implementation**
22. Social learning A person will be more motivated to perform a target behavior if he or she can use a system to observe others performing the behavior.	The system should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior.	A shared fitness journal in a mobile application for encouraging physical activity Consolvo *et al*. (2006).
23. Social comparison System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.	The system should provide means for comparing performance with the performance of other users.	Users can share and compare information related to their physical health and smoking behavior via instant messaging application Sohn and Lee (2007).
24. Normative influence A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.	The system should provide means for gathering together people who have the same goal and get them to feel norms.	Possibility to challenge relatives or friends to quit smoking from a web site via email or text message.
25. Social facilitation System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.	The system should provide means for discerning other users who are performing the behavior.	A shared fitness journal in a mobile application for encouraging physical activity Consolvo *et al*. (2006).
26. Cooperation A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.	The system should provide means for cooperation.	The behavioral patterns of overweight patients are studied through a mobile application, which collects data and sends it to a central server where it can be analyzed in detail Lee *et al*. (2006).
27. Competition A system can motivate users to adopt a target attitude or behavior	The system should provide means for competing with other users.	Online competition, such as Quit and Win (stop smoking for a month and win a prize).

by leveraging human beings' natural drive to compete.		
28. Recognition By offering public recognition (for an individual or a group), a system can increase the likelihood that a person or group will adopt a target attitude or behavior.	The system should provide public recognition for users who perform their target behavior.	Personal stories of the people who have succeeded in their goal behavior are published on a Web site. Names of awarded people, such as "quitter of a month", are published on a Web site.

In order to conduct researches in different fields using PT strategies, according to Orji *et al*. (2014) is common to select a combination of strategies from various authors to inform their design. The choice and the suitability of a strategy for a particular behavior and user group are often based on a designer's own intuition, making it difficult to tailor strategies to users or user groups.

Based on that, for conduct, this study, were reused the 10 PT strategies selected by Orji *et al*. (2014) to use on the gamification domain (Customization, Simulation, Self-monitoring (also called Feedback), Suggestion, Praise, Reward, Competition, Comparison, Cooperation, Personalization). In the section proposal, we present a relationship between these strategies, the game design mechanics, and the gamification elements. For a detailed discussion of the strategies see Oinas-Kukkonen and Harjumaa (2008).

2.6. Flow Theory

The notion of "flow state" was introduced by Csikszentmihalyi (1975) as a technical term to describe a good feeling or "optimal experience" that people have as a motivating factor in their daily activities, such as at work, sports, and artistic performance (Faiola *et al*. 2012). According to this author, the key to understanding flow state is the "autotelic experience" concept (from the ancient Greek αὐτοτελής, or "self-goal"). Autotelic experience is the result of an activity or situation that produces its own intrinsic motivation, rewards, or incentives, specifically without any outside goals or rewards.

Since the establishment of the basis of Csikszentmihalyi's Flow Theory, several approaches have been presented in order to describe this kind of experience. Csikszentmihalyi (1990) describes nine necessary dimensions in order for an activity to prompt a flow state: (1) clear goals; (2) immediate feedback; (3) a match between personal skills and challenges; (4) merger of action and awareness; (5) facilitate concentration on the task, (6); aid a sense of control; (7) loss of self-consciousness during the task; (8) sense of time changed; and (9) the experience of becoming “autotelic”.

Hoffman and Novak (1996) summarized the dimensions proposed by Csikszentmihalyi (1990) into five dimensions: (1) enjoyment; (2) telepresence; (3) focused attention; (4) engagement; and (5) time distortion. On the other hand, Rodriguez-Sanchez and Schaufeli (2008) stated that the previous dimensions could be simplified into just three key aspects: (1) absorption, (2) enjoyment, and (3) intrinsic interest.

In order for an activity to lead an individual to flow state, it should provide a balance between challenge’s level and ability required for the person to complete the activity. If the difficulty of a challenge is greater than the person’s skill level, he/she gets anxious. By contrast, if the difficulty of the challenge is lesser than the person’s ability, it tends to be a boring activity (Admiraal *et al*. 2011).

2.6.1. Flow Models

Over the time, different conceptual models have been proposed in order to describe flow state. These models established parameters to measure flow state level, through flow state scales and others instruments. Csikszentmihalyi (1975) was the first researcher to propose a model to describe flow state. He proposed the flow as an emotional state located between anxiety/arousal and relaxation/control (see Figure **6**). In the first model, Csikszentmihalyi describes flow as an emotional state that people can feel during specific activities, especially, activities that provide a balance between people skill level and activity challenge level and immediate feedback.

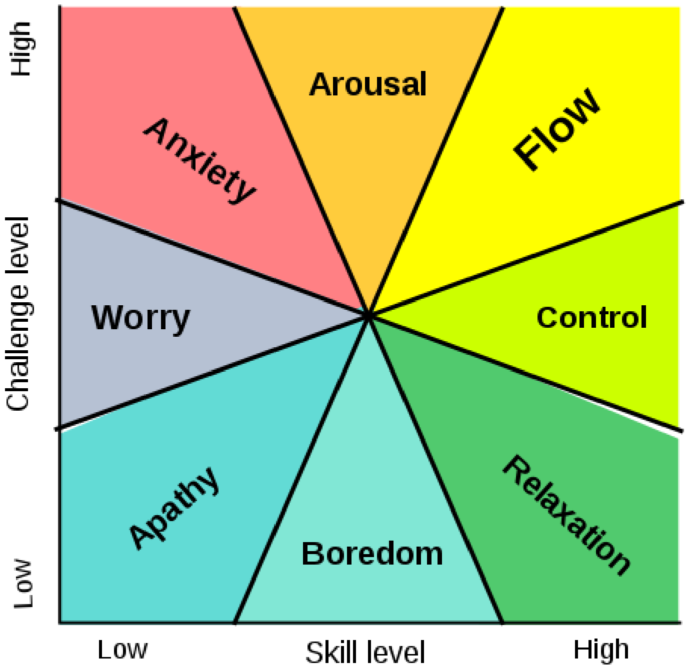
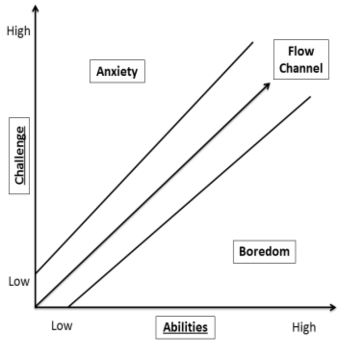
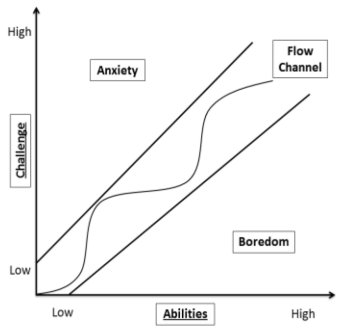


Figure 6 - Csikszentmihalyi (1975) original flow model

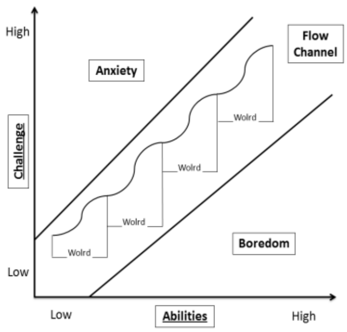
Some years later, new researches have been conducted and new models have been proposed. Csikszentmihalyi proposed a new model (see Figure **7**a) based on the first one, which represents a simplification model, synthesizing the skill-challenge balance to flow state. Afterward, others researchers proposed different flow models and representations (all based on the Csikszentmihalyi's flow models). Schell (2008) proposed a slightly different model (see Figure **7**b) on which flow state can vary in each people and the flow state level can be bigger or smaller at different times of the activity. More recently, Sala (2013) addressed flow state by dividing it into different modules (worlds), on which each state is located in a different slice of time (see Figure **7**c). Furthermore, Massimini and Carli (1988) proposed a flow model that separates the flow components in different channels (see Figure **7**d).



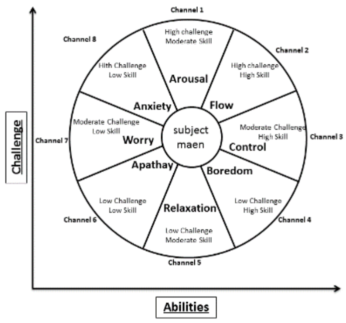
Csikszentmihalyi’ flow model (a)



Schell’ flow model (b)



Sala’s flow model (c)



Massimini and Carli’s flow model (d)

Figure 7 - Different types of flow models

2.6.2. Flow State Scale

A measurement of flow state has also been addressed in the last decades. Indeed, a series of methods have been proposed in order to identify and measure flow state levels. Jackson and Marsh (1996) proposed the Flow State Scale (FSS), which is a technique to measure flow state of people in different activities, for instance: sport, physical educational activities, and others. An FSS is generally composed of questions related to different flow dimensions, such as clear goals, immediate feedback, a match between personal skills and challenges, and others.

As a result of such scale, several studies have implemented different FSSs. It is composed of 36 items, representing the nine flow dimensions proposed by Csikszentmihalyi (1990). More recently, Yoshida *et al*. (2013) proposed an FSS in order to measure flow state level in an occupational task. This FSS is composed of 14 items and based on the nine flow dimensions proposed by Csikszentmihalyi (1990). Another proposal was made by Novak *et* *al*. (2000), which measured the flow state level in online environments. Martin and Jackson (2008) proposed other FSS evaluate the subjective experience of flow through two brief measures of flow.

Finally, FSSs have also been developed in order to measure flow state in Educational Games. Fu *et al*. (2009) and Kiili *et al*. (2012) proposed scales for it. The former proposed the *EGameFlow*, composed of 42 items and with eight flow dimensions (Concentration, Clear Goal, Feedback, Challenge, Autonomy (control), Immersion, Social Interaction, Knowledge Improvement). The latter proposed the scale by taking into account nine items and ten dimensions (challenge, goal, feedback, playability, concentration, time distortion, rewarding experience, loss of self-consciousness, and sense of control).

In this plethora of FSS proposes, some scale was proposed for specific topics or domains, for instance, Fu *et al*. (2009) and Kiili *et al*. (2012) (before related) for flow state measurement in educational games. At the same time, other studies conducted studies in order to validate pre-existents FSSs to specific fields. For the gamification domain (main interest of this study), Hamari and Koivisto (2014) conducted an empirical study in order to validate the scale proposed by Jackson and Marsh (1996) to the gamification domain. The validated scale for gamification field by Hamari and Koivisto (2014) is also composed of 36 questions.

2.6.3. Systematic Literature Review about Flow Theory applied to Computers and Education

The flow experience is the main construct analyzed in this study, so, in order to identify the main constructs of Flow Theory applied to C&E (*i.e*. the main theory and instruments used to identify students' flow experience in the field of C&E) we conducted a SLR about Flow Theory applied to C&E. The main finds of this SLR were used to make important decisions about the study (*i.e*. theoretical background and instruments to measure students' flow experience). Following, we will to present the main steps of the SLR protocol and our main finds.

2.6.3.1. Systematic Literature Review

An SLR is a means of identifying, evaluating and interpreting available research findings related to some research questions, topic areas, or phenomenon. The main purpose to conduct an SLR is to gather evidence from which some conclusions can be made Kitchenham and Charters (2007). According to them, an SLR is composed of three phases: (*i*) **Planning Phase** – specify research questions, develop review protocol and validate review protocol; (*ii*) **Conducting Phase** – identify relevant research, select primary studies, assess study quality, extract required data and synthesize data and (*iii*) **Documenting Phase** – write review report and validate the report.

2.6.3.2. Review Protocol

In order to perform the planning phase, the guidelines proposed by Kitchenham (2004) were followed and the phases are presented in this section.

2.6.3.3. Research Questions

In order to achieve the objectives of this review, four main research questions (RQ) and an additional secondary question were defined and presented in Table 6, along with their description and motivation.

Table 6 - Research Questions

Research Question	Description and Motivation
RQ1: How students' flow state has been identified during computer-based learning activities?	These questions provide a starting point for understanding how students' flow state are identified during computer-based learning activities, as well as FSSs associated to these studies. The answers to these questions are important to understanding how different techniques have been used to identify flow states in the studies.
RQ1.1: Which Flow State Scales (FSSs) have been used to identify students' flow state levels during computer-based learning activities?	
RQ2: How computer-based learning activities have been designed to lead students to achieve the flow state?	This question intends to describe how computer-based learning activities are implemented. The answer to this question identifies the techniques being used to create learning activities aiming to lead students to flow state and provide directions for future

	studies.
RQ3: Which are the empirical results of applying flow state to the students' performance in computer-based learning activities?	This question allows identifying empirical studies regarding flow state application in students during computer-based learning activities. The answer to this question identifies the flow state implications for students' performance and provide a general explanation of the benefits of achieving the flow state to students, as well as provide prospects for future studies in this field.
RQ4: Which flow models have been used in the studies?	This question aims to provide an overview of the flow models used for researchers in C&E and identify if there is a flow model pattern in this research field. The answer to this question allows providing a theoretical background for future studies in Flow Theory applied to C&E.

2.6.3.4. Search String

The search string was created using keywords derived from the research questions. It was created by interconnecting terms and with the following logical expression: ((flow theory OR flow state) AND (<computers in education terms>)). The terms related to "computers in education" were chosen based on Bittencourt *et al*. (2015) and opinion of experts in this theme. The search string was applied the first time over title and abstract on the source search used in this SLR. Table 7 presents the used terms (both main terms and synonymous terms), Table 8 illustrates the simplification of the string and Table 9 describes the used search string.

Table 7 - Search String Distribution

Search String Distribution		
Id	**Main Term**	**Synonymous Terms**
1	flow theory	• flow state
2	educational software platform	• computers in education • informatics in education • technology in education • educative software • educational software
3	educational system	• learning management system • online education • educational environment
4	learning environment	• virtual learning environment • artificial intelligence in education • artificial intelligence for education
5	web-based learning	• e-learning • electronic learning • m-learning • mobile learning • t-learning

		• transformative learning • internet-based learning • web-based education
6	semantic web-based education	• semantic web and education • semantic web for education
7	collaborative learning	• cooperative learning • collaborative networked learning • collaborative learning in virtual worlds
8	adaptive hypermedia	• adaptive educational systems • hypermedia-based education
9	intelligent tutoring system	• intelligent educational systems • intelligent tutor
10	distance education	• distance learning • *MOOC • massive open online courses • web-based online courses • web-based courses • internet conducted courses
11	educative game	• game-based learn • game-based learning • educational game • game-based education • serious game • gamification

Table 8 - Search String Simplification

```
((1) AND (2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11))
```

Table 9 - Full string

```
((“flow theory” OR “flow state”) AND ("educational software platform" OR "computers in education" OR "informatics in education" OR "technology in education" OR "educative software" OR "educational software" OR "educational system" OR "learning management system" OR "online education" OR "educational environment" OR "learning environment" OR "virtual learning environment" OR "artificial intelligence in education" OR "artificial intelligence for education" OR "web-based learning" OR "e-learning" OR "electronic learning" OR "m-learning" OR "mobile learning" OR "t-learning" OR "transformative learning" OR "internet-based learning" OR "web-based education" OR "semantic web-based education" OR "semantic web and education" OR "semantic web for education" OR "semantic web-based education" OR "collaborative learning" OR "cooperative learning" OR "collaborative networked learning" OR "collaborative learning in virtual worlds" OR "adaptive hypermedia" OR "adaptive educational systems" OR "hypermedia-based education" OR "intelligent tutoring system" OR "intelligent educational systems" OR "intelligent tutor" OR "distance education" OR "distance learning" OR "*MOOC" OR "massive open online
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courses" OR "web-based online courses" OR "web-based courses" OR "internet conducted courses" OR "educative game" OR "game-based learn" OR "game-based learning" OR "educational game" OR "game-based education" OR "serious game" OR "gamification"))
```

2.6.3.5. Sources Search (Digital Libraries)

The sources were chosen according to Dieste *et al*. (2009). In this way, the authors established the following source selection criteria: availability of primary studies; coverage of publications; and relevant conferences of research areas. The selected digital libraries were ACM Digital Library[2], PsycNet[3], Engineering Village[4], IEEE Explorer[5], PubMed Central[6], Science Direct[7], Scopus[8], Springer Link[9] and Web of Science[10].

2.6.3.6. Inclusion and Exclusion Criteria

The definition of inclusion and exclusion criteria aims to identify those primary studies which provide direct evidence about the research questions as well as reduce the likelihood of bias (Kitchenham and Charters 2007). Only English written studies were selected (adopted in the main scientific conferences and journals). To increase the chances of retrieving more results about the topic in this SLR, the SpringerLink digital library, for example, publishes many proceedings papers as book chapters; most of them are peer-reviewed. As such, in this review, book chapters are not considered as gray literature and were included in the SLR. Table 10 shows the inclusion and exclusion criteria for this work. Recall that our decision on such period was made because to gather more recent papers about the joint use of flow theory and computers and education.

[2] http://dl.acm.org/
[3] http://psycnet.apa.org/
[4] http://www.engineeringvillage.com/
[5] http://ieeexplore.ieee.org
[6] http://www.ncbi.nlm.nih.gov/pmc/
[7] http://www.sciencedirect.com/
[8] http://www.scopus.com
[9] http://link.springer.com/
[10] http://apps.webofknowledge.com

Table 10 - Inclusion and exclusion criteria

Inclusion	Exclusion
Primary studies about Flow Theory applied to Computers in Education	Non-English papers
Studies published between 2005 and 2015	Studies with less than or equal to 5 pages
Peer-reviewed studies that provide answers to the research questions	Duplicated studies
Primary sources	Secondary or tertiary studies
	Redundant paper of the same author
	Works not related to Flow Theory in Computers in Education
	Grey Literature

2.6.3.7. Data Extraction

The data extraction phase was based on Kitchenham and Charters (2007). The elements for data extraction are presented as follows:

- **Paper Information** (Study Reference; Paper Title; Authors list; Authors Country; Affiliations; Source; Source Type (Journal, Book chapter or Conference); Year; and abstract)*;*
- **Date publication** (Date between 2005 and 2015);
- **Educational Technology Type** (Educational Games, ITS; Virtual Learning Environment; Gamification; etc.);
- **Flow Model** (Csikszentmihalyi; Schell Sala; Massimini and Carli, *etc*.);
- **Flow State Scale** (Yoshida; Jackson & Marsh; Fu, etc.);
- **Software Tool** (Name of software implemented or used in the study);
- **Instrument for the Flow State Identification** (Questionnaire; Data-log analysis; Recording user face, etc.);
- **Approach for the Design of Computer-based Activities** (Game design elements; Mobile elements; gamification elements, etc.);
- **Flow State Consequences** (Increase Learning; Increase Motivation; Internet Addiction, etc.);
- **Empirical results about flow state identification** (Yes or Not).

2.6.3.8. Quality Assessment

The Quality assessment phase allows classifying studies according to specific criteria (Kitchenham and Charters 2007). Quality assessment have been organized into two categories: *i*) general criteria (in order to evaluate the technical quality of the work, for instance, if the paper present clear goals, general discussions, explicitly threats to validation, and others (questions 1 to 8)); and *ii*) specific criteria – in order to evaluate the quality of studies selects regarding empirical results about Flow Theory applied to C&E (questions 9 to 12)). Table 11 presents the quality assessment questions used as well as the possible answers and scores associated with each question.

Table 11 - Quality assessment

#	Quality Assessment	Possible Answers		
QA1	Is there a rationale for why the study was undertaken? (Mahdavi-Hezavehi 2013)	Y= 1	N= 0	-
QA2	Is the paper based on research (or is it merely a "lessons learned" report based on expert opinion)? (Dyb and Dingsyr 2008)	Y= 1	N= 0	-
QA3	Is there a clear statement of the goals of the research? (Dyb and Dingsyr 2008)	Y= 1	N= 0	P= 0.5
QA4	Is the proposed technique clearly described? (Achimugu *et al*. 2014)	Y= 1	N= 0	P= 0.5
QA5	Is there an adequate description of the context (industry, laboratory setting, products used and so on) in which the research was carried out? (Dyb and Dingsyr 2008) and (Mahdavi-Hezavehi *et al*. 2013)	Y= 1	N= 0	P= 0.5
QA6	Is the study supported by a tool? (Dermeval *et al*. 2014)	Y= 1	N= 0	-
QA7	Is there a discussion about the results of the study? (Dermeval *et al*. 2014)	Y= 1	N= 0	P= 0.5
QA8	Are the limitations of this study explicitly discussed? (Ding *et al*. 2014)	Y= 1	N= 0	P= 0.5
QA9	*Does the paper present how to identify students' flow state during Computer-based learning activities?*	Y= 1	N= 0	-
QA10	*Does the paper describe how learning activities have been designed aiming to aid students achieving the flow state?*	Y= 1	N= 0	-
QA11	*Are there empirical results related to the application of flow state in students' performance during computer-based activities?*	Y= 1	N= 0	-
QA12	*Are the empirical results related to the identification of students' flow state during computer-based learning activities?*	Y= 1	N= 0	-

Subtitle: Y= Yes; N= No; P= Partially

2.6.3.9. Data Collection and Analysis

In Data Collection phase, a software tool was used to support the SLR protocol. The tool called *StArt* (State of the Art through Systematic Reviews) Hernandes *et al*. (2012 *a*) was developed to support researchers conducting SLRs. The *StArt* was empirically evaluated, with positive results in the execution of SLRs (Hernandes *et al*. 2012 *b*) and has several features, such as allowing the organization of papers, removal of duplicated studies, reading titles and abstracts, selecting papers to be evaluated in the next step of protocol and so on.

The first step is the execution of the Search String in the search sources in order to identify and organize studies gathered from the digital libraries. The total of studies was 1,746 papers. The second step was the stage of automatic removal of duplicated articles, using the *StArt* tool. This stage found and removed 172 studies. Then, 1,574 titles and abstracts from the remaining studies were read, and those that not addressed the inclusion criteria were excluded (third step). As a result, 117 studies matched the inclusion criteria and were selected for the next step.

In the last step, a full-paper reading was conducted, resulting in the inclusion of 57 studies that, somehow, addressed the inclusion criteria of this SLR. Over the data collection and analysis process, six professionals (PhD. with expertise in the field of C&E and gamification) participated in the process. In the titles and abstracts reading, the papers were read by two researchers and were also analyzed for other two researchers (in this case, conflicts were solved by other two researchers, through discussions based on the inclusion and exclusion criteria).

In the next step - full-paper reading – papers were also read by other two researchers and the papers with conflicts were analyzed by two different researchers. Finally, all the researchers participated in the organization of the data, discussion of results and writing process of this paper. The data collection and analysis process was conducted during six months (between August 2015 and February 2016). Figure 8 presents the complete process starting from studies identification and organization step (step one) until the final step (step four), on which the 57 studies were included.

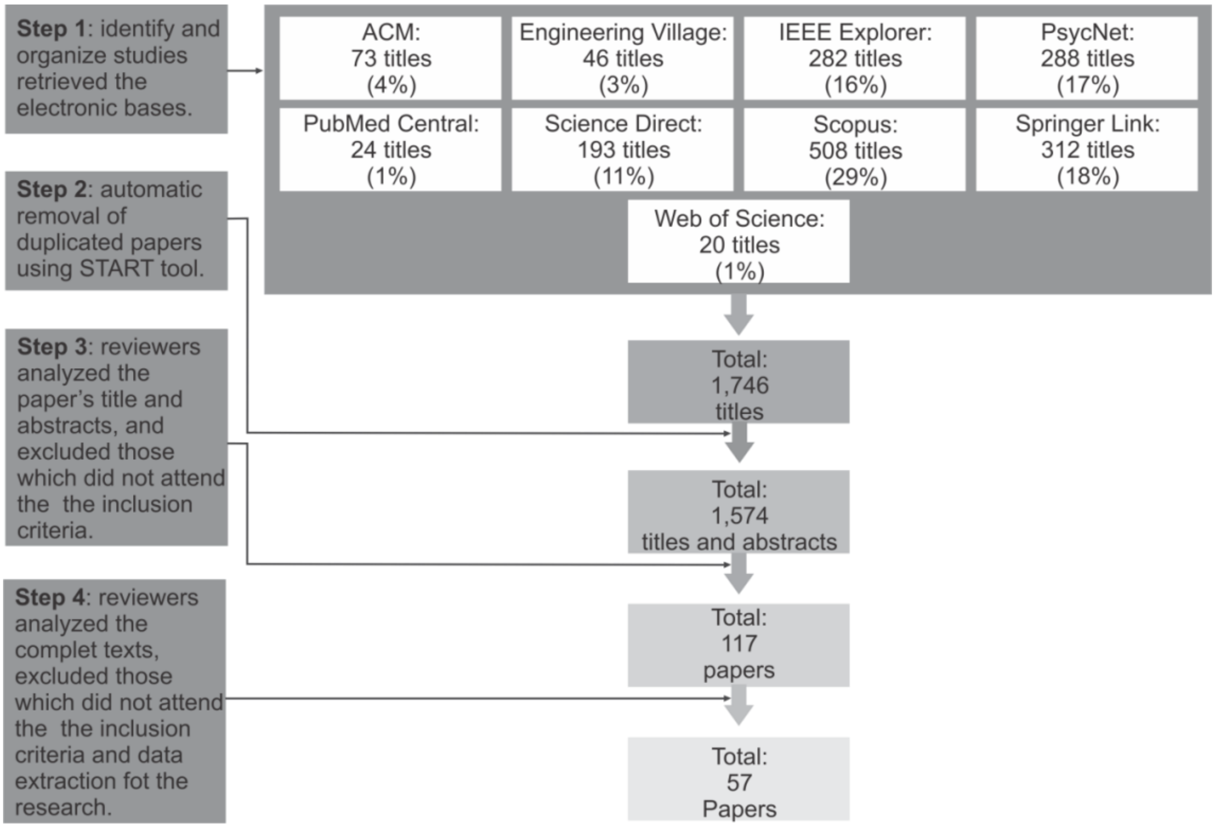


Figure 8 - Studies Overview

2.6.3.10. Quality Assessment Result

The results of the Quality Assessment were divided and classified based on the general and specific evaluation. The general evaluation refers to a group of common questions broadly used in SLRs to measure papers quality in terms of general aspects (*i.e*. methodology, discussion, and so on). The specific evaluation refers to a group of questions particularly created to measure the quality of papers of this SLR with respect to our research question, *i.e*., if the paper presents data support answering our research questions.

According to the results, with respect to the general quality assessment criteria (questions 1 to 8), the evaluation of the 57 studies presented an average of about 6 points (in a maximum of 8) and only nine papers presented less than 50% of the general quality assessment. Regarding the specific quality assessment criteria, (questions 9 to 12), the evaluation of the 57 studies presented an average of about 2 points (in a maximum of 4).

Among these studies, only seven have presented activities which were designed to aid students reaching flow state as well as have presented how the flow state was identified in the activities.

Furthermore, 25 papers (44% of the total) present empirical results related to the application of flow state in students' performance during computer-based learning activities and 47 studies (82%) present empirical results related to the identification of students' flow state during computer-based learning activities. Figure 9 summarizes the quality assessment results in spider graph. To a comprehensive review of the quality assessment of studies, see Santos *et al*. (2017).

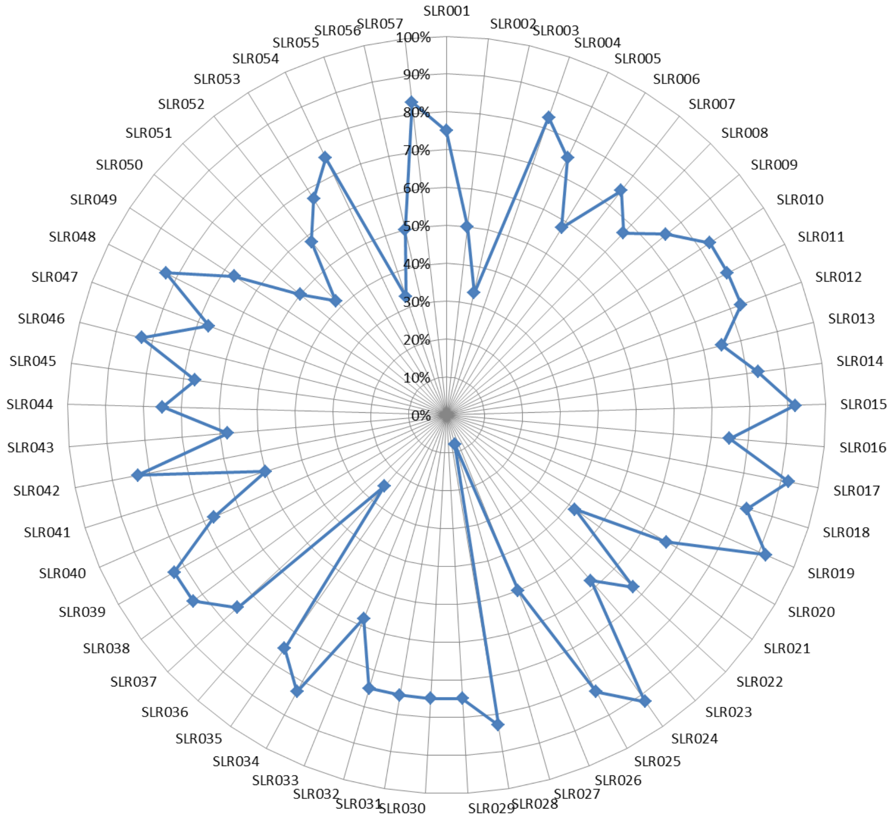


Figure 9 - Quality assessment results

2.6.3.11. Main Results

Among the 57 studies, 49 studies (86%) proposed some mechanism for identifying the flow state. The majority of the papers used questionnaires (45 studies; 79%) to identify students' flow state, followed by User Data Logs (4 studies; 7%) and Interview and Recording User Face (both with 2 studies; 4%). Note that a study could have used more than one instrument, thus, the sum of percentages may be greater than 100%. The classification on the level of automation of the instruments is related to the instrument used itself. Thus, studies that used only User Data Logs or Recording User Faces are classified as Automatic, studies that used at least one manual instrument (*i.e.*, Interview or Questionnaire) are classified as Semi-Automatic and studies that only use manual instruments are classified as Manual.

The predominant automation level of the instruments is the manual identification (75% of the studies), followed by automatic identification (7% of the studies) and semi-automatic (4% of the papers). Moreover, we could not identify the type of mechanism for eight studies (14%), thus, we categorized them in the Not Applicable category.

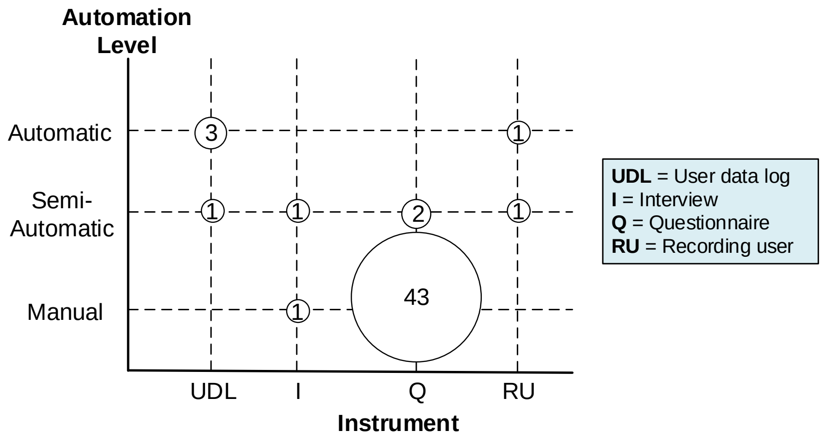


Figure 10 - Automation level and instrument

In fact, we could only identify that 24 papers (42% of the studies) used some kind of FSS. Figure 8 depicts these studies considering the FSSs over the instruments used to identify flow state. As can be seen, most of the FSSs (except for Jackson and Ecklund 2002) is used along with questionnaires (21 studies). The flow state scale proposed by Jackson and Ecklund (2002) was used by only one study along with user data log instrument to identify flow state. The flow state adapted from Chang *et al*. (2012) (F14) is used along with two instruments, *i.e.*, questionnaire and recording user face. Note that the flow state proposed by Fu *et al*. (2009) "F5" was also used in a study along with a non-specific instrument for identifying flow state. Moreover, no studies used flow state scales along with an interview.

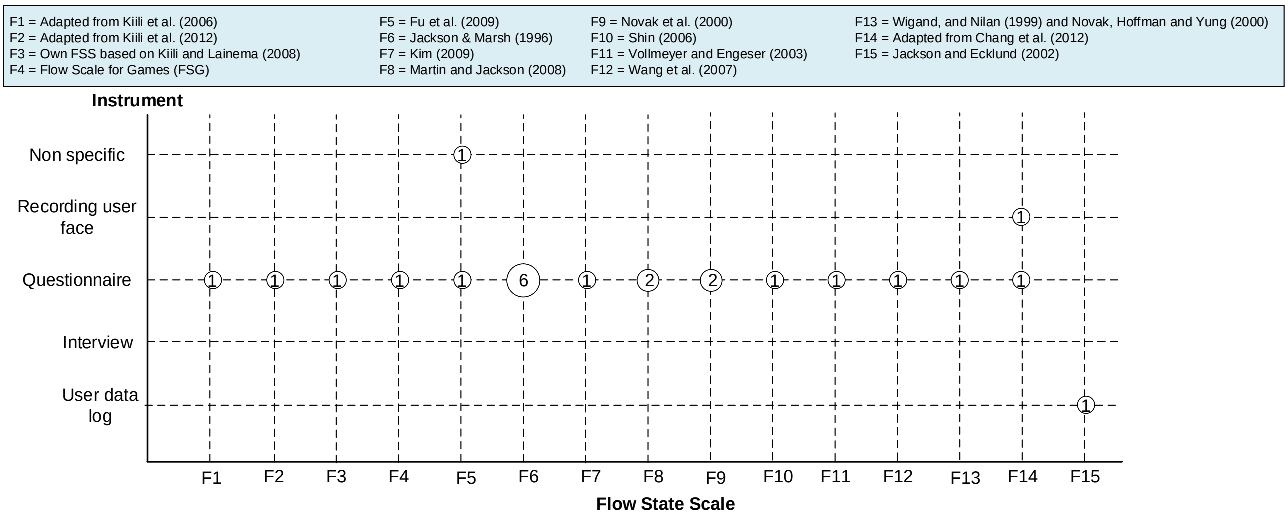


Figure 11 - Instrument and FSS

Among 57 papers, only 13 actually presented some technique to design learning activities. Most of the papers (44 studies; 76%) do not implement activities aiming to lead students to the flow state, as shown in Figure 9. More than half of the studies that presented such activity used Game Design Elements (7 studies; 12% of the total). Two studies (4%) used a Skill-Challenge Balancing technique to design learning activities and only 1 study (2%) used each one of the following techniques: Computer Assisted Learning System, *GameFlow* (which is a methodology aiming to lead students to flow state), Gamification Elements and Mobile Guide Design Principle.

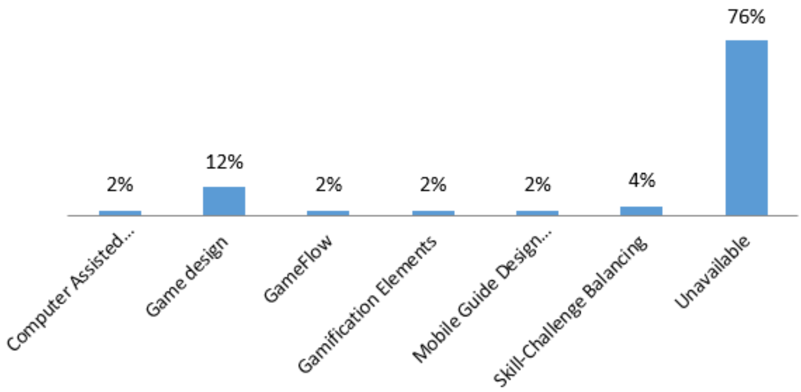


Figure 12 - Principles design to flow

Twenty-five studies (44%) presented evidence about the application of flow state in computer-based learning activities, as presented in Figure 10. In fact, the two studies

(SLR018 and SLR045) that reported negative evidence were not expecting these results. They both explain that the negative results were surprising since previous similar studies reported in the literature presented different results. In the study SLR018, students have demonstrated confusion and disequilibrium while were performing computer-based learning activities designed to lead them to the flow state.

As positive consequences reported on the study, they mention the exploratory behavior among the students. About the negative consequences, the study identified that flow state in the domain of internet usage can cause addiction in the internet usage. The other 22 studies that presented some students' flow state evidence found only positive consequences.

Moreover, others positive evidence were found in different studies, such as increase of satisfaction with educational activity, more in-depth reflective process, and exploratory behaviors. We could only identify the flow model used as theoretical background in 18 studies (32%). Among these 18 studies, 17 used the flow model proposed by Csikszentmihalyi (1975) and only one study used the flow model proposed by Csikszentmihalyi (1975) combined to the flow model proposed by Massimini and Carli (1988).

Table 12 - Flow state models

Flow State Model	**Papers**	**Total**	**%**
Csikszentmihalyi (1975)	SLR001; SLR002; SLR003; SLR005; SLR006; SLR007; SLR008; SLR010; SLR014; SLR017; SLR019; SLR030; SLR039; SLR043; SLR046; SLR053; SLR054	17	30%
Csikszentmihalyi (1975) and Massimini and Carli (1988)	SLR025	1	2%
Non-specific	SLR004; SLR009; SLR011; SLR012; SLR013; SLR015; SLR016; SLR018; SLR020; SLR021; SLR022; SLR023; SLR024; SLR026; SLR027; SLR028; SLR029; SLR031; SLR032; SLR033; SLR034; SLR035; SLR036; SLR037; SLR038; SLR040; SLR041; SLR042; SLR044; SLR045; SLR047; SLR048; SLR049; SLR050; SLR051; SLR052; SLR055; SLR056; SLR057	39	68%

Based on the SLR finds, some strategies were adopted in this study. Initially, the original flow model proposed by Csikszentmihalyi (1975) was adopted to guide the theoretical background of the study. This decision was adopted because the original Csikszentmihalyi flow model is the most used in the empirical studies in the field of C&E. In order to measure the students' flow experience, questionnaires were used. This the main way used to analyze students' flow experience in computer-based activities. So, the FSS 2 proposed by Jackson and Marsh (1996) were used, its version validated to gamified systems domains, by Hamari and Koivisto (2014) composed of 36 questions were chosen. This FSS was adopted because is the most used to identify students' flow state in the domain of C&E, and it was validated in the field of gamified systems. To a comprehensive review about the SLR, see Santos *et al*. (2017).

3. Related Works

This section has the objective to present the main related works, as well as to conduct a discussion about the studies related with the proposal presented in this master thesis. The related works were obtained through an SLR about gamer types applied to C&E. Next, we will present the SLR and its main results. After the SLR, the related works obtained through the SLR will be individually presented, discussed and compared with our study.

3.1. Systematic Literature Review

This SLR followed the same protocol of the SLR about Flow Theory applied to C&E before presented.

3.1.1. Review Protocol

In order to perform the planning phase, the guidelines proposed by Kitchenham (2004) were followed and the phases are presented in this section.

3.1.1.1. Research Questions

In order to achieve the objectives of this review, four main research questions (RQ) and an additional secondary question were defined and presented in Table **13**, along with their description and motivation.

Table 13 - Research Questions

Research Question	Description and Motivation
RQ1: How students' gamer type has been identified during computer-based learning activities?	These questions provide a starting point for understanding how students' gamer types are identified during computer-based learning activities, as well as player model associated with these studies. The answers to these questions are important to understanding how different empirical techniques have been used to identify the students' gamer types.
RQ1.1: Which player models have been used to identify students' gamer type during computer-based learning activities?	
RQ2: How computer-based learning	This question intends to describe how computer-based learning

activities have been designed to specific students' gamer type?	activities are implemented based on students' gamer type. The answer to this question identifies the techniques being used to create learning activities specific to students' gamer type.
RQ3: Which are the empirical results about specific studies on player types students' performance in computer-based learning activities?	This question allows identifying empirical studies regarding player models' application to students during computer-based learning activities. The answer to this question identifies the player models' implications for students' performance.

3.1.1.2. Search String

The search string was created using keywords derived from the research questions. It was created by interconnecting terms and with the following logical expression: ((gamer type OR player type OR player model OR player topology) AND (<computers in education terms>)). The terms related to "computers in education" were chosen based on Bittencourt *et al*. (2016) and opinion of experts in this theme. The search string was applied the first time over title and abstract on the source search used in this SLR. Table **14** presents the used terms (both main terms and synonymous terms), Table **15** illustrates the simplification of the string and Table **16** describes the used search string.

Table 14 - Search string terms and synonyms

Search String Distribution		
Id	**Main Term**	**Synonymous Terms**
1	gamer type	• player type • player model • player topology
2	educational software platform	• computers in education • informatics in education • technology in education • educative software • educational software
3	educational system	• learning management system • online education • educational environment
4	learning environment	• virtual learning environment • artificial intelligence in education • artificial intelligence for education
5	web-based learning	• e-learning • electronic learning • m-learning • mobile learning • t-learning • transformative learning • internet-based learning

		• web-based education
6	semantic web-based education	• semantic web and education • semantic web for education
7	collaborative learning	• cooperative learning • collaborative networked learning • collaborative learning in virtual worlds
8	adaptive hypermedia	• adaptive educational systems • hypermedia-based education
9	intelligent tutoring system	• intelligent educational systems • intelligent tutor
10	distance education	• distance learning • *MOOC • massive open online courses • web-based online courses • web-based courses • internet conducted courses
11	educative game	• game-based learn • game-based learning • educational game • game-based education • serious game • gamification

Table 15 - Simplification of string

(**(1)** AND **(2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11)**)

Table 16 - Full String

```
(("gamer type" OR "player type" OR "player model" OR "player topology") AND ("educational software platform" OR "computers in education" OR "informatics in education" OR "technology in education" OR "educative software" OR "educational software" OR "educational system" OR "learning management system" OR "online education" OR "educational environment" OR "learning environment" OR "virtual learning environment" OR "artificial intelligence in education" OR "artificial intelligence for education" OR "web-based learning" OR "e-learning" OR "electronic learning" OR "m-learning" OR "mobile learning" OR "t-learning" OR "transformative learning" OR "internet-based learning" OR "web-based education" OR "semantic web-based education" OR "semantic web and education" OR "semantic web for education" OR "semantic web-based education" OR "collaborative learning" OR "cooperative learning" OR "collaborative networked learning" OR "collaborative learning in virtual worlds" OR "adaptive hypermedia" OR "adaptive educational systems" OR "hypermedia-based education" OR "intelligent tutoring system" OR "intelligent educational systems" OR "intelligent tutor" OR "distance education" OR "distance learning" OR "*MOOC" OR "massive open online courses" OR "web-based online courses" OR "web-based courses" OR "internet conducted courses" OR "educative game" OR "game-based learn" OR "game-based learning" OR "educational game" OR "game-based education" OR "serious game" OR "gamification"))
```

3.1.1.3. Sources Search (Digital Libraries)

The selected digital libraries were ACM Digital Library[11], Engineering Village[12], IEEE Explorer[13], Science Direct[14], Scopus[15], Springer Link[16] and Web of Science[17].

3.1.1.4. Inclusion and Exclusion Criteria

Only English written studies were selected (adopted in the main scientific conferences and journals). To increase the chances of retrieving more results about the topic in this SLR. The SpringerLink digital library, for example, publishes many proceedings papers as book chapters; most of them are peer-reviewed. As such, in this review, book chapters are not considered as gray literature and was included in the SLR. Table **17** shows the inclusion and exclusion criteria for this work. Recall that our decision on such period was made because to gather more recent papers about the joint studies on gamer types in the field of computers and education.

Table 17 - Inclusion and Exclusion Criterias

Inclusion	**Exclusion**
Primary studies about Gamer Types applied to Computers in Education	Non-English papers
Studies published between 2006 and 2016	Studies with less than or equal to 5 pages
Peer-reviewed studies that provide answers to the research questions	Duplicated studies
Primary sources	Secondary or tertiary studies
	Redundant paper of the same author
	Works not related to Gamer Types in Computers in Education
	Grey Literature

[11] http://dl.acm.org/
[12] http://www.engineeringvillage.com/
[13] http://ieeexplore.ieee.org
[14] http://www.sciencedirect.com/
[15] http://www.scopus.com
[16] http://link.springer.com/
[17] http://apps.webofknowledge.com

3.1.1.5. Data Extraction

The elements for data extraction are presented as follows:

- **Paper Information** (Study Reference; Paper Title; Authors list; Authors Country; Affiliations; Source; Source Type (Journal, Book chapter or Conference); Year; and abstract)*;*
- **Date publication** (Date between 2006 and 2016);
- **Educational Technology Type** (Educational Games, ITS; Virtual Learning Environment; Gamification; etc.);
- **Player model** (Bartle Test, BrainHex, Hexad, *etc*.);
- **Software Tool** (Name of software implemented or used in the study);
- **Approach for the Design of Computer-based Activities** (Game design elements; Mobile elements; gamification elements, etc.);
- **Empirical results about gamer types studies in the field of computer and education** (Yes or Not).

3.1.1.6. Quality Assessment

Eight quality criteria were considered in this SLR. The quality assessment will be presented after the presentation of the related works, in order to better explain and compare the related works with our study.

3.1.1.7. Data Collection and Analysis

The first step is the execution of the Search String in the search sources in order to identify and organize studies gathered from the digital libraries. The total of studies was 815 papers. The second step was the stage of automatic removal of duplicated articles, using the StArt tool (Hernandes *et al*. 2012 *a*). This stage found and removed 25 studies. Then, 790 titles and abstracts from the remaining studies were read, and those that not addressed the inclusion criteria were excluded (third step). As a result, 38 studies matched the inclusion criteria and were selected for the next step.

In the last step, a full-paper reading was conducted, resulting in the inclusion of 21 studies that, somehow, addressed the inclusion criteria of this SLR. Over the data collection and analysis process, two professionals (expertise in the field of C&E, gamification and gamer types) participated in the process. In the titles and abstracts reading, the papers were read by the two researchers and were also analyzed for the same two researchers (in this case, conflicts were solved by other invited researchers, based on the inclusion and exclusion criteria). In the next step - full-paper reading – papers were also read by the two researchers and the papers with conflicts were analyzed by another different invited researcher with the same expertise. Finally, all the researchers participated in the organization of the data, discussion of results and writing process of this paper. The data collection and analysis process was conducted during four months (between September 2016 and December 2016). Figure **13** - Studies Overview presents the complete process starting from studies identification and organization step (step one) until the final step (step four).

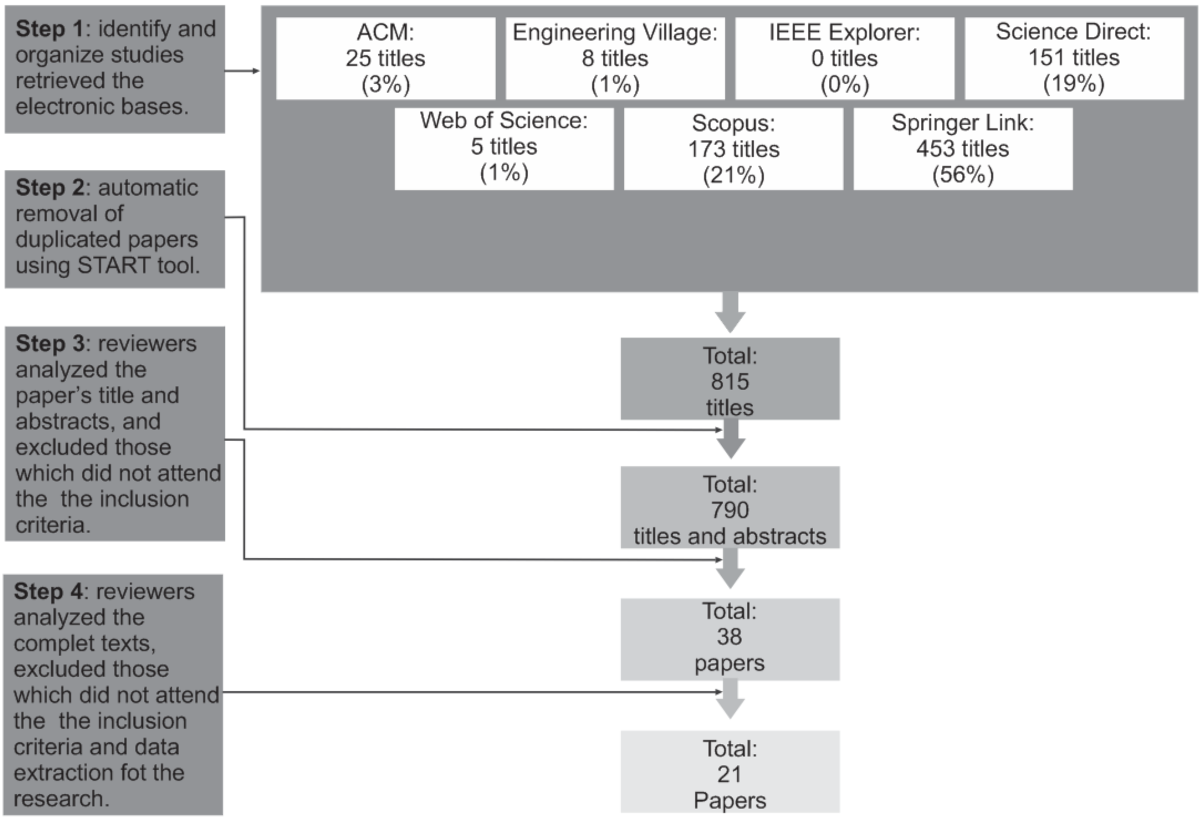


Figure 13 - Studies Overview

In order to provide a complete overview of the studies identified in this SLR, all of the studies will be described and critically analyzed in the section of Related Works and compared with our study based on eight different criteria. In addition, some studies over SLR were also inserted in the section of Related works, because are studies from other domains, however, highlights the importance of personalizing gamified VLEs based on gamer type. Following, we will start to present the studies identified in this SLR and some other studies from other domains (manually included), however, related to our study.

3.2. Tailoring Virtual Environments Based on Gamer Types

In the past few years, some studies were conducted in order to personalize the gamification design in virtual environments based on gamer types. This section aims to present the studies about tailoring virtual environments based on gamer types (no educational environments).

3.2.1. Towards personalized, gamified systems

Considered as one of the first studies to address personalization of gamification design, Ferro *et al*. (2013) presented a theoretical background about the relationship between various personality types and traits, as well as outlined player typologies that currently exist, and, assume that this relationship could better inform designers on a deeper level about the type of users that they are designing for.

In their study, they identified that game elements and mechanics may provide a dynamic toolbox to better inform the design of gamified systems and specifically target users in a more intrinsically engaging and motivating way (Table **18**). The authors clarify that their results are an initial step towards personalizing gamified systems. However, they argue the study requires further research and validation, as well as a deeper investigation into not only the relationship between player typologies and personality traits and types but also on the relation between game elements and mechanics.

Table 18 - Table to identify possible player type, personality trait/type and game element and mechanic combinations proposed by Ferro *et al*. (2013)

Player Types	**Personality**	**Game Elements**	**Game Mechanics**	**Classification**
Killer (B) The Competitor (F) The Power Gamer (L) The Butt Kicker (L) Conquer (H) Agôn (C) Contesting (Fr) Risk Taking (Fr) Conqueror (D1)	Dominance (Ca) Social Boldness (Ca) ENFP/Champion (MB) ENTJ/Field marshal (MB) Extravert Intuitive (J) Warmth [low] (Ca) Dutifulness [low] (Ca) Sensitivity [low] (Ca) Aggressiveness [high] (Ca) Social Assertiveness [high] (Ca) Anxiety [low] (Ca) Psychoticism (E) Agreeableness [low] (B5)	Technology (Sc) Players (F) Characters (F) Conflict (F) Challenge (F)	Achievements Combos Bars (progress, exp) Leader boards Points Status	Dominant
Achiever (B) The Achiever (F) Achiever (H) Manager (D1) Achievement (Y)	Dutifulness [high] (Ca) Abstractness [low] (Ca) Anxiety [low] (Ca) Intellect [high] (Ca) Perfectionism [high](Ca) Introvert Feeling (J) Conscientiousness [high] (B5) Extraversion [low] (B5)	Boundaries (F) Players (F) Objectives (F) Challenge (F) Premise (F)	Badges Bonuses Combos Levels Bar (progress) Reward Schedule	Objectivist
Socializer (B) Socializer (H) The Joker (F) Amusing (Fr) The Storyteller (F) The Performer (F) Immersion (Y) Leadership (Y) Mimicry (C) Roleplaying (Fr) Socializer (H)	Warmth [high] (Ca) Emotional Stability [high] (Ca) Liveliness [high] (Ca) Dutifulness [high] (Ca) Social Assertiveness [high] (Ca) Paranoia [low] (Ca) Introversion [low] (Ca) Anxiety [low] (Ca) Independence [low] (Ca)	Boundaries (F) Story/Narrative (Sc) Story (F) Characters (F) Players (F) Premise (F) Dramatic Arc (F)	Customization Quests	Humanist

Networkers (B) Participant (D1) Relationship (Y)	Tension [low] (Ca) ESFP/Performer (MB) INFJ/Counselor (MB) ESTP/Promoter (MB) Extravert Feeling (J) Extravert Sensation (J) ESTJ/Supervisor (MB) ENFJ/Teacher (MB) Extraversion (E) Extraversion [high] (B5) Agreeableness [high] (B5)			
Explorer (B) The Explorer (F) Seeker (H) Leaving to Chance (Fr) Ilinx (C) Persuing Vertigo (Fr) Daredevil (H) Survivor (H) Wanderer (D1)	Social Assertiveness [low] (Ca) Introversion [low] (Ca) Open-mindedness [high] (Ca) Independence [high] (Ca) ISTJ/Inspector (MB) Introvert Sensation (J) Openness to Experience [high] (B5)	Story/Narrative (Sc) Story (F) Aesthetics (Sc) World Building (F) Premise (F) Boundaries s (F) Dramatic Arc (F)	Quests Reward Schedule	Inquisitive
The Craftsman (F) Creating (Fr) Problem Solving (Fr) Alea (C) Leaving it to chance (Fr) Mastermind (F) Ludus (C)	ISTP/The Crafter (MB) ISFP/Composer (MB) INTP/Architect (MB) ENTJ/Inventor (MB)	Resources (F) World Building (F) Premise (F) Boundaries (F)	Inventory Customization Quests	Creative

Legend

(B) Bartle (C) Caillois (F) Fullerton (L) Laws (H) Hex (D1) DGD1 (Fr) Fritz (Y) Yee	(Ca) Cattell (E) Eysenck (MB) Myer-Briggs Keirsey Temperaments (J) Jung (B5) Big 5 Note: [high] and [low] indicate which end of the spectrum the personality	(Sc) Schell (F) Fullerton		

	trait is located.			

The study conducted by Ferro and his colleagues are important because they provide an initial structure to personalize a different kind of gamified systems, as well to highlight if the gamified system uses the same gamification elements to both students, can frustrate or demotivate the system's users. The results also highlighting the importance of personalizing these gamified systems based on the user's gamer type. However, the study is merely theoretical and do not provide any evaluation to the proposal, as highlighted by the authors of the study.

3.2.2. Tailoring Persuasive Health Games to Gamer Type

In order to give another important step to tailor gamified environments, Orji *et al*. (2014) highlighted that most games and gamified environments adopt a *one-size-fits-all* approach to persuasion in their design, and, this is a bad design approach because a motivational approach that works for one individual may actually demotivate the desired behavior in others.

Orji and her colleagues conducted a large-scale study on 1108 gamers, which examined the persuasiveness of ten persuasive strategies, and the receptiveness of seven gamer types identified by *BrianHex* to the strategies most commonly used in persuasive strategies design. They also developed models showing the receptiveness of the gamer types to the ten strategies and created persuasive profiles, which is a list of strategies that can be employed to motivate behavior for each gamer type.

In another study, Orji *et al*. (2013) developed seven different models of healthy eating behavior for the gamer types identified by *BrainHex* and explored the differences between the models, also creating two approaches for effective persuasive game design. A *one-sizefits-all* approach was proposed to motivate the majority of the population, while not demotivating any players and a personalized approach that will best motivate a particular type of gamer. In Figure **14** is presented a storyboard illustrating the personalized approach used by Orji and her colleagues.

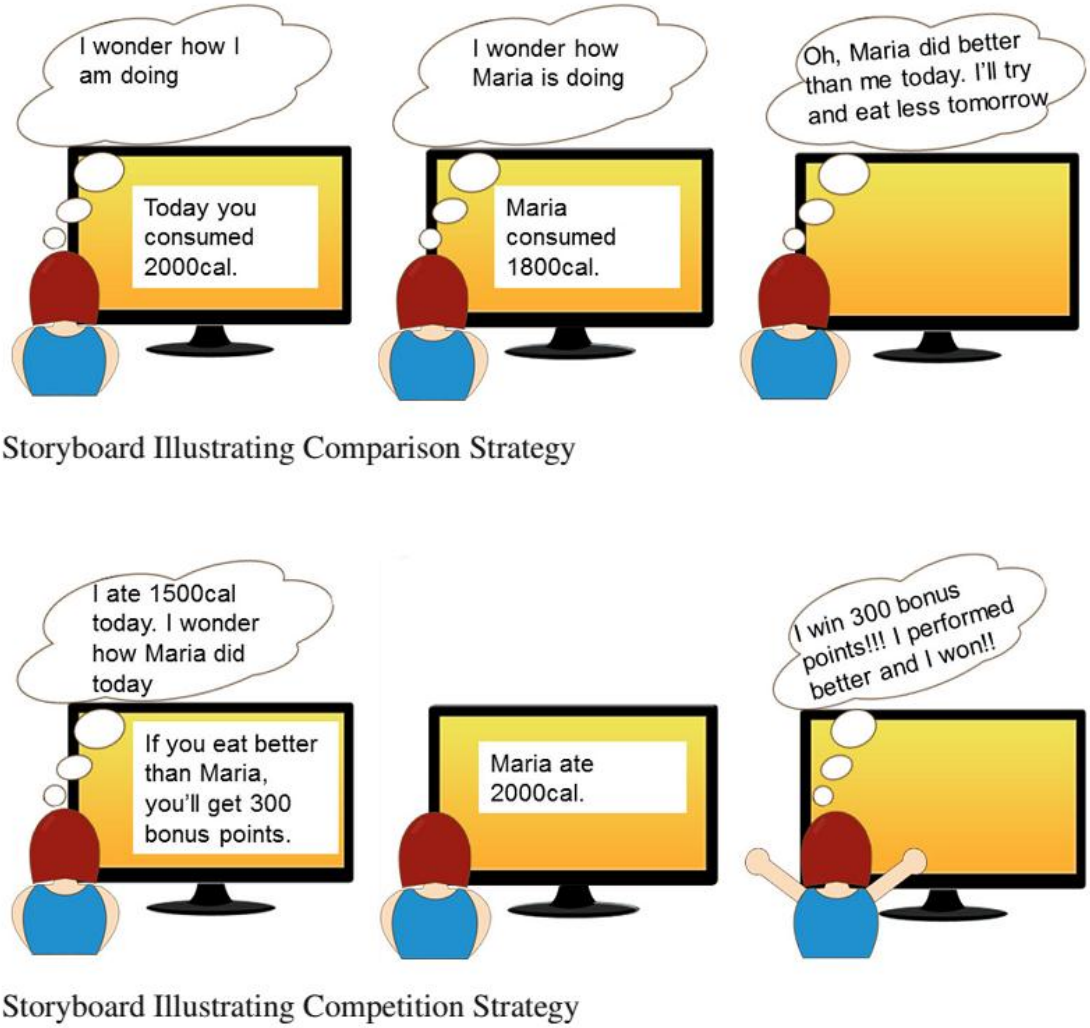


Figure 14 - Storyboard illustrating the persuasive strategies used on the personalized system

The studies conducted by Orji and her colleagues are important because highlights the importance of tailoring gamified systems based on gamer types, as well as provide a relationship between better persuasive strategies to motivate each gamer type, and a guideline to design this kind of system. However, such studies were conducted in the field of health science, highlighting a gap in the other fields, such as education.

3.3. Tailoring Virtual Learning Environments Based on Gamer Types

Based on the recently conducted studies in order to provide personalized virtual environments based on gamer types, some recent studies have improved the works in the field of education and tried to personalize gamified VLEs. This section aims to present some studies that had provided some resource in order to tailor educational VLEs.

3.3.1. An intelligent adaptation of digital game-based learning

Magerko *et al*. (2008) presented an approach for methodically identifying the possible adaptations a game can take, and mapping those adaptations to learner needs. They describe a prototype mini-game, called S.C.R.U.B. (Figure **15**), which intelligently adapts its gameplay based on an individual player's learning style. This study address three different gamer types (explorer, achiever, and winner) based on the Bartle's player model. In their study, was first analyzed the game experience to identify the different features that make up the gameplay, the interface, and the knowledge presented to the player (*e.g*. having a high score, the visualization of text-based facts, and having a time limit), and ended up with six initial adaptive features of particular importance to Explorers, Achievers, or Winners.

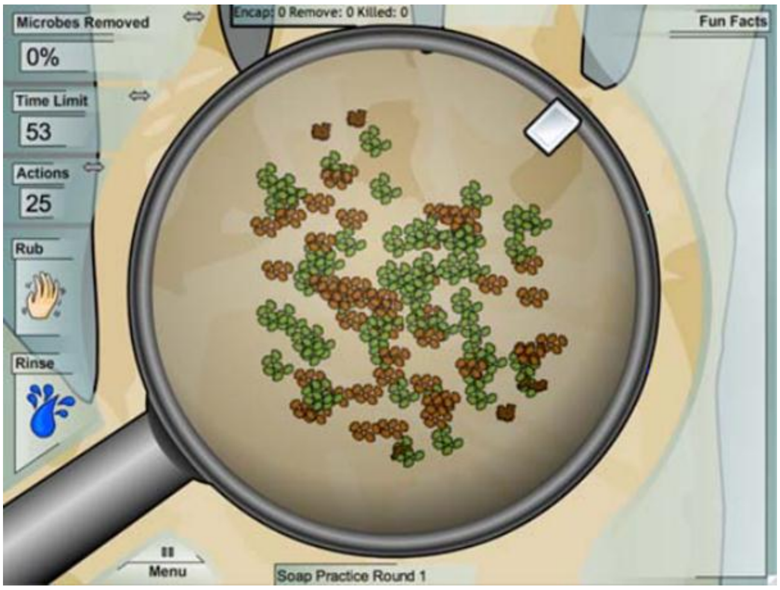


Figure 15 - S.C.R.U.B. game screenshot

The study conducted by Magerko *et al*. (2008) gave an important initial contribution to game design field, especially because provided an association between game features preferences for three different gamer types. However, the study was not conducted using a complete player type, like *BrainHex*, as well, did not an association between player types and game mechanics or persuasive technologies, and not conducted a deep evaluation in terms of user feeling during the come, for instance, concentration, engagement, and others, open space to conduct studies with these characteristics in domains as gamified VLS.

3.3.2. Approach to identifying and constructing profiles of user interfaces

Jovanovic *et al*. (2008) proposed an approach to identifying and constructing profiles of user interfaces for educational games. The approach is based on framing games as educational tools that incorporate fun and learning through motivation as the key ingredient in the learning process, and multimodal interaction as the medium for conveying educational material. The authors highlight that to date, there is no common standard to design this kind of games and individual solutions are usually carried out by an ad hoc process. In the Figure **16** will be presented the synthesized player classification proposed by Jovanovic *et al*. (2008), Figure **17** presents an example of a developed game's interface based on the model proposed.

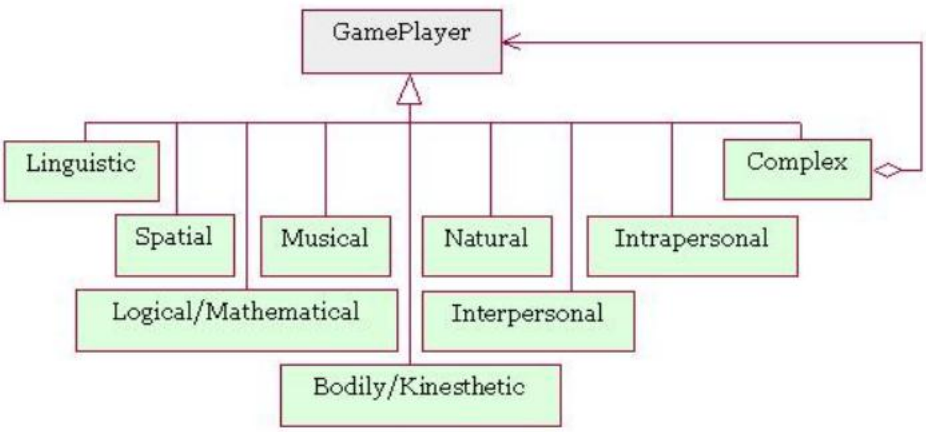


Figure 16 - Proposed player classification

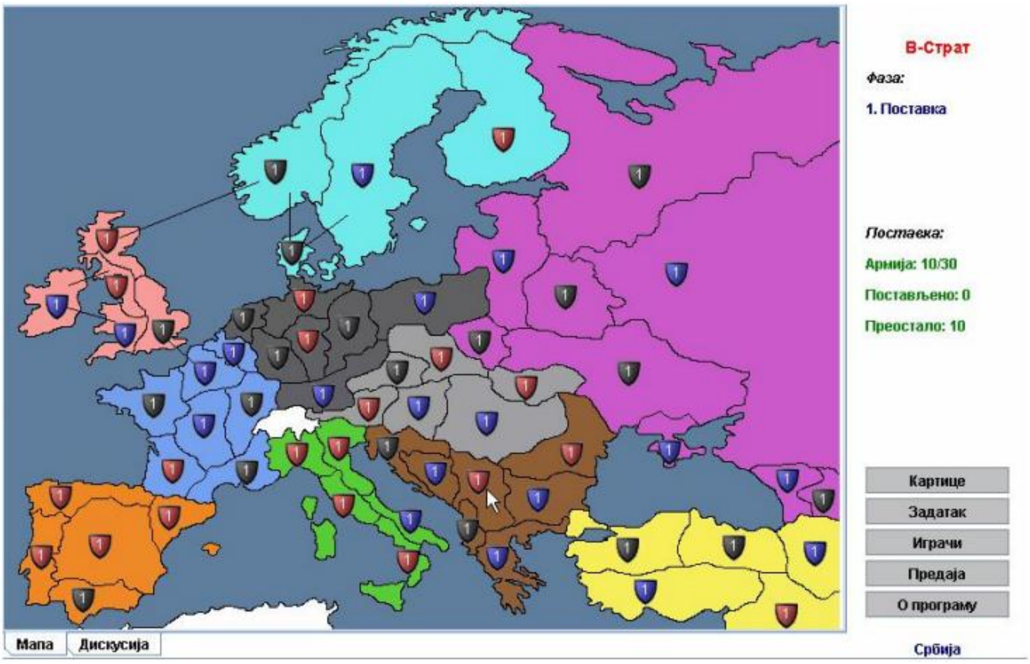


Figure 17 - Example of developed game's interface

In this study, Jovanovic *et al*. (2008) propose a framework able to help game designers to tailor educational games interface. The study, nevertheless, did not present concerns about the analysis of the student gamer type, for instance, how to tailor the game interface based on students gamer types or evaluate the game tailored in comparison with the same game without personalization.

3.3.3. Game design and the challenge-avoiding, self-validator player type

Heeter *et al*. (2009) consider whether and how eight very different modern games accommodate Explorers, Achievers, and Self-Validators and discuss implications for entertainment and learning game design and research. Seven of eight diverse games analyzed primarily served either the Explorer or Achiever player type. Self-Validators were partially accommodated in some Achiever-oriented games, through user-selectable difficulty. Design with all three types in mind would encourage the inclusion of features that enable players to optimize their preferred style of play.

The study executed by Heeter *et al*. (2009) showed that is important tailor educational games based on student's gamer types, and the results highlight that tailored games can better increase the student's motivations and learning. This study makes it clear the importance to conduct studies aiming to also tailor gamified VLEs.

3.3.4. Automatically Adjusting Player Models

Thammanichanon and Kotrajaras (2009) highlighted in their study that Player Archetype Change Management (PACM) system is a drama management system which changes the story of role playing games according to a player model monitored during gameplay. Authors gave each of his stories a matching player model. While a player plays the game, PACM selects the story that most matches the current player model. However, players may not agree with a model defined for a story by its author. In their study, these authors present the technique for adjusting the player model of each story in PACM using observed data from players and to provide the system with a more reliable player model for future playing sessions.

On one hand, the study of Thammanichanon and Kotrajaras (2009) provided for us understand the importance to tailor educational environments based on the student's preferences. On the other hand, the study is limited in terms proposal to tailor this kind of environments, without present the player model or evaluation used during the study conduction. The study is also being limited in terms of comprehensiveness and open a gap to conduct new studies in this field.

3.3.5. A model for a richer dynamic adaptation

Sajjadi *et al*. (2014) proposed a model for a richer dynamic adaptation, in which several aspects are taken into account for providing a more personalized gaming experience to sustain the engagement of the players to the game. The model allows for adapting an educational game based on different aspects and at different moments, in order to provide a rich personalized experience, to sustain the engagement of the learner, and thus providing a more suitable frame for the flow state experience (explicated on Figure **18**).

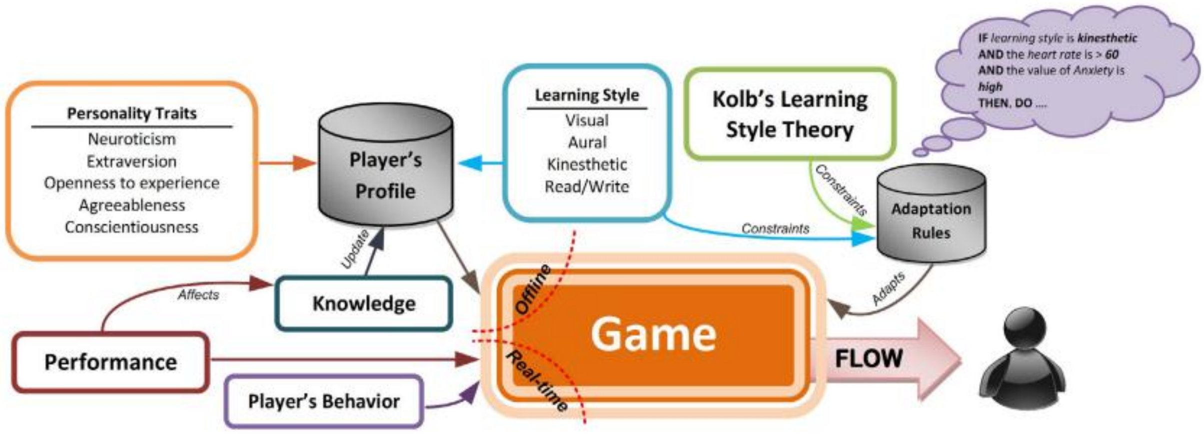


Figure 18 - Dynamic Adaptive Educational Game Model

On the study made by Sajjadi and their colleagues, is take into account important points, as the engagement of the learning of the player, as well, the evaluation if the frame is suitable for the flow state experience on the users. The study, however, did not provide concerns about the use of the player model and the relationship between the user's gamer type and their game elements preferences. The study was conducted in the field of game design open space to conduct similar studies in similar areas, such as gamified educational environments.

3.3.6. A Framework to Adapt Gamification in Learning Environments

Monterrat *et al*. (2014) proposed a complementary player model to existing learner models, aiming to predict to which game mechanics the user is responsive in order to adapt the gamified features of the system. The authors designed a gamification layer composed of gaming features, a player model, and an adaptation engine for selecting the features for the users.

In the framework proposed by Monterrat and his colleagues, the gaming features are represented by a vector based on the classification of Ferro *et al*. (2013), with values between

0 and 1. For instance, the leaderboard vector could be [*dominant 1, objectivist 0.4, humanist 0.2, inquisitive 0, creative 0*]. The users are represented in the same way. Indeed, users are generally interested in more than one game mechanic. The study also proposed an adaptation engine for selecting the features for the users.

The study conducted by Monterrat *et al*. (2014) was important in order to start the investigation about tailoring educational environments based on gamer types in the field of education. However, the study conducted by Monterrat and his colleagues is an initial research and do not provide concerns about the player model used to conduct the research, as well, not present the implementation or evaluation of the proposal.

3.3.7. Adaptive Gamification System

In order to deepen the aforementioned research, in another study Monterrat *et al*. (2014) presents a generic and adaptive gamification system that can be plugged on various learning environments. The architecture of the proposed system was based on the separation between the control of the pedagogical elements and the control of the game elements, as shown in Figure **19**.

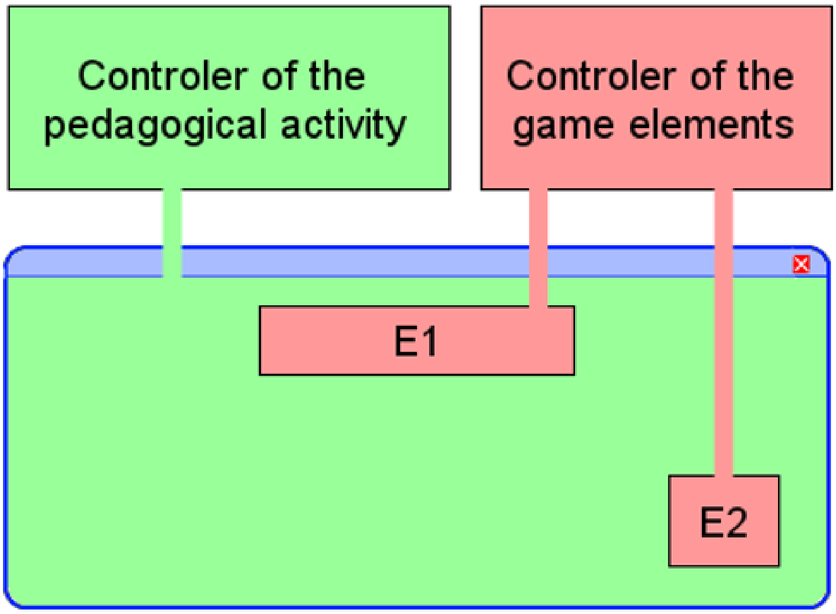


Figure 19 - Independence of pedagogical control and game control by (Monterrat *et al*. 2014)

In his proposal, the adaptation of system happens after the student start to use the system, basically, when a new user registers on the learning environment, the values of each motivational factor are initialized for him/her according to user data. During the use of the learning environment, the values will change according to the user's interactions (Monterrat *et al*. 2014). If the users disable a feature, their values for the corresponding player types decrease, if users interact often with a gaming feature, their values for the corresponding player types increase. The Figure **20** resume the system architecture.

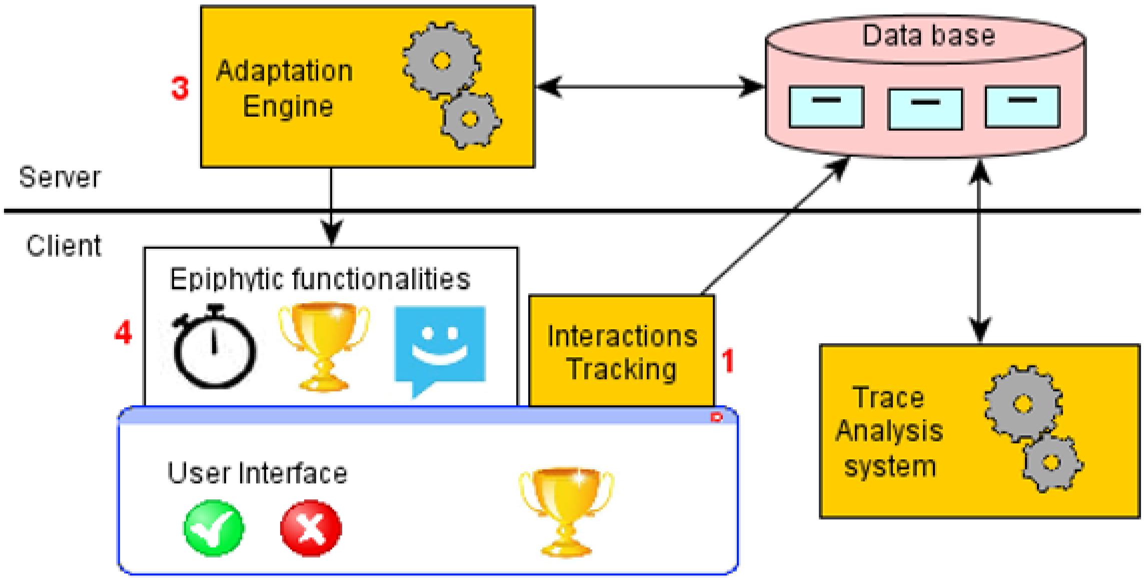


Figure 20 - Architecture of the gamification system by Monterrat *et al*. (2014)

Besides the study conducted by Monterrat *et al*. (2014) to provide a gamification system that can be plugged on various learning environments, the adaptation of system happens only after the student use the system sometimes, first leaving the students to a state of demotivation, to change the gamification model in the system, it could harm the user's experience in the system. Moreover, the study conducted by Monterrat and your colleagues used the initial player model proposed by Ferro *et al*. (2013), that considers only a few number of player types, and do not provide empirical validation, at the same time, they not consider more recent and robust player models, such as *BrainHex*, that considers seven different gamer types and was empirically evaluated (see section about gamer types for a complete review).

3.3.8. Generic and adaptive gamification system

Monterrat *et al*. (2014) also presented in another study a generic and adaptive gamification system that can be plugged on various learning environments. The system can be automatically personalized, based on an analysis of the interaction traces. In this specific study, they presented the architecture of the proposed system to support the generic of the game elements.

Monterrat and his colleagues provide a generic architecture that can be used to adapt the gamification in different kind of system, independent of the pedagogical design. This study has not presented concerns in terms of choice of player profiles, as well did not provide information about the architecture evaluation in terms of students engagement or students learning during their experience using the personalized system based on the architecture proposed.

3.3.9. Towards a player model for adaptive gamification in learning environments

Monterrat *et al*. (2015) in another work presented a generic and adaptive gamification system that also can be plugged on various learning environments. The game elements can be automatically adapted, based on an analysis of the interaction traces. The architecture of the proposed system is based on the separation between the control of the pedagogical elements and the control of the game elements. To support the adaptively of the game elements, the authors refer to a user model based on a list of player types. The user model has initialized thanks to the traces of interactions and finally used to predict which game feature will be relevant for the user. The Figure **21** will to show an overview of the collected and calculated data in the user model, proposed by Monterrat *et al*. (2015).

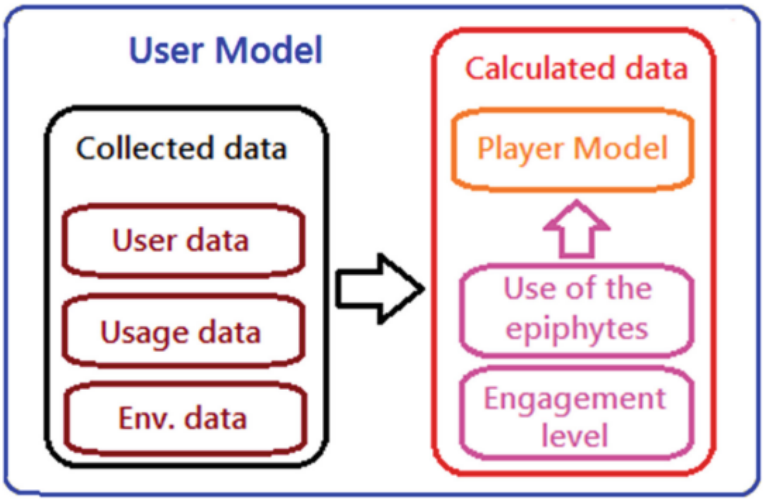


Figure 21 - Overview of the collected and calculated data in the user model, proposed by Monterrat *et al*. (2015)

In this study, Monterrat and his colleagues also present their architecture to adapt gamification system, take into account the student's gamer type, and using the *BrainHex* player model to classify the student's gamer types, in order to provide a gamified system tailored based on the student's preferences about games. In this study, however, Monterrat and his colleagues have not presented concerns about the architecture evaluation, and its applicability to tailor the gamification design of gamified VLS.

3.3.10. A player model for adaptive gamification in learning environments

Monterrat *et al*. (2015) in a quite similar study, also presents a model to tailor gamification features according to a player profile of the learners. Two version of this model was evaluated within a gamified online learning environment. The first version comes from expert's judgment, and the second one is induced from empirical data.

In this specific study, Monterrat and his colleagues evaluate the two versions of its system (tailored and counter-tailored system). The evaluation was conducted in two steps, the first by specialists, and the second using empirical data. This study did not present concerns regarding the student's receptiveness of system, or the student's leering, in the comparison between the tailor and counter-tailored system, highlighting the importance to conduct more deep evaluations in terms to evaluate comparatively tailored and counter-tailored systems.

3.3.11. Model to tailor gamification features according to a player profile of the learners

Monterrat *et al*. (2015) presented a model to tailor gamification features according to a player profile of the learners. In their study, two versions of the model were evaluated within a gamified online learning environment. The first version comes from experts' judgment, and the second one is induced from empirical data. The experiments conducted by Monterrat *et al*. 2015 confirmed that the first version can be efficient to predict the player's preferences among the gamification features. The approach was to the adaptive interface of the learning environment relies on two separate engines developed independently, one for the didactic content adaptation and the other for the gamification adaptation. Was developed a model that estimates the preference for a feature by a weighted sum of personality traits, which bears similarities to existing learner models that predict student success based on a linear or boolean combination of skills.

In the same study, was conducted two experiments, the first experiment in order to associate the player type (using *BrainHex* player model) with the game features preferences (was used five different game features: Stars, Leader, Board, Tips, Walker, and Timer). As in experiment one, they filled in the *BrainHex* survey answered a game feature assessment questionnaire. The members of the first group were provided with the two game features that best matched their profile, and the members of the second group, with the two features that worse matched their profile.

In this study, Monterrat *et al*. (2015) provided a strong contribution to the field of user modeling based on gamer types, especially because Monterrat and their colleagues take into account the *BrainHex* player model and their preferences about the gamification style in the educational system. The study, however, is limited in terms of gamification elements, addressing about only five different game features (stars, leader, board, tips , walker, and timer), without take into account other important game features, as well, forgetting to associate these game features with their respective persuasive technology , and evaluate the system tailored in terms of students receptiveness.

3.3.12. Impact of the semi- automatic adaptation of game interfaces

Torrente *et al*. (2015) is one recent study conducted in this field, and explore the potential impact of the semi- automatic adaptation of game interfaces as a way to facilitate accessible game development (and thus trim the cost down). The authors propose a game interface model optimized for point-and-click adventure games (Figure **22**), a popular genre among serious games that were used to perform different semi-automatic adaptations in a game. The authors had tested the resulting adapted game with end users with specific disability profiles. The tests discovered that the automatic adaptations produced usable games that retained part of their attractive, although different usability issues had a negative impact on the user experience.

Figure 22 - Left: Standard visualization of a game scene from eAdventure game 'Eating Out'. Right: Adapted visualization of the scene for people with low vision. High contrast rendering mode is applied darkening the background and highlighting the interactive elements

The study executed by Torrente *et al*. (2015) was an important step to highlights the need to tailor game interface, as well, gamified systems interface, in order to increase the player's experience. However, the study is focused in the field of serious game, without comprehensiveness to the field of educational environments, and provides an evaluation just in the scope of the game interface. The study makes it clear the importance to conduct similar studies in another field, and evaluate the solutions in different terms.

3.3.13. Adapt and validate generic mechanics and player types

Gil *et al*. (2015) present a preliminary user study in an e-learning environment aimed to adapt and validate generic mechanics and player types proposed in the gamification literature, incorporating well-known gamification mechanics into a number learning activities, implemented them as functionalities of an e-learning system, and investigate the learning effectiveness of the proposed mechanics, as well the relations between the mechanics and their assumed player types. In summary, the study of Gil *et al*. (2015) had preliminary validated gamification mechanics and player types in education (Figure **23**) and identified the gamification mechanics really corresponded to the students' inferred player types.

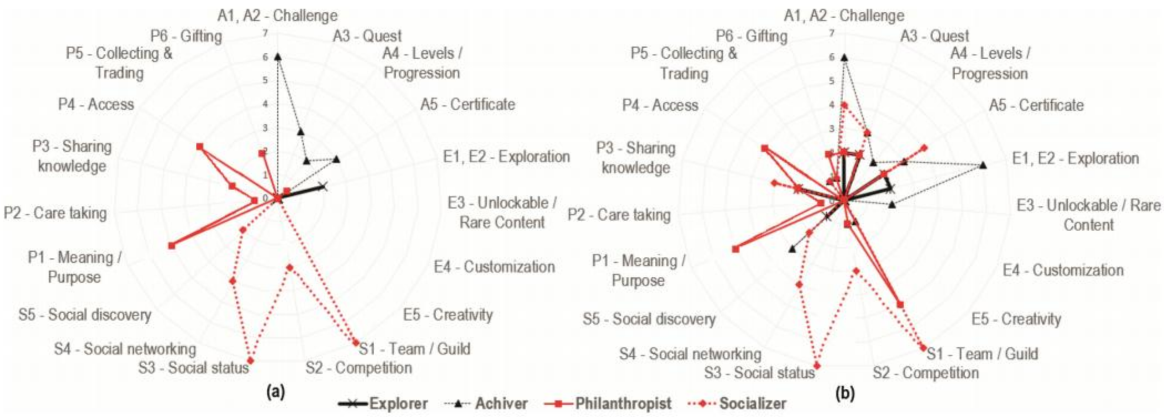


Figure 23 - Number of students who performed each action, grouped by their inferred player types

The study performed by Gil *et al*. (2015) also provide an import initial step in order to associate gamification mechanics and player types, showing that students are differently engaged in gamified VLEs according to their gamer type, however, the study not provided resources to gamification designers start to design systems tailored based on the students gamer types, showing more the importance to conduct more deep studies in order to provide ways to professionals from industry and academy design educational system personalized according to their users gamer type.

3.3.14. Classify gamers according to their preferences and habits

Manero *et al*. (2016) developed an instrument to quickly classify gamers according to their preferences and habits and classifies participants into four “clusters” or types of gamers, allowing for easy interpretation of the results. These clusters are: (1) Full gamers, covering individuals that play all kinds of games with a high frequency; (2) Hardcore gamers, playing mostly first-person shooters and sport games; (3) Casual gamers, playing moderately musical, social and thinking games; and (4) Non-gamers, who do not usually play games of any kind. The instrument may have used in psychology and behavioral sciences, as there is evidence suggesting that attitudes towards gaming affect personal attitudes and behavior. The following figure (Figure **24**) shows the cluster composition when clustering into *K* ¼ 3, 4 or 5 clusters, indicating migrations as *K* increase.

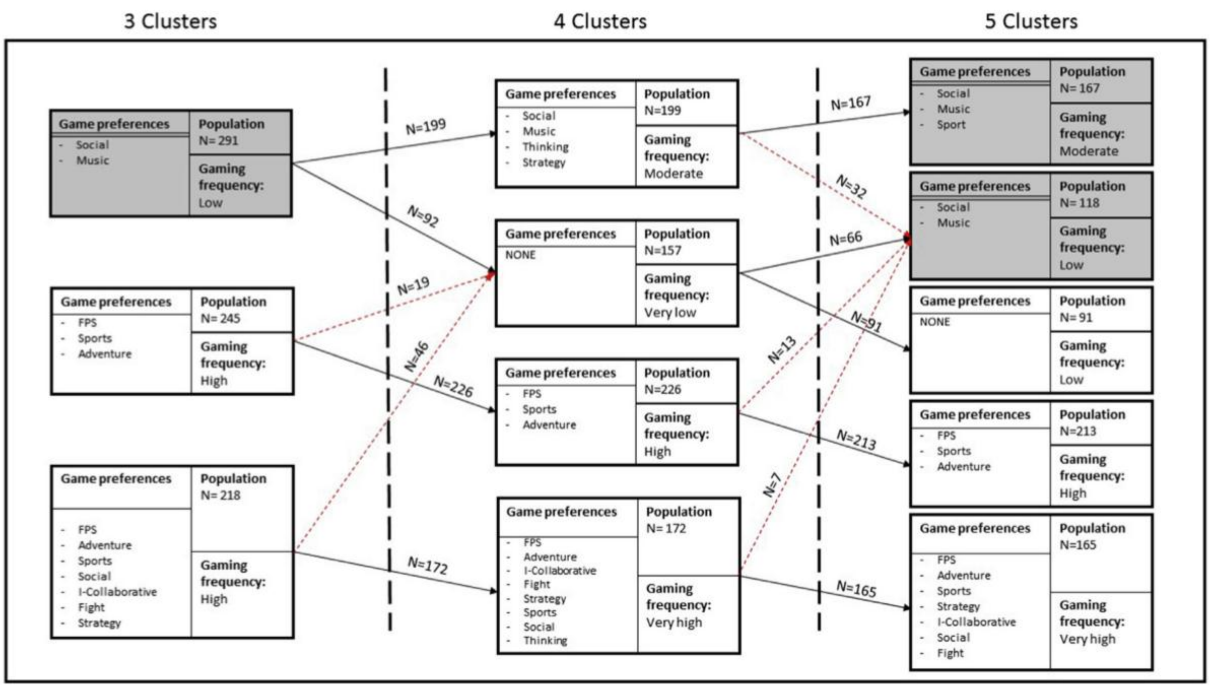


Figure 24 - Cluster composition and summarization

The study performed by Manero *et al*. (2016) is a very young study highlighting the importance to understand the relationship between gamer types and their preferences in terms of systems usability, as well, to provide tailored system to each gamer profile, especially in educational domains, such as, educational games, or gamified learning environments.

3.3.15. Gamification preference profiles

Knutas *et al*. (2016) presented in its study conducted in 2016, evidence-based method and a case study where interaction analysis and k-means clustering are used to create gamification preference profiles, these profiles can be used to create adaptive gamification approach for online learning or collaborative learning environments, improving on static gamification designs.

This study helps gamification designers to tailor educational systems creating adaptive gamification models to improve the student's leering. This study, however, is limited in terms of providing a practical structure to design gamified VLEs personalized based on gamer types, making it's clear the importance to provide resources to gamification designer create gamified VLEs tailored based on student's preferences or student's gamer types, such as architectures and frameworks to facility the tailoring process.

3.3.16. Comprehensive framework of engagement in gamification for learning

Silpasuwanchai *et al*. (2016) propose a comprehensive framework of engagement in gamification for learning. The framework sketches out the connections among gamification strategies, dimensions of engagement, and the ultimate learning outcome. The framework provides an in-depth understanding of the mechanism of gamification for learning and can serve as a theoretical foundation for future research and design. In the Figure **25** will be presented the gamification interface used in this study.

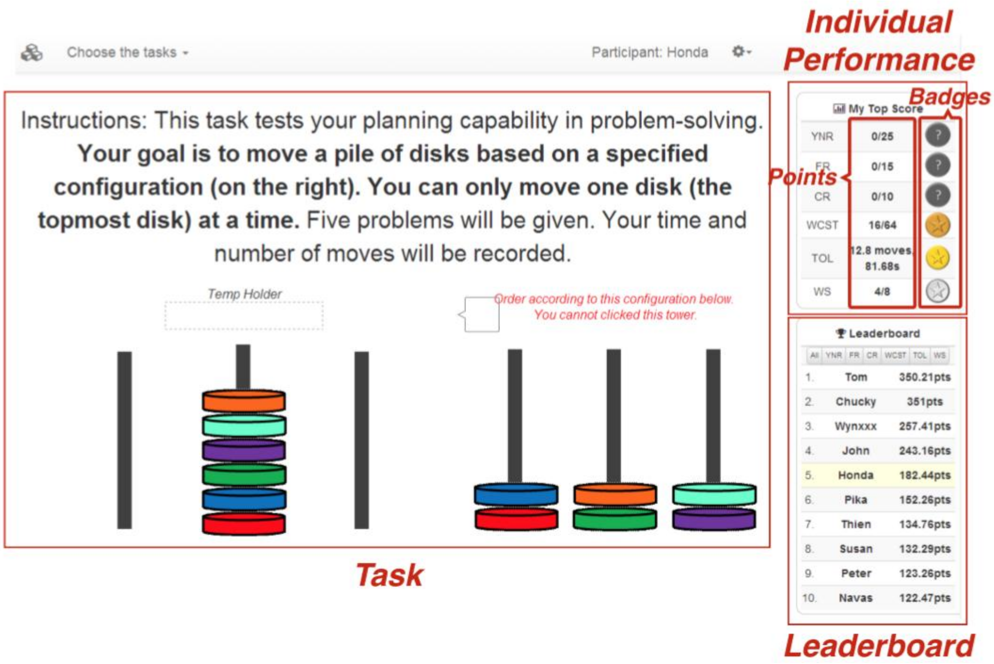


Figure 25 - Sample screenshot of the gamification interface (by Silpasuwanchai et al. (2016))

In this study, Silpasuwanchai and their colleagues provide a relationship between gamification strategies and dimensions of engagement towards to learning, constructing an important framework to the community understand. The study provides to understand that specific game design elements can help the more specific player, however, did not provide steps to help gamification designers to tailor educational gamified systems according to students gamer types.

3.3.17. Ontological model for describes concepts from gamification and its use as PT Strategy

Challco *et al*. (2016) showed an ontological model for the formal systematization and representation of knowledge that describes concepts from gamification and its use as Persuasive Technology (PT) in Collaborative Learning (CL) scenarios. This model enables the creation of intelligent systems that can personalize and apply the gamification techniques in group learning contexts in which the scripted collaboration decreases the motivation and engagement of students. The approach proposes to formalize the connection of concepts from theories and models to design PT in order to specify gamified CSCL scripts that induce students to willingly follow an intended learning behavior. They also presented a case study that showed how our ontological model could be used by in an intelligent theory-aware system to build better personalized gamified CL scenarios. Figure **26** presents the ontological model to design personalized gamified CL scenarios.

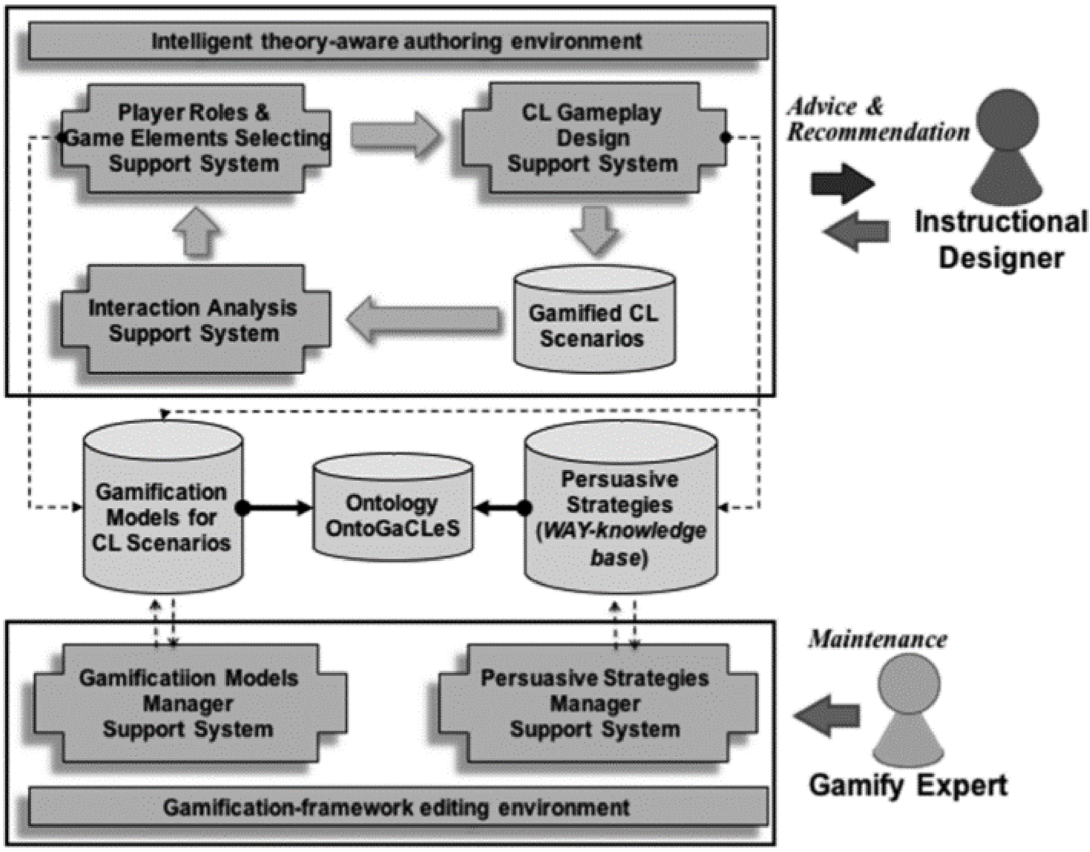


Figure 26 - Activity flow to gamify CL scenarios in a reference architecture for semantic-web intelligent theory-aware systems

The work makes by Challco and his colleagues in 2016 is a recent study providing an import contribution to gamification designers tailor gamified educational environments based on the specific group of students in CL scenarios, connecting PT strategies and gamification elements in CL scenarios, aiming to better tailor gamified CL scenarios and increase the students learning. The study of Challco *et al.* (2016) did not have concerns in terms of tailor the system based on student's gamer types or evaluate the system in terms of student's emotions during their experience using the personalized system.

3.4. Discussions about our Related Works

The system's field modeled based on the users' preference is a recent topic, that beggined with the advent of Artificial Intelligence (AI), and the need of to create personalized systems according to the users' profile, preferences, emotional traits, and others (Masthoff and Vassileva 2015). Most of the studies in this domain were conducted in the last decade, especially in the last few years, end, in general, aimed to conduct an investigation related to the users' implicit preferences (Vail *et al*. 2015), users types (Hamari and Tuunanen 2014), and to provide relationships between the users' preferences and types (Orji *et al*. (2013) and Orji *et al*. (2014)).

Some of the related works are theoretical studies. Ferro *et al*. (2013) presented a theoretical background regarding the relationship between several personality types and traits. Some of the studies were dedicated to identifying the relationship between gamer types and user preferences. For instance, Magerko *et al*. (2008) presented an approach for methodically identifying the possible adaptations that a game can take, and mapping those adaptations to the learner's needs. Jovanovic *et al*. (2008), proposed an approach to identify and build profiles of user interfaces for educational games, and Orji *et al*. (2014) examined the ten persuasive strategies, and its receptiveness by the seven gamer types identified by *BrianHex* to the strategies most commonly used in persuasive strategies design.

Moreover, some recent studies have started to propose and implement tailored systems based on the students' gamer types. Monterrat and his colleagues conducted a lot of studies between 2014 and 2015, proposing a model to tailor gamification features according to the player's profile. The studies conducted by Monterrat are still very recent, giving an important advance in this field, and highlighting the importance to conduct new more in-depth and empirically evaluated studies. Others similar studies, like, for instance, Torrente *et al*. (2015), explored the potential impact of the semi-automatic adaptation of game interfaces as a way to facilitate accessible game development.

Based on the studies presented in the section of related works, it is possible to perceive that in the field of system modeling based on the student's gamer types, the studies are generally characterized as theoretical ones, with few implementing or evaluating the outcomes and solutions. In summary, the studies conducted made clear that this field is actually concentrated in some specific areas. It is important to conduct empirical studies, in order to implement and evaluate the theoretical studies, to provide valid solutions to tailor virtual environments based on the user's gamer types, making clear the need to conduct specific studies in different areas, with special atention to the educational one.

In the field of VLEs personalization, most of the studies were conducted in the last years, and these recent studies are an adaptation of previous researches from another area. The empirical studies conducted in the field of education, in general, are focused only on the implementation or evaluation, not covering modern player types, such as the *BrainHex* player model, as well as not providing an empirical evaluation of the proposed solution.

This master thesis intends to provide a process and architectural desing to tailor the gamification design of gamified VLEs, being used to implement different gamified VLEs. The study was developed based on a methodology covering the entire development process, beginning with the identification of the problem, and ending with the empirical evaluation in industrial and academical contexts. The study presented in this master thesis was implemented based on a modern player model (*BrainHex* player model), that identifies seven different gamer types. Table **19** will present a comparative analysis of our study and the other related works. The terms addressed on the comparative analysis will be presented as it follows:

Q_1: The study was conducted in the field of gamified VLEs;

Q_2: The study was developed based on an empirical methodology;

Q_3: The study provides details about the implementation;

Q_4: The study provides details about the evaluation;

Q_5: The study provides an empirical evaluation;

Q_6: The study provides an evaluation of the Industrial and Academical context;

Q_7: The study used a modern player model, the BrainHex player model.

Q8: The study presents a comprehensive discussion of its results.

Table 19 - Comparative analysis

Study/ comparative term	**Q_1**	**Q_2**	**Q_3**	**Q_4**	**Q_5**	**Q_6**	**Q_7**	**Q_8**

Our Study	X	X	X	X	X	X	X	X
Ferro *et al*. (2013)		X		X	X			X
Orji *et al*. (2013)		X	X	X	X		X	
Orji *et al*. (2014)		X	X	X	X		X	X
Magerko *et al*. (2008)			X	X	X			X
Jovanovic *et al*. (2008)				X	X			X
Heeter *et al*. (2009)				X				X
Thammanichanon and Kotrajaras (2009)								X
Sajjadi *et al*. (2014)		X		X	X			X
Monterrat *et al*. (2014 *a*)	X		X					
Monterrat *et al*. (2014 *b*)	X		X					
Monterrat *et al*. (2014 *c*)	X	X	X					
Monterrat *et al*. (2015 *a*)	X	X	X				X	
Monterrat *et al*. (2015 *b*)	X	X		X	X		X	X
Monterrat *et al*. (2015 *c*)	X	X		X	X		X	X
Torrente *et al*. (2015)		X	X	X	X			X
Gil *et al*. (2015)	X	X		X	X			X
Manero *et al*. (2016)		X		X	X			X
Knutas *et al*. (2016)	X	X		X	X			X
Silpasuwanchai *et al*. (2016)		X		X	X			X
Challco *et al*. (2016)		X	X	X	X			X

On Table 19, it is possible to perceive that most of the studies do not provide some important criteria, such as details about its implementation or empirical validation of the proposal. Complete studies from the terms addressed in this analysis (*e.g.* Orji *et al*. (2013), Orji *et al*. (2014) and Challco *et al*. (2016)), were conducted in the health science field. The table also shows that the studies conducted in the field of VLEs (*e.g*. Monterrat *et al*. (2015 *b*) and Monterrat *et al*. (2015 *c*)) are initial studies, generally not providing an empirical evaluation or considering modern player models. Finally, Figure **27** shows a general classification of the related works, with each evaluation criteria providing a general comparative overview regarding the related works and our study.

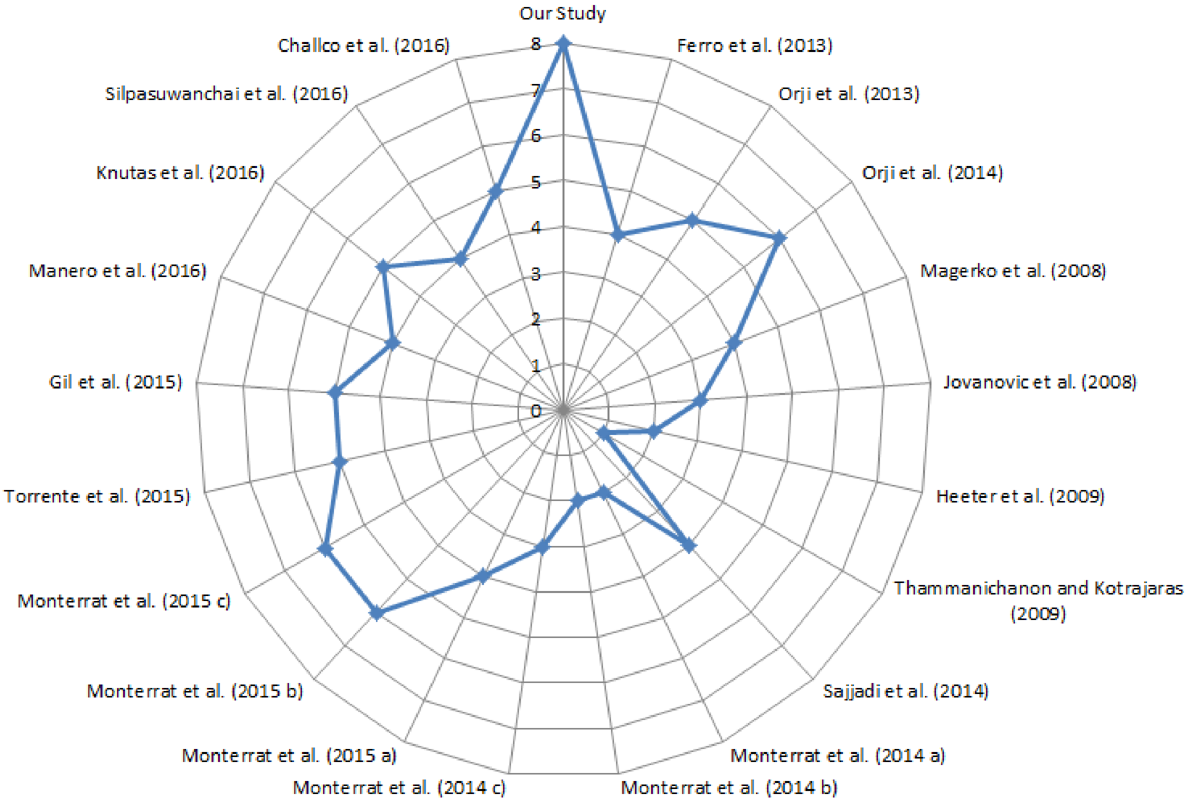


Figure 27 - Related Works Classification

4. Proposal

In this section, we will present this study's proposal. The proposal consists of designing a process and structure based on Orji's guidelines (Orji *et al*. 2014) for tailoring gamified VLEs based on the *BrainHex* player types (Nacke *et al*. 2014). We'll also implement and empirically evaluate the proposed structure and process.[18]

4.1. Tailoring Proposal

This study provides a process and architecture in order to help gamification designers to tailor gamified VLEs based on the students' gamer types. Through the process and architecture, is possible to create gamified VLEs tailoring the gamification design according to the students' gamer types. It is also possible to edit a pre-existing gamified VLE by changing the system gamification model. The process and structure provides exclusive support in the tailoring of the system's gamefication (the gamification design is distributed in the user's interface, independent of the pedagogical activity control, which means, the process changes only the gamification design of the system).

The process and architecture were proposed based on Orji's guidelines (Orji *et al*. (2013) and Orji *et al*. (2014)). Orji's guidelines are a systematic structure providing the best PT strategies for each gamer type and the game mechanics associated with each PT strategy addressed. In other words, these are the persuasive strategies which best motivate each gamer type and its game mechanics (see the Related Works section for a comprehensive review). The best persuasive strategies associated to each gamer type addressed are presented in Table **20** and the association between each PT strategy and its game mechanics will be presented in Table **21**. Figure **28** summarizes the best PT strategy to each gamer type and the game mechanics present in each PT strategy.

[18] This study was performed in the University of Saskatchewan (Canada) and was approved by the local ethics committee (*BEH# 16-142*).

Table 20 - PT Strategies to *BrainHex* gamer types by Orji *et al*. (2014)

	Best Strategies		
Gamer Type	**Best First Strategy**	**Best Second Strategy**	**Best Third Strategy**
Achiever	Cooperation	Reward	Self-monitoring and suggestion
Conqueror	Competition and comparison	Simulation	Personalization
Daredevil	Simulation	-	-
Mastermind	Self-monitoring and suggestion	Competition and comparison	Personalization
Seeker	Customization	Personalization	Competition and comparison
Socializer	Cooperation	Competition and comparison	-
Survivor	Self-monitoring and suggestion	Competition and comparison	-

Table 21 - PT strategies associated with the game mechanics by Orji *et al*. (2014)

	Strategies and game mechanics	
Strategies	**Game mechanics**	**Explanation**
Praise	Level	Level as a sign of a good job can serve as praise for actions. Players can level up and gain new abilities.
	Pride	Feeling of joy and fulfilment after accomplishment
Cooperation	Communal Discovery	The community must work together to overcome obstacles, individual effort is undermined
	Social fabric of the games	People grow closer after playing together; people will play together to make friends
	Viral game mechanics	Game elements that are more enjoyable or only accessible with others will make people want to cooperate
	Companionship gaming	Cross-platform gaming can be used to increase the opportunity for many players to play together
Competition and comparison	Status	Rank players to force them to compare with each other and therefore compete
	Envy	Striving for what other players have will increase competition and comparison
	Countdown	Players only get a limited amount of time to complete challenge
	Leaderboard	Displaying high scores in leaderboards will introduce competition and comparison
Reward	Physical goods	Distributing physical goods to reward players might lead to increased performance especially if the physical good appeals to players but it might also divert the intention of performing the task
	Virtual items	Distributing virtual items to reward players. This may be counterproductive
	Reward schedules	Variable and fixed reward intervals to encourage performance
	Lottery	Give players opportunity of winning stuff
	Free lunch	Give players free gifts
	Points	Success measurement on in-game actions
	Bonuses	In-game reward for overcoming challenges to reinforce desired behavior, *e.g*. combos

Simulation	Appointments	Fixed in-game appointments to make players return at certain times
	Leaderboards	Leaderboards to display and project high scores over time
	Achievements	Virtual/physical representation of accomplishment; achievements can be broken and tied to tasks, it can also be projected
	Status	Player rank or level to show and project a link between behavior and outcome
	Epic meaning	Having something great as a background story to give meaning to in-game actions. The story could link behavioral outcomes to the players' actions.
	Behavior momentum	Players keep going on because they feel what they are doing is valuable. Projected behavior outcome over a longer period will increase value and reinforce behavior
	Urgent optimism	High self-motivation, players want to work on issues instantly with the belief that they will succeed.
	Blissful productivity	Players work hard within game if actions are meaningful
Personalization	Cascading info. Theory	Gradually introducing players to the game will create a sense of personal relevance
	Epic meaning	Having something epic as a background story to give meaning to in-game actions. The story can be tailored to each player using various characteristics *e.g.*, gender.
	Privacy	Certain information is shared, certain information is kept private for the user alone
Customization	Shell game	Illusion of choice to guide the player to the desired outcome will create a sense of customization
	Discovery	Giving players opportunity to explore and find new things makes players fill a sense of control and autonomy associated with customization
	Epic meaning	Having something epic as background story to give meaning to in-game actions
Self-monitoring and suggestion	Quest	Displaying tasks that the player must complete help the player monitor his performance and progress
	Achievement	Virtual/physical representation of accomplishment enables players to monitor progress
	Level	Players receive points for actions to show performance and progress, and they can level up and gain new abilities
	Loss aversion	Not punishing the player as long as the desired behavior is shown (but not rewarding either)
	Repeat simple action	Players enjoy repeating simple in-game actions

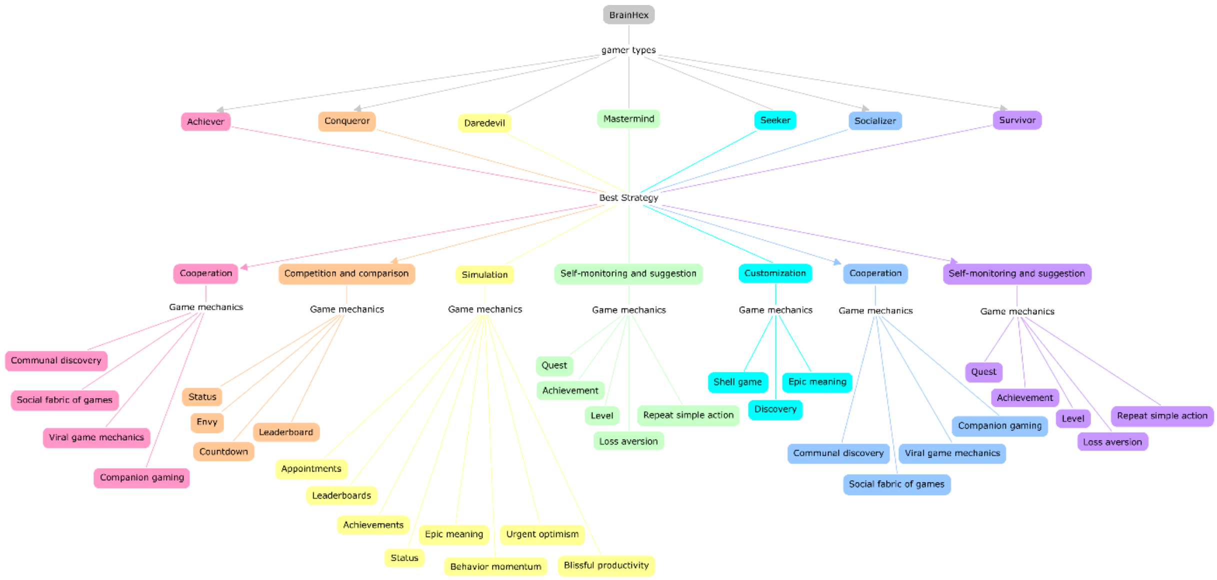


Figure 28 - Gamer types associated to persuasive strategies and game mechanics

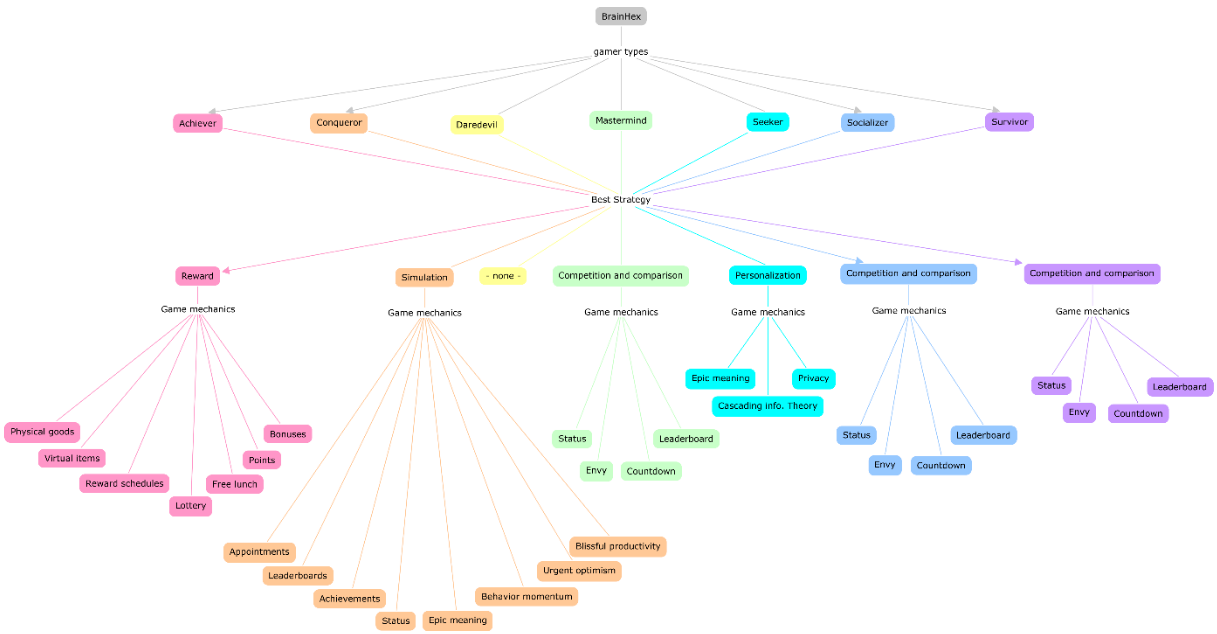


Figure 29 - Gamer Types and the Second Best Persuasive Strategy

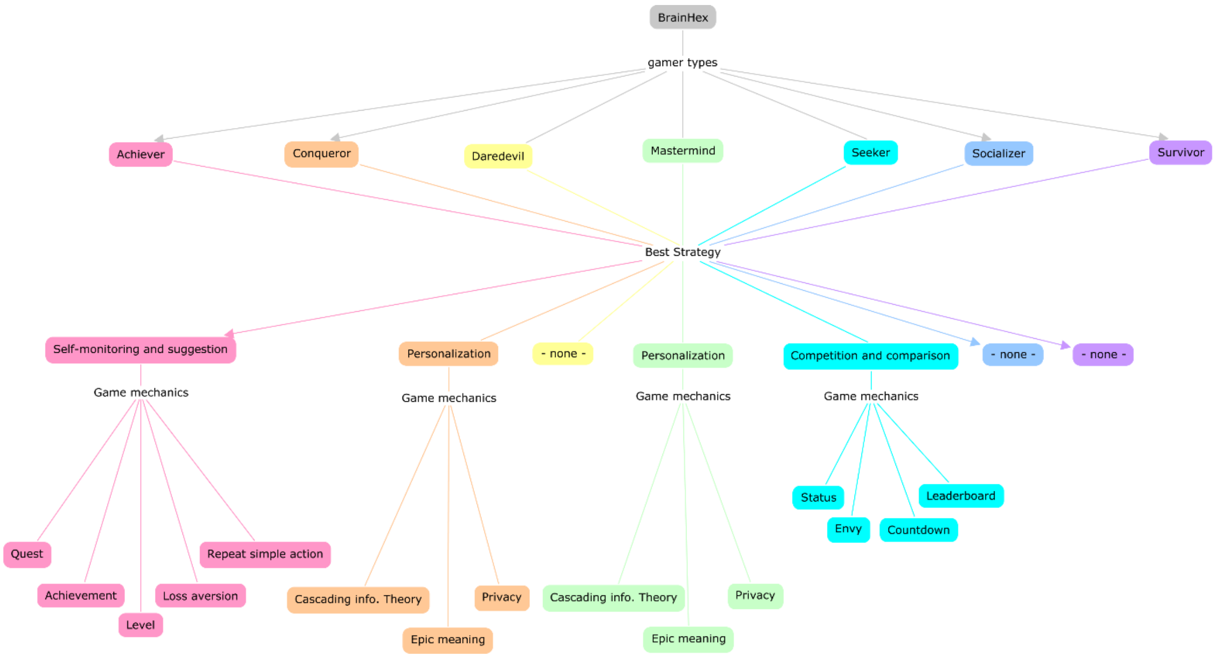


Figure 30 - Gamer Types and the Third Best Persuasive Strategy

Orji' guidelines provide an important step to tailor gamified environments associating the best PT strategies to each gamer type. However, the guideline doesn't provide a structure to tailor the systems, making it difficult to understand and identify which are the specific game design elements that should be used in the gamified system to motivate the students based on their gamer type and how to design or modify pre existent systems based on the guidelines.

Based on Orji's guideline, as well as the popular literature about gamification and game design (*e.g.* Hamari *et al*. (2014), Nah *et al*. (2014), Schuytema (2007) and Fullerton (2014)) we have created a systematic structure assonating the game design elements and gamification elements to each persuasive strategy addressed in the Orji' guideline and also, as a consequence, associating the best game design elements and gamification elements to each gamer type (see Table **22**).

Table 22 - Gamer types and gamification elements

Gamer types	**Gamification elements**
Achiever	Team missions
	Points
	Badges

	Trophies
	Surprise Rewards
Conqueror	Ranking
	Leaderboard
	Limited time
	Timeline
	Badges
	Adapted history according to the student's gender
Daredevil	Ranking
	Leaderboard
	Progress bar
	General history
Mastermind	Progress bar
	Points
	Badges
	Ranking
	Leaderboard
	Limited time/ timing
	Adapted history according to the student's gender
Seeker	Choose the prizes
	Adapted history according to the student's gender
	Ranking
	Leaderboard
	Limited time/ timing
Socializer	Team missions
	Ranking
	Leaderboards
	Comparison
Survivor	Progress bar
	Points
	Ranking
	Leaderboard
	Limited time/ timing

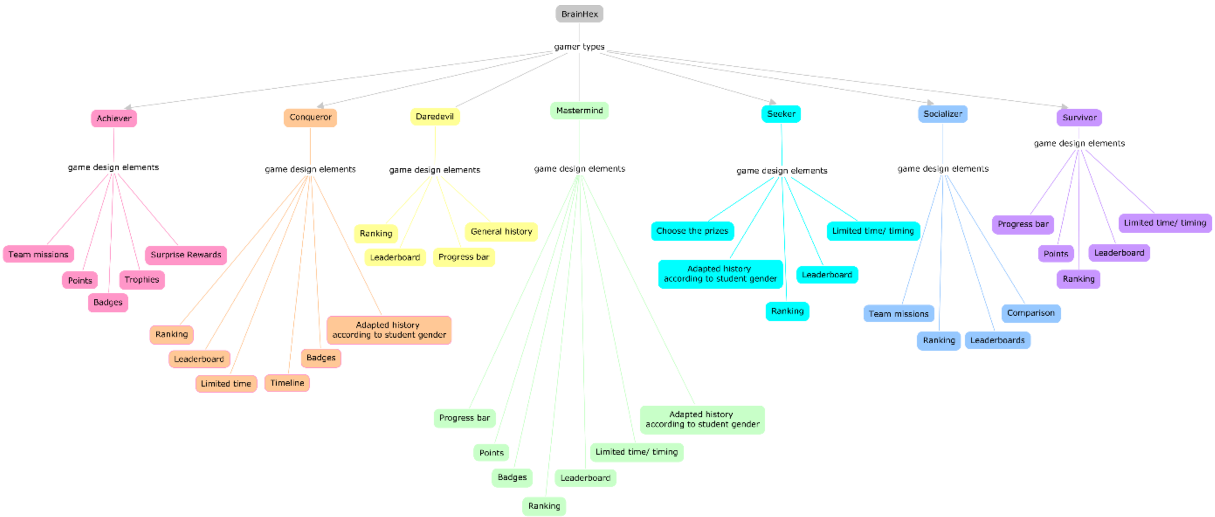


Figure 31 - Gamer types and the game design elements

4.2. Process and Architectural Design

The proposal consists of a process and architectural design that can be used to implement gamified VLEs independent of its pedagogical model. The implementation of our proposal happens as a service system, using students' data (initial students' data should be required when the student begins to use the system) to identify the student's gamer type (through the *BrainHex* questionnaire).

The proposed solution must provide a registration system for the participant, and the registration must provide options for the students to insert their personal data (according to the general specifications of the system). The system needs to provide a way to identify the student's gamer type (*BrainHex* questionnaire). After the student's gamer type identification, the implemented system based on our architectural design will be capable of provide a gamification system (graphical interface), tailored using as basis the student' game type. Basically, the general architecture is composed of five different moments. Figure **32** synthesizes this structure:

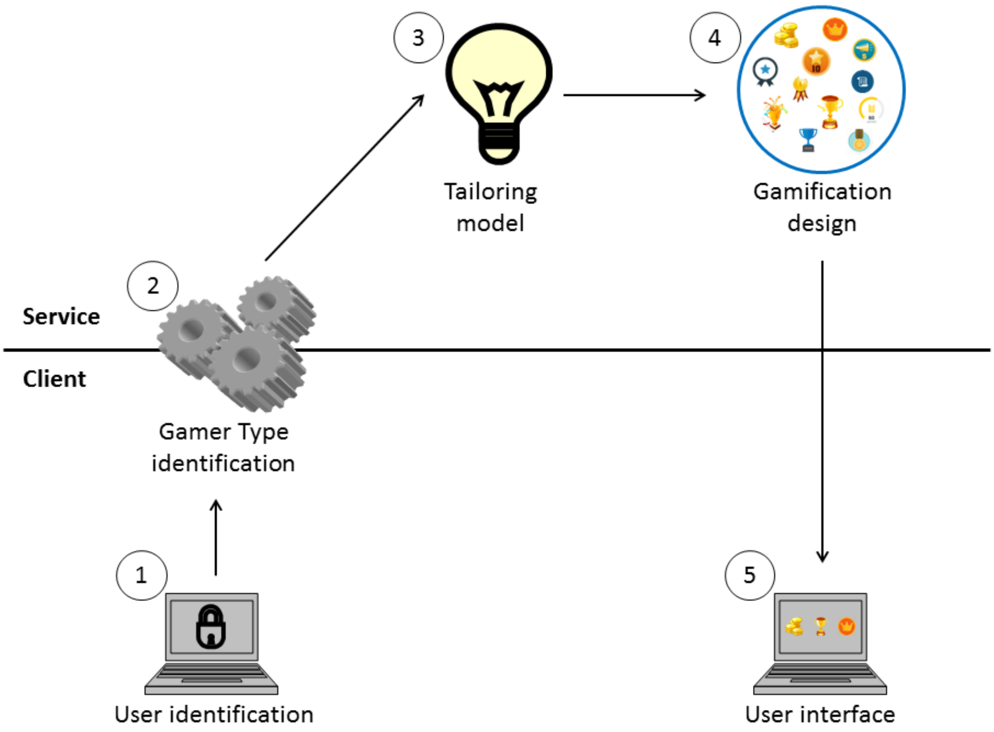


Figure 32 - System Architecture

1. **User's identification**: in the first moment, the system must provide options for the students to create an account in the system and provide basic information, such as login, password, email, and others (according to the default system specifications). These data are important to hereafter associate the student with their gamer type. In the case of pre-existing systems (edited by the proposed structure, the basic information previously obtained can be used);
2. **Gamer type identification**: the gamer type identification consists of a semi automatic process, based on the *BrainHex* player model. In the same moment of the user's identification, the system should provide the *BrainHex* questionnaire to the students. After the student completes the questionnaire, the system should process the student' answers, identify the student' gamer type, and begin to provide the system, tailored on the student' gamer type. In the case of pre-existing systems (edited by the proposed architectural design), the system can provide the *BrainHex* questionnaire after the student login in the system, and associate their personal data and their gamer type;

3. **Tailoring process**: the tailoring process is the main step of the process. In general, the tailoring model is responsible for the identification of the student's gamer type, make the game design elements available on the system, and to associate algorithmically the correct game design elements to each student's gamer type, based on the structure previously defined;
4. **Gamification design**: the gamification design is the system model, responsible for generating the student's graphical interface with the best game design elements associated with their gamer type, based on the tailoring model process before its execution;
5. **User's interface**: the user's interface represents the system *output* and is responsible for providing the students with the game elements design associated to their player type, generated by the gamification design model.

The system structure is composed of three different parts: *front-end*, *back-end*, and *satellite*. The *front-end* is responsible for the user's graphical interface (input and output), the *back-end* is responsible for the gamification system processing (tailor model), and finally, the *satellite* is an external component, using the elements from the third part (original gamified system). Figure **33** - Tailor System Component Diagram presents high-level diagram components.

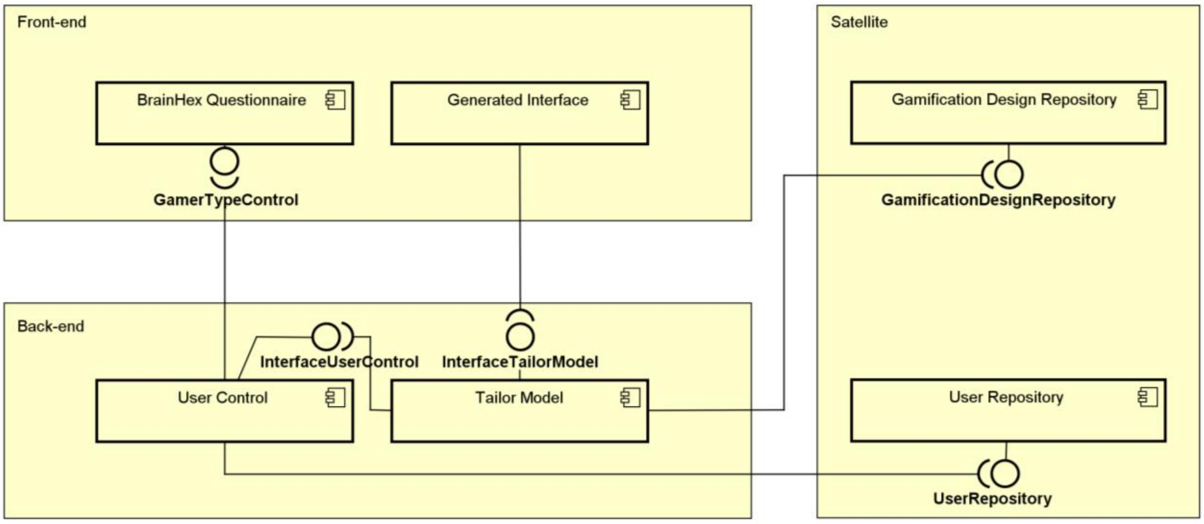


Figure 33 - Tailor System Component Diagram

The system starts with the *BrainHex questionnaire* component (input component), responsible for identifying the student's gamer type. The student's gamer type is used for the *User Control* component. The *User Control* component uses the data allowed by the *User Repository* component to associate the student's data with the gamer type.

The *Tailor Model* component (main system component) uses the student's data (including the student's gamer type), and the system game design elements, associating the best gamification elements to each gamer type and creating the tailored user's graphical interface. The *Generated Interface* component (tailored interface) presents the tailored system based on the student gamer type previously created. To deepen the general architecture, following, we present the class diagram.

The class diagram showed in the Figure **34** represents the general classes of the system to be tailored based on the proposed structure, addressing only the inherent parts of the gamification design, independent of the system pedagogical design. In other words, for a system to be tailored based on the proposed structure, we must implement the classes highlighted on the diagram (associating these classes with the system pedagogical design).

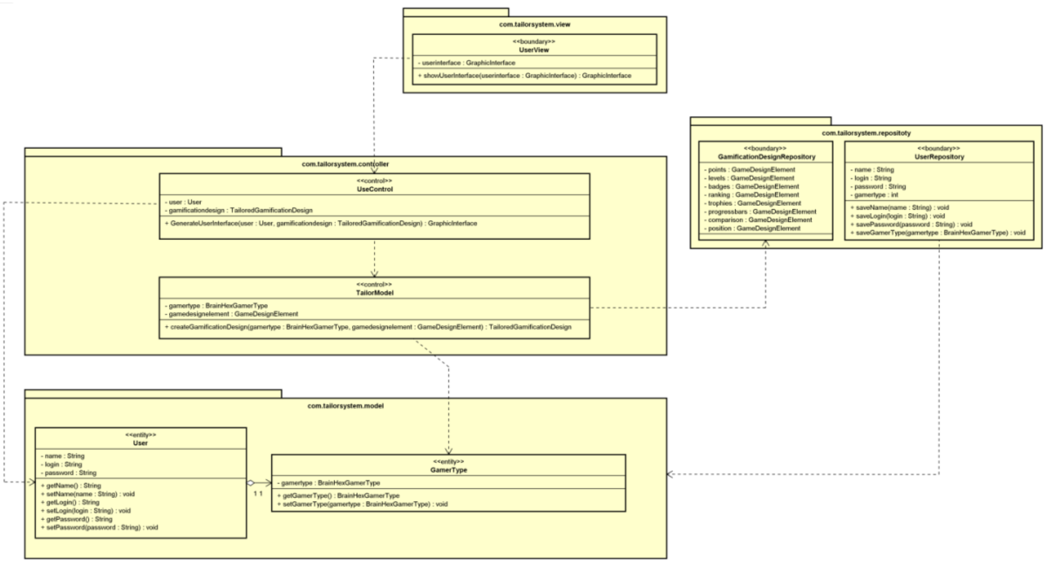


Figure 34 - Tailored System Class Diagram[19]

[19] Link to see the extended figure: https://goo.gl/G3ecn5

The classes are organized in four different packages: *model*, *repository*, *controller*, and *view*. The *model* package has the classes *User* and *GamerType* that identify the main student's data (including the student's gamer type), used with the purpose of tailoring the system. The *repository* package has the class *UserRepository* saving the students' information previously obtained, and *GamificationDesignRepository* storing the game design elements of the system.

The *controller* package is the most important package because has the classes *TailorModel* and *UserControl* responsible for tailoring the system (selecting the specific game design elements for each student) and creating the user's graphical interface according to their gamer type and its game design elements. The package *view* has the class *UserView*, responsible for showing the tailored user's graphical interface.

The *User* class is responsible for allowing the students to create and/or edit their account. Default information should be required (*name*, *login*, and *password*). However, the system design can require other information, according to the system design specifications. The *User* class is associated with the *GamerType* class (*cardinality = 1:1*), the class *GamerType* is composed by the *BrainHex* questionnaire, and is responsible for identifying the student's gamer type. In summary, each user is associated with a gamer type (their gamer type identified by the *BrainHex* questionnaire).

The *UserRepository* (*repository* package) takes the information obtained by the class *User* and *GamerType*, associated (student and their gamer type) and save this information on the repository. The *GamificationDesignRepository* class (repository package), store the game design elements of the system. The minimal game design elements recommended to implement the proposed structure are: *points, levels, badges, ranking, trophies, progress bar, comparison, and position.* However, other game design elements are important for the good operation of system.

The *TailorModel* class (*controller* package) is the "core" of the system. The class takes the student's gamer type and the game design elements and implements the personalization. Through a conditional structure (abstracted on the diagram), the class selects the correct game design elements associated with the identified gamer type. For instance, if the student's *gamer type* is *achiever*, it will be selected points, badges, and trophies to compose the student's graphical interface, or if the student *gamer type* is *socializer*, it will be selected *ranking*, *comparison, and position* to compose the student's graphical interface.

The *UserControl* class (controller package) takes the gamification design generated by the *TailorModel* class and associates the gamification design generated with the specific student, creating the student's graphical interface. Finally, the *UserView* class (*view* package), takes the tailored interface generated by the *TailorModel* class and then shows the interface for the student. Following, we'll begin to present the architecture to each gamer type, starting with the student's first use. The Figure **35** and Figure **36** present the general structure to the system, providing the first user's access and identifying the students' game type.

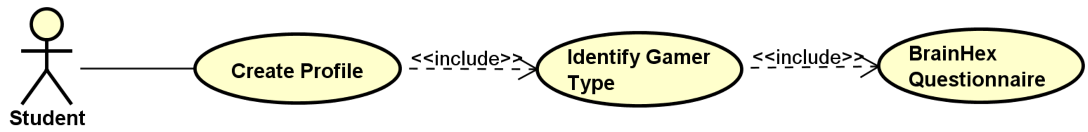


Figure 35 - Tailor System Use Case (Student Actor)

To create an account and identify the student's gamer type, the default process is shown on the use case presented in Figure **35**, based on the student's (client) perspective. Initially, the student should create their account (create a profile), with their basic information. The created profile includes the gamer type identification through the *BrainHex* questionnaire.

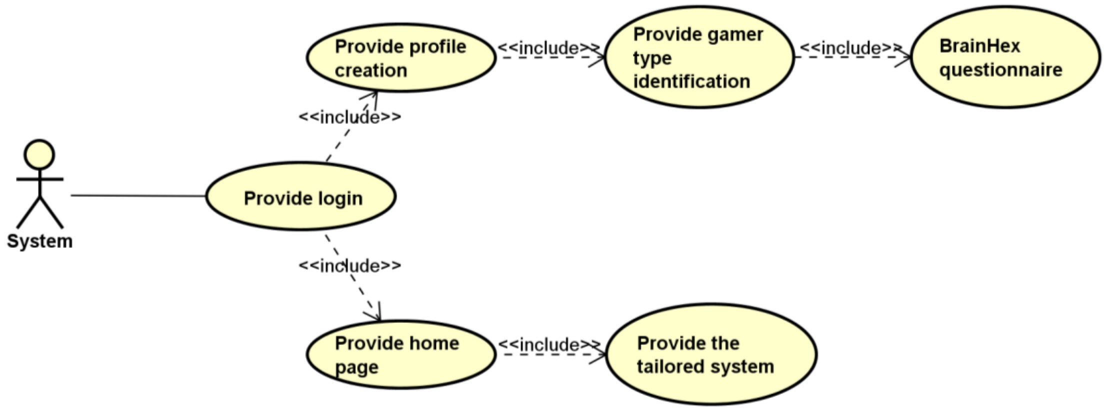


Figure 36 - Tailor System Use Case (System Actor)

At the same time, with the view based on the system (author), as showed in Figure **36**, for the student's first login, the system provides a home page with options for the students to create their profile (first access), or log into on system. In the first case, the system provides options for the students to create their profile, and identify their gamer type through the *BrainHex* questionnaire. After this process, the student will be conducted to the tailored system, based on their gamer type. Next, we will begin to present the specific architectural design that tailors each gamer type.

4.2.1. Tailoring the Achiever Gamer Type

According to the Orji' guideline, achievers are a more individualistic type, prefering individual activities. They prefer to receive *i*) points, badges, and trophies as rewards for their performance in the activities, and *ii*) they are better stimulated if they are surprised during their experience in the system. Based on Orji' guideline, in this study, the PT strategies cooperation, rewards, self-monitoring and suggestions were used to tailor gamified VLEs to the achiever's gamer types.

To this specific gamer type, the system must provide different missions to be solved individually, and these activities must provide points, badges, and trophies, according to their results in the educational activities. This personalization must occur because the achiever gamer type is motivated by the PT strategies cooperation, reward, self-monitoring and suggestion. Cooperation uses the game mechanics, such as communal discovery and social fabric of games, implementing activities to be solved in teams, together with colleagues. Reward use the game mechanics: physical items, virtual items, lottery, and points, proposing the distribution of virtual items to reward players, giving players fee gifts and the opportunity of winning gifts. Self-monitoring and suggestions use the game mechanics quest, achievement levels, loss aversion and repeating simple actions, providing points and allowing the players to follow their progress without punishing them.

The "reward" PT strategy also addresses two other game mechanics (reward schedules and bonuses), with these game mechanics using variable and fixed reward intervals to encourage performance and using the rewards to overcome challenges, reinforcing desired behavior. So, it is a good strategy to provide surprise rewards in variable and fixed intervals, to engage and motivate them. The process of tailoring gamified VLEs for the seven *BrainHex* gamer types developed and evaluated in this study considers the structure presented in Table 22. Figure 37 shows a use case for the achiever's gamer type, placing the student as an author, and Figure 38 shows the same process, with the system as an author.

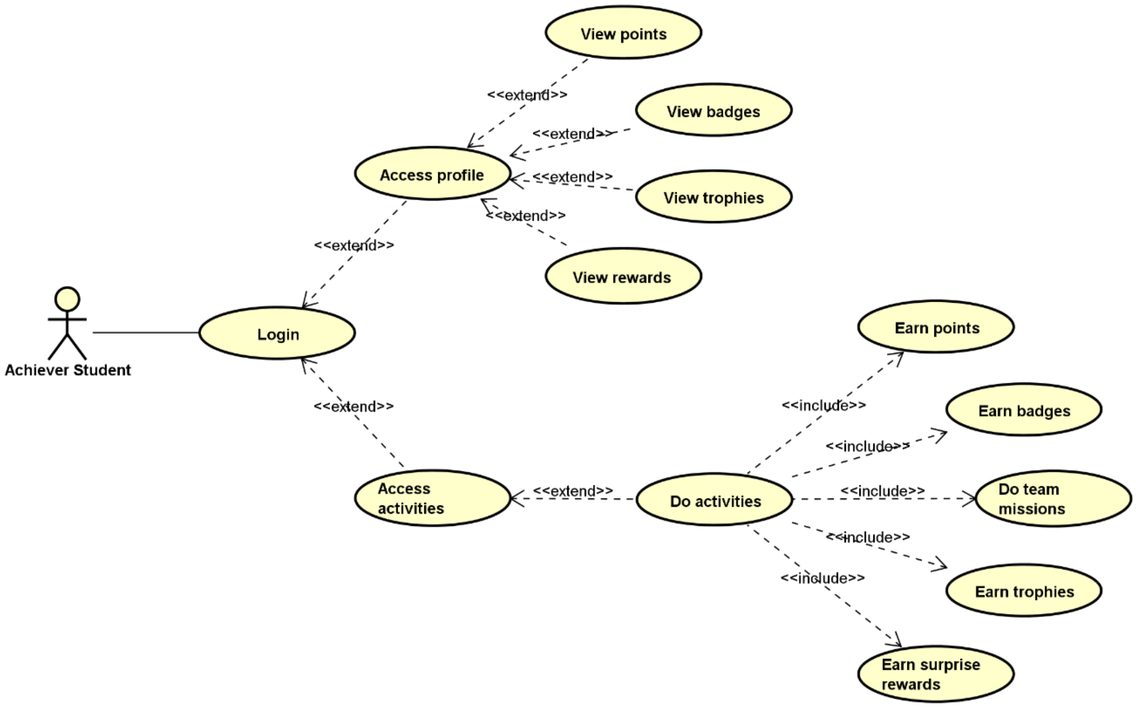


Figure 37 - Achiever Tailored System Use Case (Student Actor)

In order to start the process, the students are required to create a profile, inserting their personal data (the initial data should be required according to each system, such as name, school, login, password, and others) after the student inserts the initial data. The gamer type is identified through the *BrainHex* questionnaire. In pre existent systems, the *BrainHex* questionnaire can attach to the system.

Next, the student can log into the system (after the first student log into the system, he will receive the default activities, being able then to access and perform the educational activities, without interference of the pedagogical model of the system) and perform the activities and solve the exercises. The gamification model of the system will be tailored based on the student's gamer type, so the user will receive the specific game design elements according to their gamer type (*i.e*. points, badges, trophies, and surprise rewards, according to the achiever's gamer type).

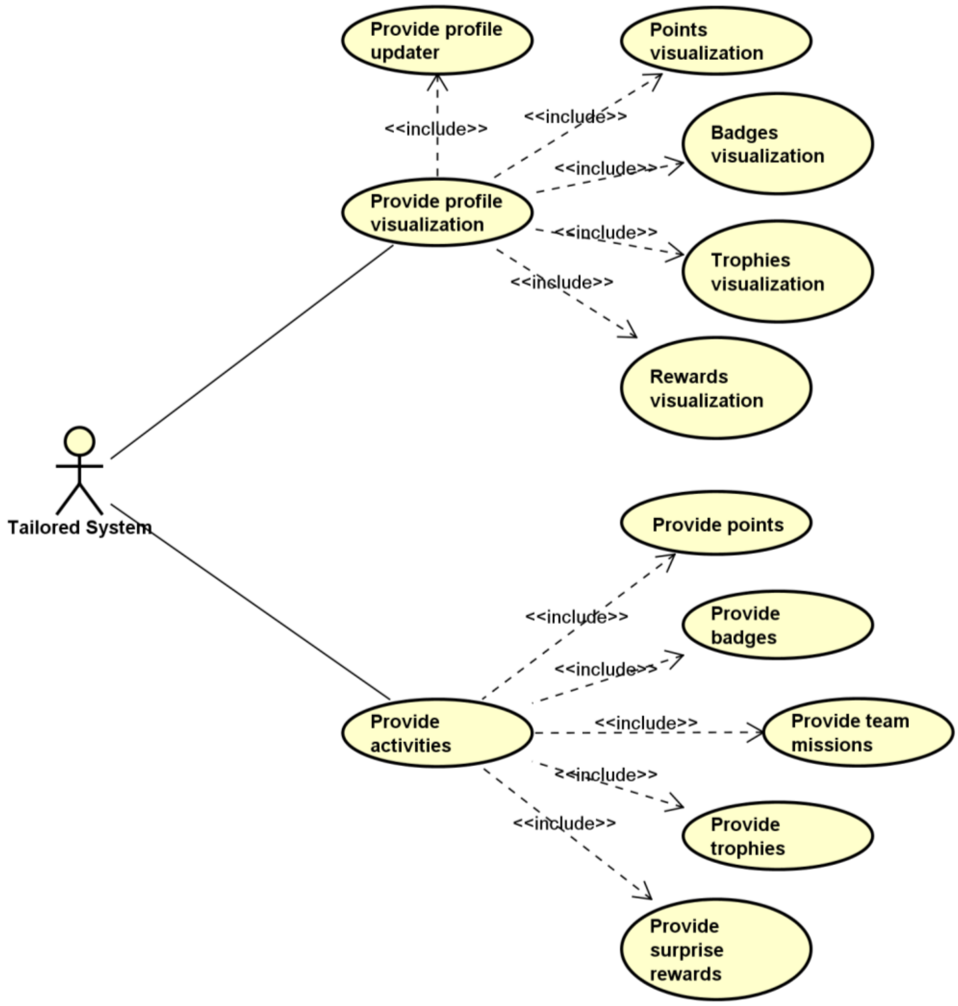


Figure 38 - Achiever Tailored System Use Case (System Actor)

With the system based perspective, as is shown in Figure 38, the system provides the default educational activities. These activities flow and conduction doesn't receive any influence of the proposed structure. However, these activities generate points, badges, trophies, and surprise rewards to the students, according to their performance in the system. The system also provides profile visualization, and this page provides options for the students to see their points, badges, trophies, and rewards in an organized manner on the scream. Table 23 and the Figure 39 present a systematic sequence that should be followed to implement the system.

Table 23 - Tailoring the Process for the Achiever Gamer Type

Gamer Type	Persuasive Strategies	Steps
Achiever	Cooperation, reward, self-monitoring and suggestion	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login to the system
		1.1.3. Provide different educational activities to solve individually and/or collaboratively
		2. Provide points, badges, and trophies, according to their result in each mission
		3. Provide surprise rewards for the conducted activities

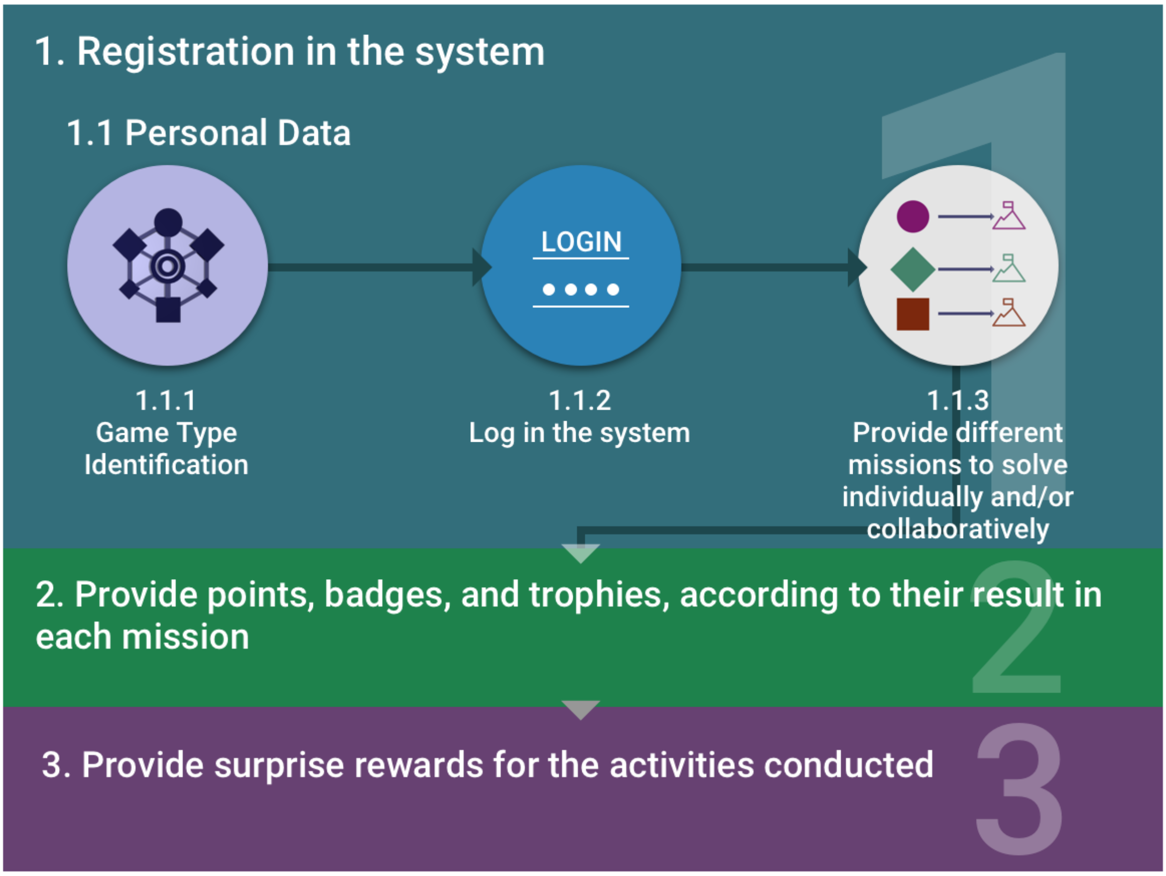


Figure 39 - Process to Tailor Gamified Educational Systems to Achievers

4.2.2. Tailoring the Conqueror Gamer Type

According to the Orji' guideline, conquerors are more interested in winning medals or badges to show and share their achievements, as well as comparing their results with their colleagues. They prefer to receive: *i*) rankings with their achievements and position in comparison with the other users, and *ii*) they are better stimulated if they received activities with limited time competing for badges. Based on the Orji' guideline in this study, the PT strategies competition and comparison, simulation and personalization were used to tailor gamified VLEs to the Conqueror gamer type.

With this gamer type, the system must provide different missions to be solved individually and with a time limit. These activities must provide rankings according to the individual achievements. This personalization must occur because the PT strategies used to motivate this gamer type (competition and comparison, simulation and personalization) use mechanics such as status and leaderboards, using the ranking of the players to force them to compare and therefore compete.

The competition and comparison PT strategy also use the game mechanics countdown and leaderboard that provide a limited amount of time for the student to complete the challenges, and display high scores in leaderboards, introducing competition and comparison. So, it is a good strategy to provide an individual comparison of players and provide a limited time for the students to complete some activities. The process of tailoring gamified VLEs for conquerors, developed and evaluated in this study, also uses the structure presented in Table 22. Figure 40 shows a high-level use case of the Conqueror's gamer type, with a point of view based on the conqueror student, and Figure 41 shows an use case based on the tailored system point of view.

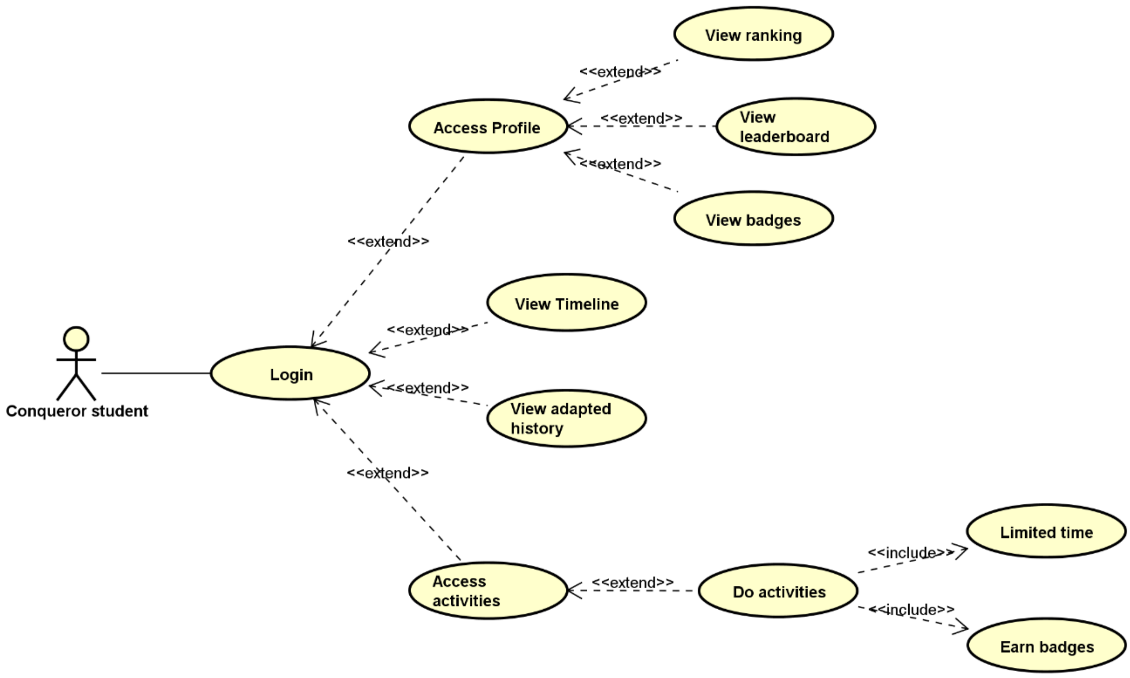


Figure 40 - Conqueror Tailored System Use Case (Student Actor)

After the Conqueror student logs into the system, he can access the available educational activities and perform them without the influence of the proposed structure, but with a time limit. These activities will generate badges to the students. The students also can access their profile and see their badges and the overall ranking (generated by their badges) with their position, and view a comparison between them and their colleagues with a similar position.

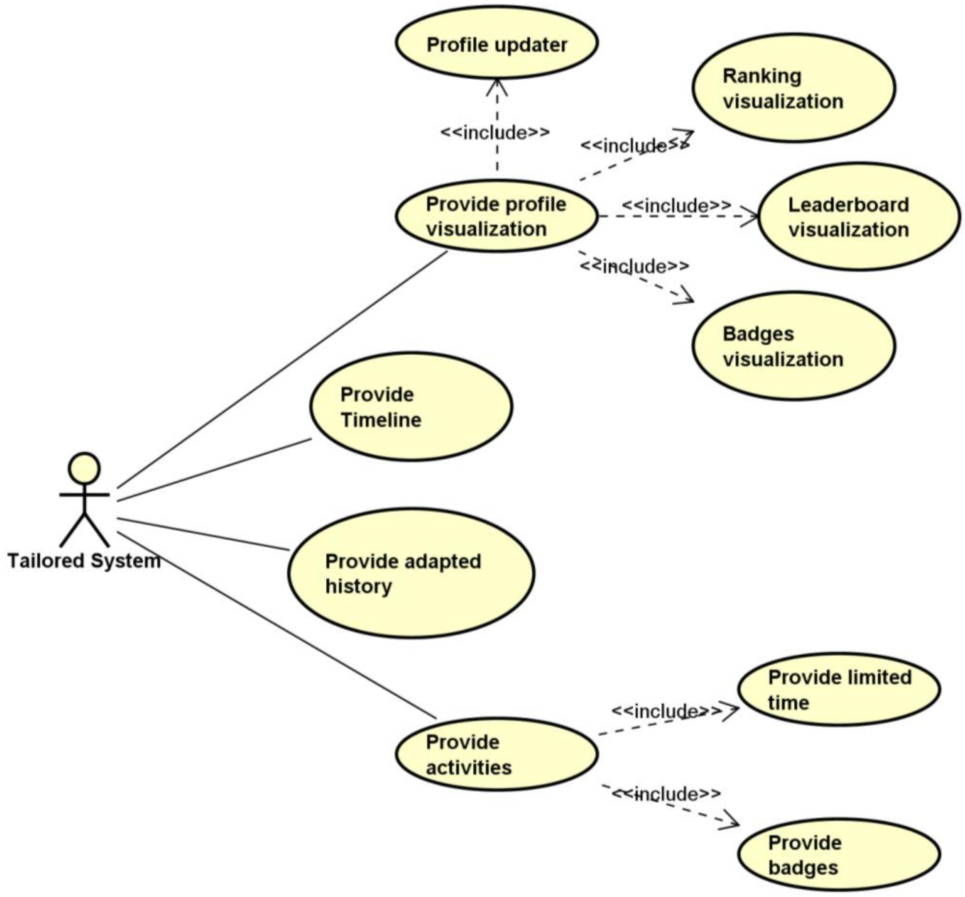


Figure 41 - Conqueror Tailored System Use Case (System Actor)

As we can observe in the system overview exbited on the Figure 41 above, the system provides the default educational activities for the students with a time limit to conclude the activities, and provide badges based on the student's performance (these badges also must be used to calculate the ranking). The system provides an option for the students to see their badges on their profile, as well as the ranking, including their position with a comparison between themselves and their colleagues in a similar position.

Next, the Table 24 and the Figure 42 presents the specific process to tailor gamified VLEs for the conquerors' gamer type. The process is organized in three different steps, with the first step being the general structure that must be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the different kind of educational activities and missions to solve individually. The second step is to provide a ranking with leaderboard, timeline, and badges, according to the student's results in each mission in the system. Finally, the last step of the process is to provide a time limit for the students to conduct their educational activities and adapted background history according to the student's gender.

Table 24 - Tailoring Process for the Conqueror Gamer Type

Gamer Type	Persuasive Strategies	Steps
Conqueror	Competition and comparison, simulation and personalization	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to be solved individually
		2. Provide ranking, leaderboard, timeline, and badges, according to the student's results in each mission
		3. Provide limited time for to the students conduct their activities and adapted background history according to the student's gender

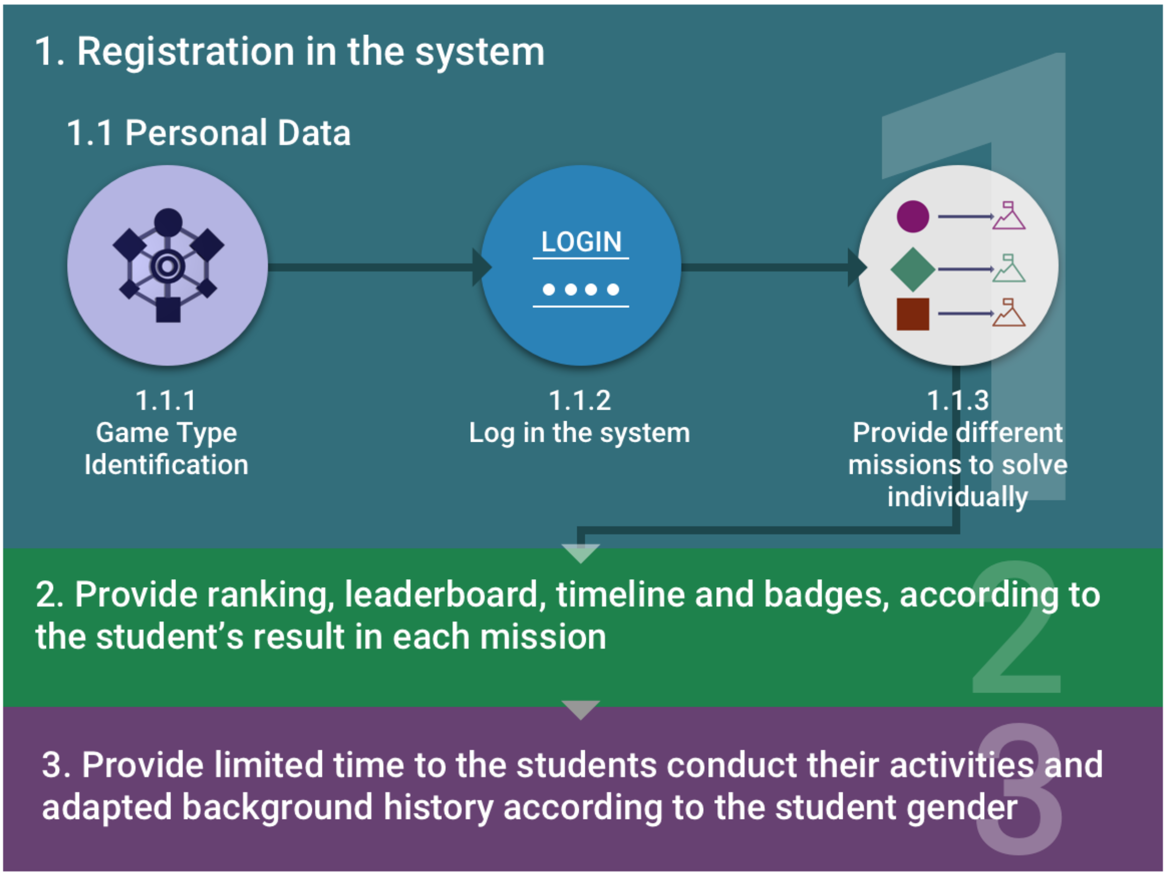


Figure 42 - Process to Tailoring Gamified Educational Systems for the Conquerors

4.2.3. Tailoring the Daredevil Gamer Type

Based on the Orji' guideline, daredevils are more interested in showing and sharing their achievements with their colleagues, monitoring their performance gradually and according to their activities on the system. They prefer to: *i*) receive rankings with their achievements and positions in comparison with the other users; *ii*) being able to monitor the sequence of their activities and achievements. Based on the results of this study, the PT strategy simulation was used to tailor gamified VLEs for the Daredevil gamer type, as was defined by Orji *et al*. (2014).

To this gamer type, the system must provide different missions to be solved individually. These activities must provide rankings according to their individual achievements (points can be used to calculate the ranking, but the points should not be displayed prominently, but only to calculate the student's rank). This personalization must happen because the PT strategy used to motivate this gamer type (simulation) use game mechanics such as a progress bar, and the ranking must be used to force them to compare and therefore compete with one another.

The process of tailoring gamified VLEs for daredevils developed and evaluated in this work also consider the structure presented in Table 22. Figure 43 shows a high-level use case of the Daredevil gamer type, and Figure 44 shows the use case based on the tailored system.

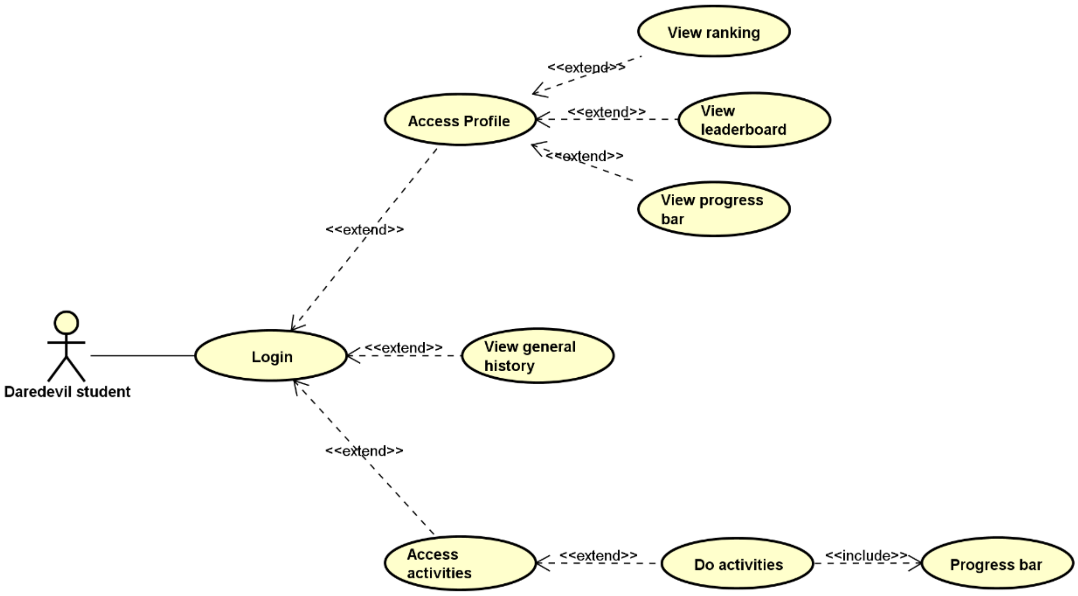


Figure 43 - Daredevil Tailored System Use Case (Student Actor)

After the daredevil student logs into the system, he can access the available educational activities inside and perform these activities, without any influence of the proposed structure. These activities can generate points (used only to calculate the ranking) and must be monitored by a progress bar (the progress bar also should be organized according to a group of activities). The student can also access their profile and see the ranking (generated by their points) with their position, and see a comparison between him and their colleagues with a similar position. The profile also should provide a general progress bar of their activities into the system.

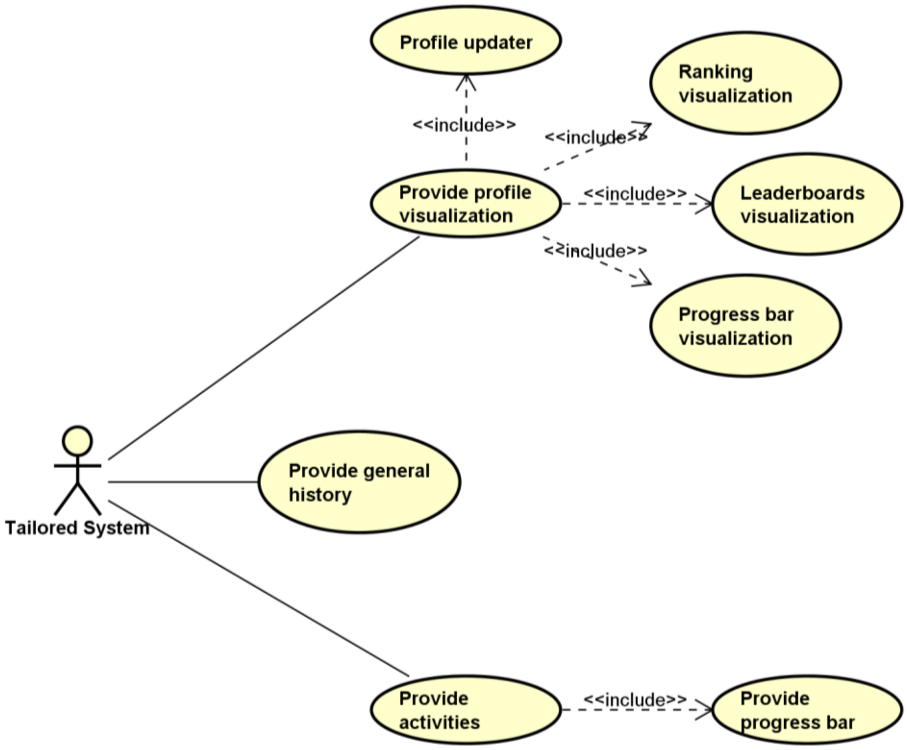


Figure 44 - Daredevil Tailored System Use Case (System Actor)

As we can observe in the overview of the system exhibited in the Figure 44 above, the system provides the default educational activities for the students, and also provides a progress bar based on their performance. The system provides the option for the students to see their progress on the profile, as well as their ranking, including their position and a comparison between themselves and their colleagues with a similar position.

Next, the Table 25 and the Figure 45 presents the specific process to tailor gamified VLEs to the Daredevils' gamer type. The process is organized in three different steps, the first being the general structure that must be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the different kind of educational activities to be solved individually. The second step is to provide a ranking, leaderboard and progress bar, according to the student's results in each mission. Finally, the last step of the process is to provide an adapted background history according to the student's gender.

Table 25 - Tailoring Process for the Daredevil Gamer Type

Gamer Type	Persuasive Strategies	Steps
Daredevil	Simulation	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to be solved individually
		2. Provide ranking, leaderboard and a progress bar, according to the student's result in each mission
		3. Provide background history according to student's gender

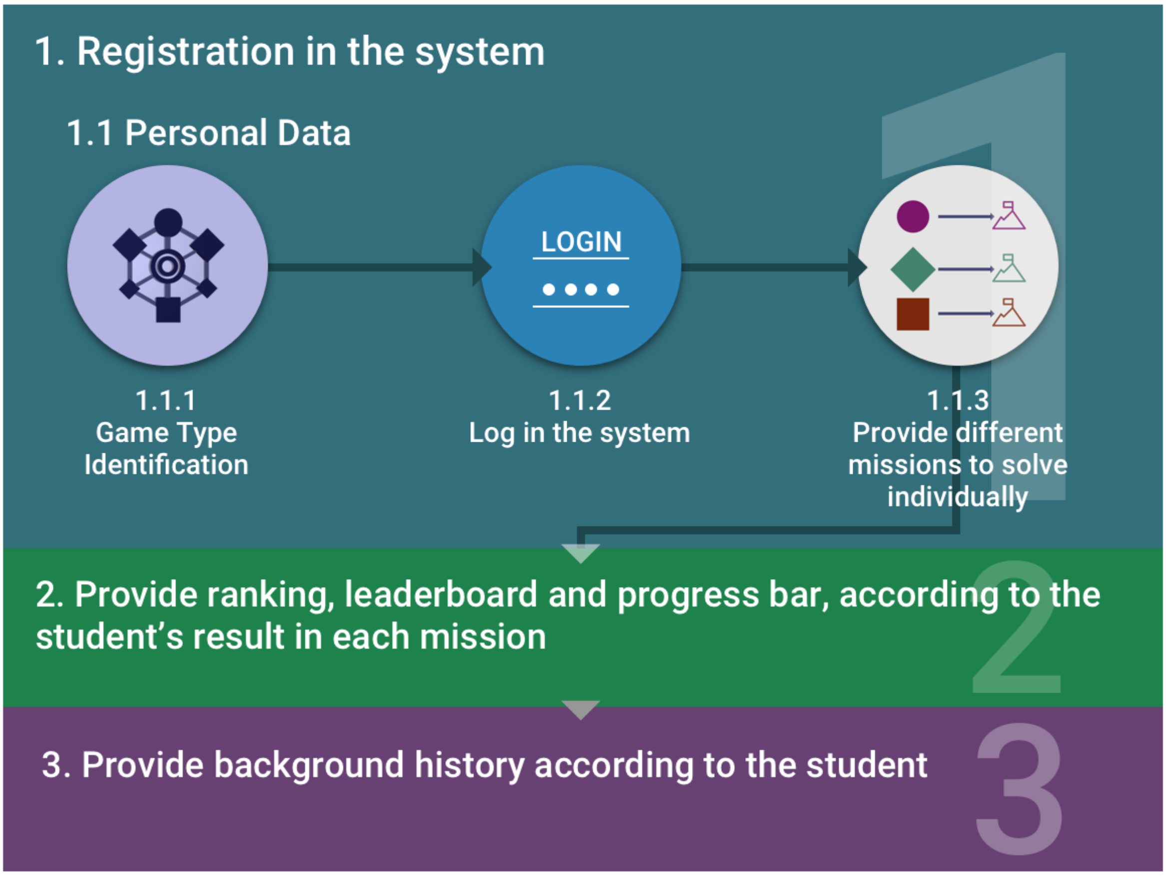


Figure 45 - Process to Tailoring Gamified Educational Systems for the Daredevils

4.2.4. Tailoring the Mastermind Gamer Type

According to the Orji' guideline, the mastermind is a gamer type motivated by different game design elements. They have interest in showing and sharing their achievements with their colleagues and monitoring their performance gradually, according to their activities on the system and winning different prizes, such as points and badges. They prefer to receive: *i*) an adapted history on the system, *ii*) view rankings with their achievements and positioning in comparison with the other users, *iii*) monitoring their activities and achievements sequences, and *iv*) earn points and badges for their activities. Based on Orji' guideline in this study, the self-monitoring-suggestion and competition – comparison PT strategies were used to tailor gamified VLEs for the mastermind gamer type.

For this gamer type, the system must provide different educational activities to be solved individually, related to an adapted history during their activities on the system. These activities must provide points, badges, and rankings according to the individual achievements. This personalization must occur because the PT strategies used to motivate this gamer type (self-monitoring-suggestion and competition -comparison- personalization) use game mechanics such as progress bar, points, and badges, using the player's ranking to force them to compare and therefore compete with one another.

The process of tailoring gamified VLEs for the mastermind gamer type developed and evaluated in this study considers the structure presented in Table 22. Figure 46 shows a high-level use case of the mastermind gamer type using the point of view of the mastermind student, and Figure 47 shows an use case based on the tailored system.

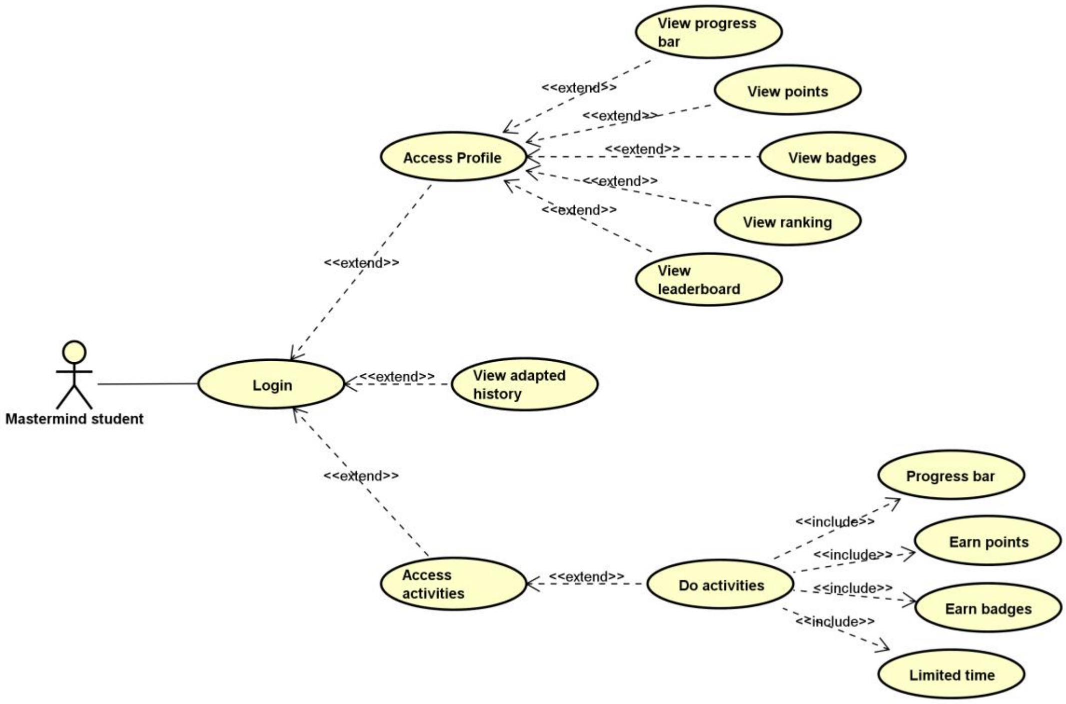


Figure 46 - Mastermind Tailored System Use Case (Student Actor)

After the mastermind student logs into the system, he can access the available educational activities and perform these activities, without any influence of the proposed structure. These activities can be provided with a time limit and generate points and badges. The student can follow his progress and performance through a progress bar. The student can also access their profile and see the ranking with their position, seeing a comparison between him and his colleagues with a similar position. The profile also must provide a general progress bar of their activities on the system.

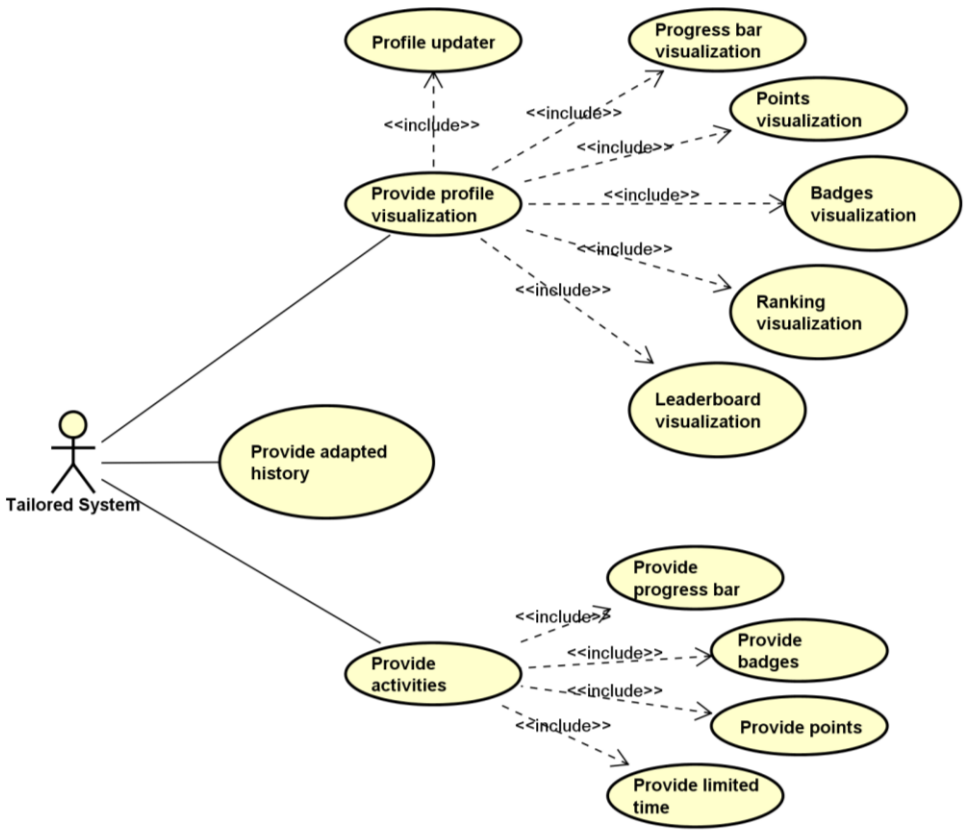


Figure 47 - Mastermind Tailored System Use Case (System Actor)

In this overview of the system, as exhibited in the Figure 47 above, the system provides the default educational activities for the students and an adapted history to each student. The system also provides to the students the option to see their progress on the profile, as well as their points, badges, and ranking, including their position with a comparison between themselves and their colleagues with a similar position.

Next, the Table 26 and the Figure 48 presents the specific process to tailor gamified VLEs for the mastermind gamer type. The process is organized in three different steps, with the first step being the general structure that must be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the different educational activities to be solved individually. The second step is to provide points, badges, progress bar, ranking, and leaderboards according to the students' results in each mission. Finally, the last step of the process is to provide a time limit and adapted background history according to the student's gender.

Table 26 - Tailoring Process for the Mastermind Gamer Type

Gamer Type	Persuasive Strategies	Steps
Mastermind	Self-monitoring and suggestion, competition, comparison and personalization	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to solve individually
		2. Provide points, badges, progress bar, ranking, and leaderboards according to the student's results in each mission
		3. Provide a time limit and adapted background history according to the student's gender

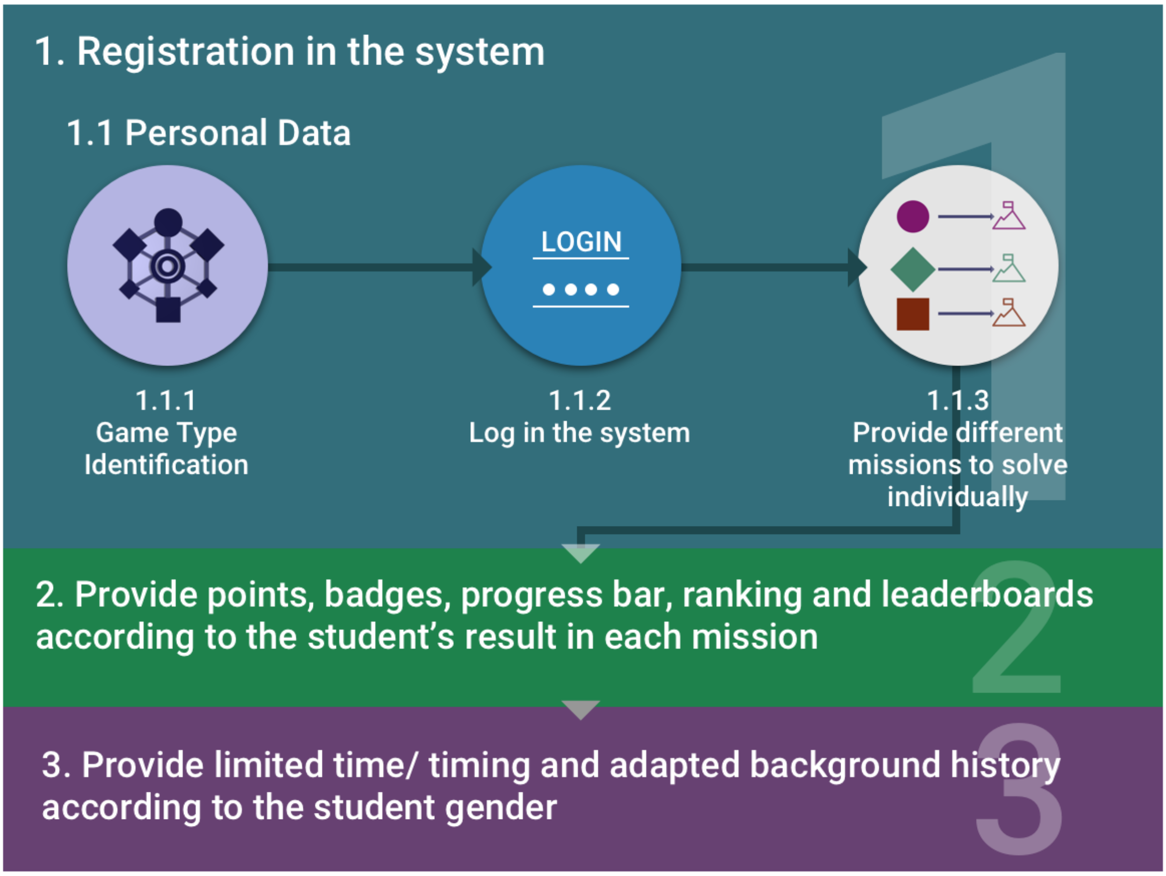


Figure 48 - Process to Tailoring Gamified Educational Systems for the Mastermind Gamer Type

4.2.5. Tailoring the Seeker Gamer Type

The seekers, according to the Orji' guideline, are more motivated by the opportunity to choose their prizes, such as receiving different options of badges or trophies to choose. This gamer type is motivated when comparing their prizes with their colleagues. They are also interested in following an adapted history. They prefer to receive: *i*) an adapted history on the system; *ii*) rankings with their achievements and position in comparison with the other users, and *iii*) choose their prizes during the game or when they're using the system. Based on Orji' guideline, the PT strategies customization-personalization and competition-comparison were used to tailor gamified VLEs to seeker's gamer types.

For this gamer type, the system must provide different educational activities to be solved individually, related to an adapted history during their activities on the system. These activities must provide a different set of prizes (*i.e*. badges and trophies), according to their individual achievements and preferences, and a ranking with leaderboards. This personalization must occur because the PT strategies used to motivate this gamer type (customization-personalization and competition-comparison) use game mechanics such as adapted history, ranking, and different prizes to be chosen by the student.

The process of tailoring gamified VLEs for seekers that was developed and evaluated inside this work also considers the structure presented in Table 22. Figure 49 shows a high-level use case of the seeker gamer type, from the point of view of the seeker student, and Figure 50 shows an use case with a point of view based on the tailored system.

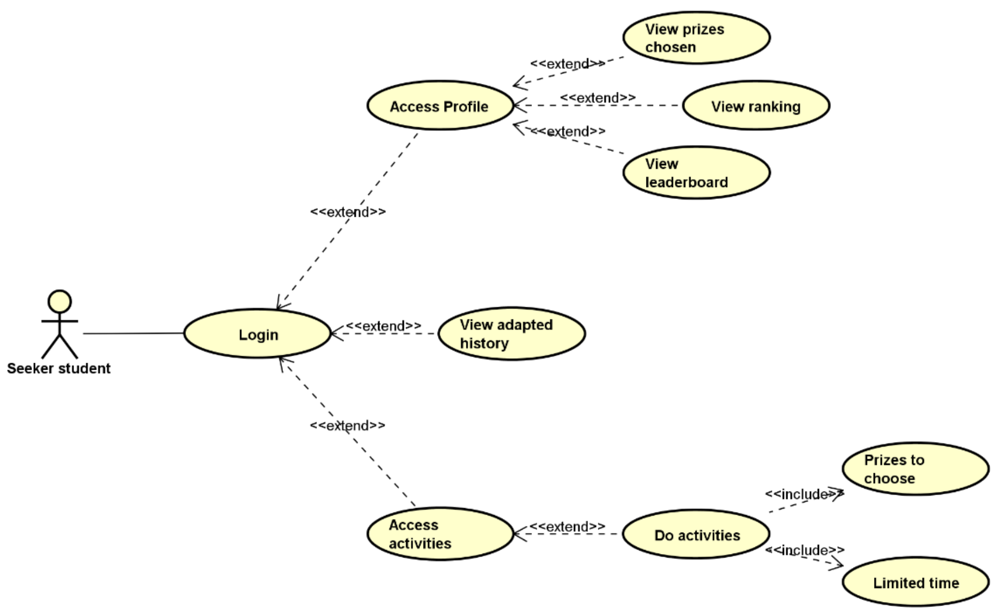


Figure 49 - Seeker Tailored System Use Case (Student Actor)

After the seeker student logs into the system, he can access the educational activities available and perform these activities, without any influence of the proposed structure. These activities can generate points (only used to calculate the ranking). They also should receive an adapted history, access their profile to see the ranking with their position and see a comparison between them and their colleagues with a similar position.

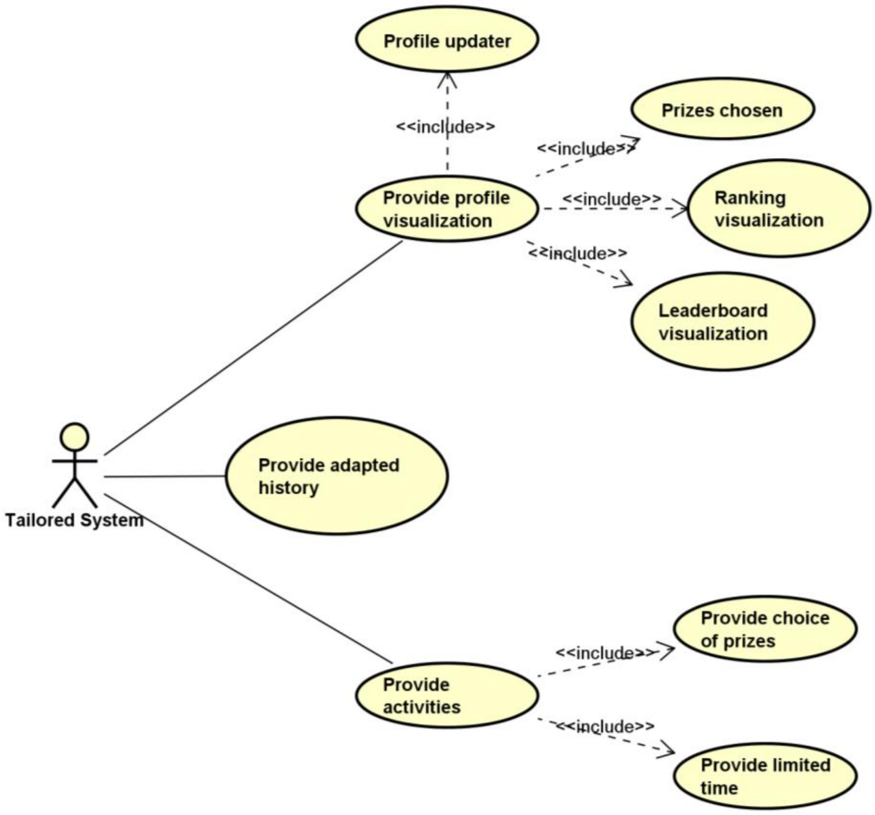


Figure 50 - Seeker Tailored System Use Case (System Actor)

In this overview of the system, as displayed in the Figure 50 above, the system provides the default educational activities for the students and an adapted history to each student. The system also provides to the students the option to see a ranking including their position with a comparison between themselves and their colleagues with a similar position, as well as the possibility of choosing the prizes throughout their activities.

Next, the Table 27 and the Figure 51 present the specific process to tailor gamified VLEs to the seeker gamer type. The process is organized in four different steps, the first step being the general structure that should be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the different educational activities to be solved individually. The second step is to provide a ranking and leaderboards according to the student's result in each activity. In the third step, the system must provide the opportunity for the students to choose their prizes. Finally, the last step of the process is to provide a time limit and an adapted background history according to the student's gender.

Table 27 - Tailoring Process for the Seeker Gamer Type

Gamer Type	Persuasive Strategies	Steps
Seeker	Customization, personalization and competition and comparison	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to solve individually
		2. Provide a ranking and leaderboards according to the students' results in each mission
		3. Provide the opportunity for the students to choose their prizes
		4. Provide a time limit and an adapted background history according to the student's gender

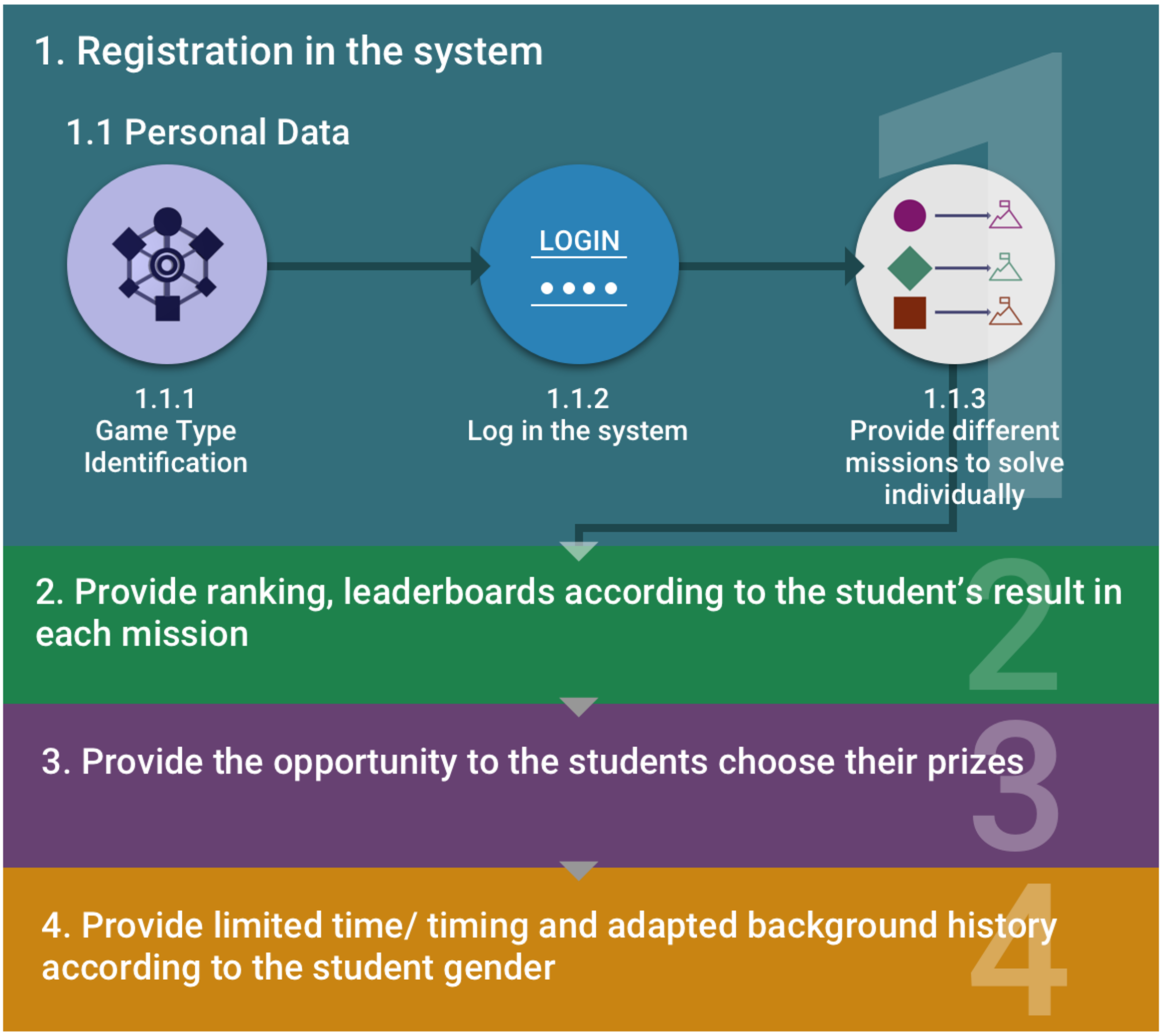


Figure 51 - Process to Tailor Gamified Educational Systems for the Seekers

4.2.6. Tailoring the Socializer Gamer Type

According to the Orji's guideline, socializers are more interested in showing their performance to other people and to share their achievements, as well as comparing their results with other colleagues. They prefer to receive: *i*) rankings with their points and positions in comparison with the other users; and *ii*) they are better stimulated if they receive a direct comparison with their colleagues that have a similar number of points and positions. Based on the Orji' guideline, the PT strategy competition and comparison was used to tailor gamified VLEs for the socializer gamer type.

For this specific gamer type, the system must provide different educational activities to be solved individually, and these activities must provide rankings according to the individual study points. This personalization must occur because the socializer gamer type is motivated by the PT strategies cooperation-competition-comparison. Competition and comparison use the game mechanics status and the player's ranking to force them to compare and therefore compete with each other, and when the student see the other players' achievements he will strive to reach their status, therefore increasing competition and comparison.

The PT strategy competition and comparison also use the game mechanics countdown and leaderboard, that provide a time limit for the student to complete their challenges, and displaying high scores in the leaderboards will increase competition and comparison. So, it is a good strategy to provide an individual comparison of players with a similar number of points, such as, using a specific type of raking, and providing a time limit for the students to complete some activities. The process of tailoring gamified VLEs for the socializer gamer type developed and evaluated in this study also considers the structure presented in Table 22. Figure 52 shows a high-level use case of the socializer gamer type, from the point of view of the Socializer student, and Figure 53 shows the use case from the tailored system point of view.

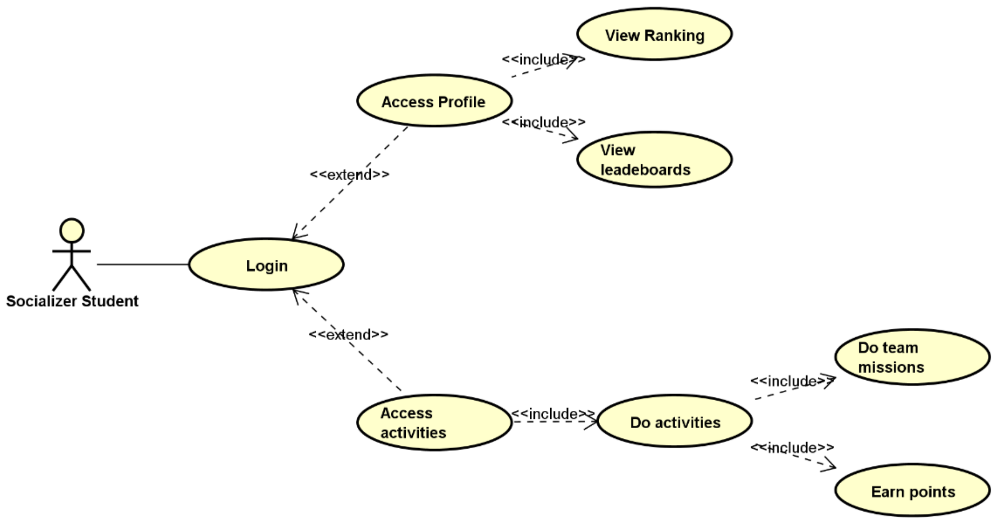


Figure 52 - Socializer Tailored System Use Case (Student Actor)

The socializer student logs into the system and access its available activities to execute them. These activities do not receive any influence of the proposed structure. They will generate points for the student based on their performance in the activities. The student can also access their profile and view the ranking (based on their points) with their position, and see a comparison between him and his colleagues with a similar position.

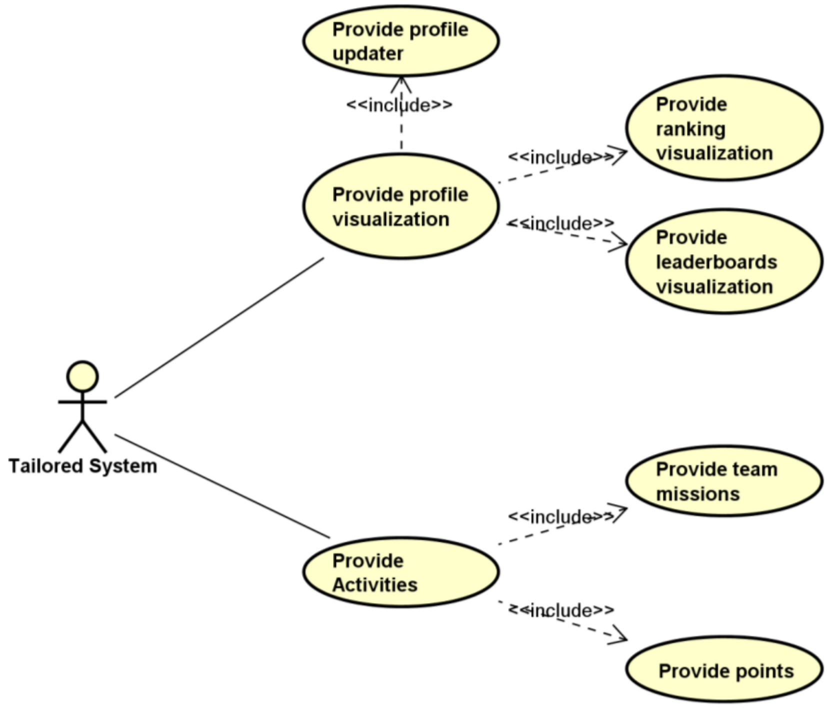


Figure 53 - Socializer Tailored System Use Case (System Actor)

In this overview of the system, as exhibited in the Figure 53 above, the system provides the default educational activities for the students, and provide points based on their performance (these points should not be displayed to the students, and must be used only with the purpose of calculating the ranking, and the other game design elements associated with this gamer type). The system provides to the students the option to see their ranking, including their positions, as well as comparisons between them and their colleagues with a similar position.

Next, the Table 28 and the Figure 54 present the specific process to tailor gamified VLEs for the socializer gamer type. The process is organized in three different steps, with the first being the general structure that must be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the type of activities provided, with the different missions to be solved individually and/or collaboratively. The second step is to provide a ranking and leaderboards according to the student's result in each mission. In the third step, the system should provide the opportunity for the students to choose their prizes. Finally, the last step of the process is to provide a time limit for the students to conduct their activities.

Table 28 - Tailoring Process for the Socializer Gamer Type

Gamer Type	**Persuasive strategy**	**Steps**
Socializer	Cooperation, competition and comparison	1. Registration in the system
		1.2. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to be solved individually and/or collaboratively
		2. Provide rankings and leaderboards according to the individual points
		3. Provide a time limit for the students to conduct their activities

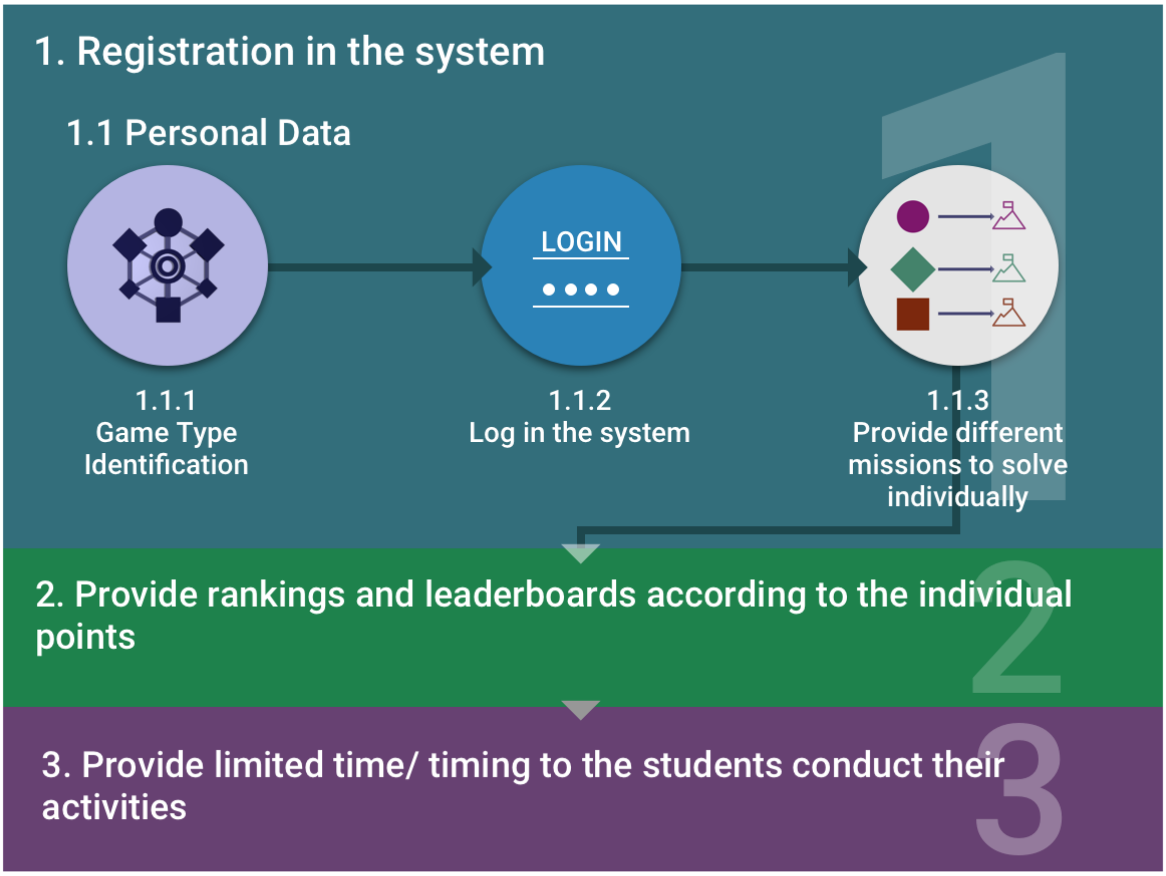


Figure 54 - Process to Tailoring Gamified Educational Systems for the Socializer Gamer Type

4.2.7. Tailoring the Survivor Gamer Type

Survivors are more interested in following and showing their performance to other people, sharing and comparing their achievements and results with their colleagues. They prefer to receive: *i*) points and a progress bar to follow their progress; *ii*) they are better stimulated if they receive a ranking with leaderboards to compare their performance with their colleagues; and *iii*) they are also motivated if the system provides a time limit to conduct the activities/tasks. Based on Orji' guideline, the PT strategies self-monitoring-suggestion and competition-comparison were used to tailor gamified VLEs for the survivor gamer type.

For this specific gamer type, the system must provide different missions to be solved individually, with these activities providing rankings according to the individual study points.

This personalization occurs because the survivor gamer type is motivated by the PT strategies self-monitoring-suggestion and competition-comparison, using the game mechanics status and the player's ranking to force them to compare and therefore compete.

The PT strategy competition and comparison also use the game mechanics countdown and leaderboard, that provide a limited amount of time for the student to complete the challenge, and displaying high scores in leaderboards will increase competition and comparison. Therefore, it is a good strategy to provide an individual comparison of players with a similar number of points, such as, using a specific type of raking and providing a time limit for the students to complete some activities. The process of tailoring gamified VLEs for survivors, developed and evaluated on *MeuTutor*®, considers the structure presented in Table 22. Figure 55 shows a high-level use case of the socializer gamer type, from the point of view of the Socializer student, and Figure 56 shows the use case from the point view of the tailored system.

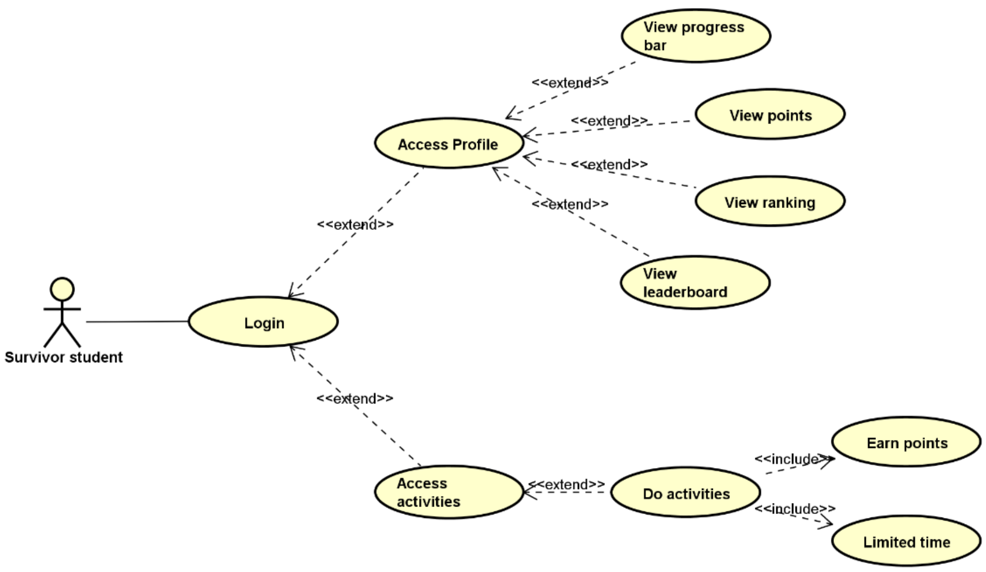


Figure 55 - Survivor Tailored System Use Case (Student Actor)

The survivor student logs into the system and access its available educational activities to execute them. These activities do not receive any influence of the proposed structure. They will generate points for the student based on their performance in the activities (with a time limit). The student can also access their profile and view the ranking with leaderboards showing his position, as well as his points and a process bar.

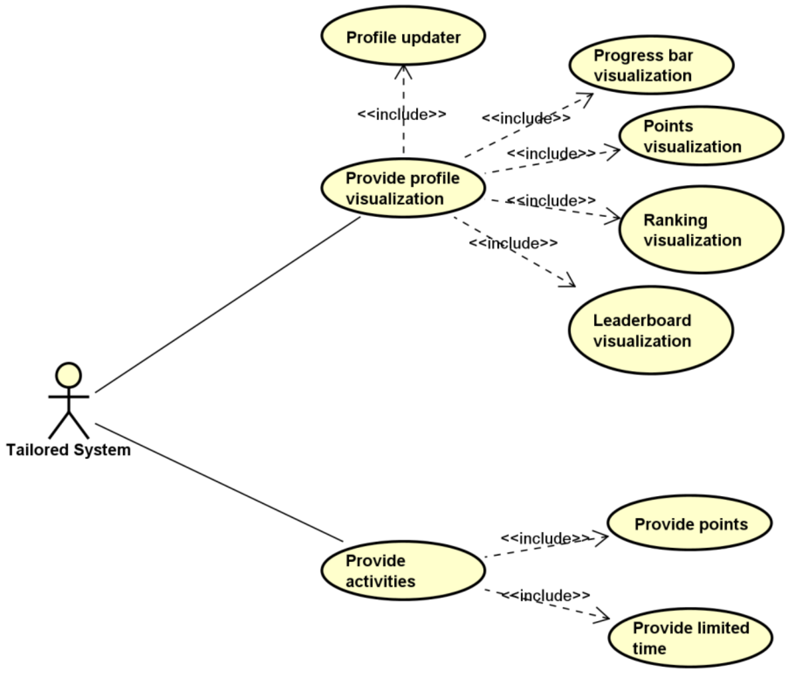


Figure 56 - Survivor Tailored System Use Case (System Actor)

In this overview of the system as an author, as exhibited in the Figure 56 above, we observe the default educational activities provided for the students (with a time limit), with the points given being based on the student's performance. The system provides the option to display a progress bar and ranking with the student's position, as well as a comparison between the student and their colleagues with a similar position.

Next, the Table 29 and the Figure 57 present the specific process to tailor gamified VLEs for the survivor gamer type. The process is organized in three different steps, with the first being the general structure that should be provided by the system (Registration in the system, Personal data, Gamer Type identification, and Login into the system), and the type of different missions to be solved individually and/or collaboratively. The second step is to provide points, progress bar, ranking, and leaderboards, according to the student's results in each mission. Finally, the last step of the process is to provide a time limit fpr the students to conduct their activities.

Table 29 - Tailoring Process for the Survivor Gamer Type

Gamer Type	Persuasive Strategies	Steps
Survivor	Self-monitoring-suggestion and competition - comparison	1. Registration in the system
		1.1. Personal data
		1.1.1. Gamer Type identification
		1.1.2. Login into the system
		1.1.3. Provide different educational activities to be solved individually
		2. Provide points, progress bar, ranking, and leaderboards according to the student's results in each mission
		3. Provide a time limit for the students to conduct their activities

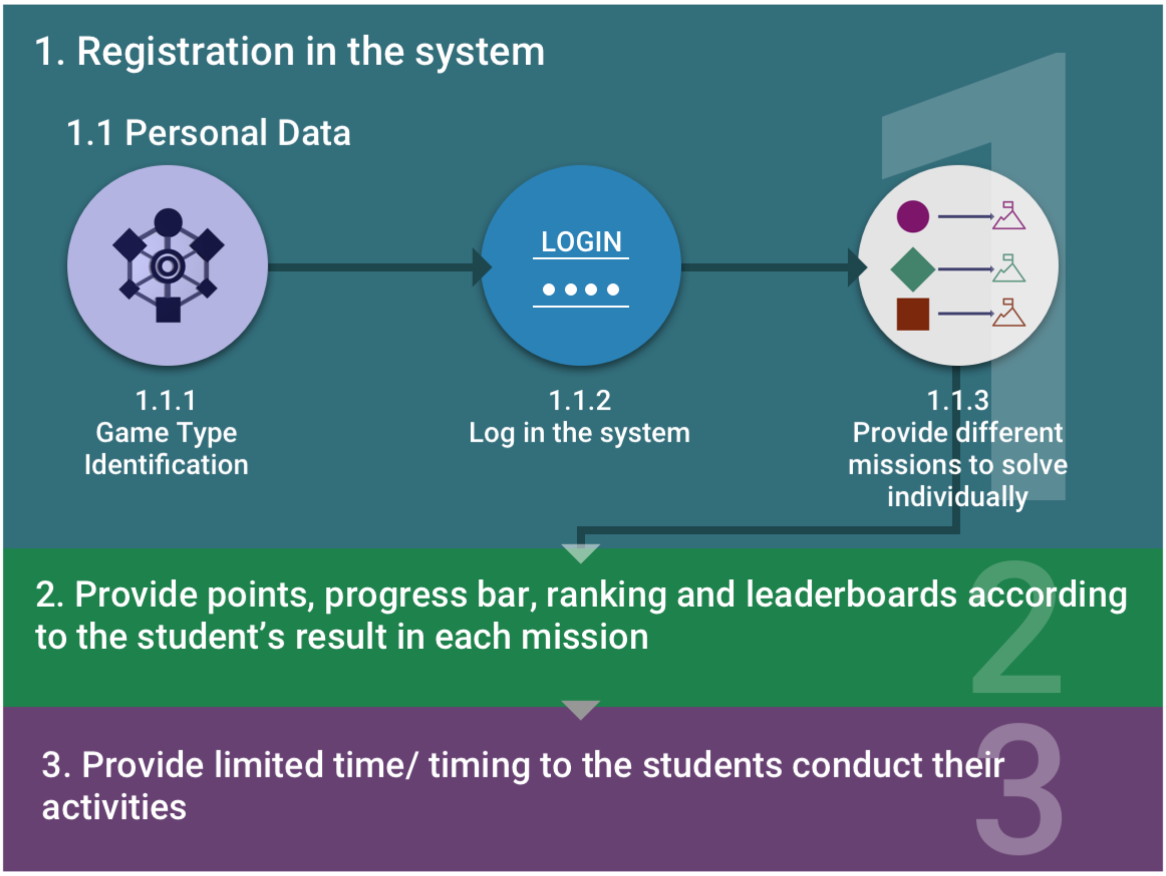


Figure 57 - Process to Tailor Gamified Educational Systems to Survivors

4.3. Implementation

The tailoring process and architectural design for gamified VLEs based on gamer types was implemented in a Brazilian gamified VLE called *MeuTutor*® (see section *MeuTutor*® for a detailed view of the system). The system was chosen after a comparative analysis among nine different VLEs (see section Virtual Learning Environments for more details). *MeuTutor*® was of interest for this study because it was considered more geographically acessible, as well as implementing the nine most used gamification elements in gamified VLE, as identified by Nah *et al*. (2014) (see section Gamification for a comprehensive review about this), avoiding some validity threats. The complete process to tailor the system followed the proposed process in this study, starting with the students' gamer type identification, continuing with the selection of gamification elements, and finishing with different versions of the system, with the specific gamification elements to each gamer type.

4.3.1. The *MeuTutor*® System

MeuTutor® is a Brazilian gamified Virtual Learning Environment, developed to provide for the professors an environment capable of developing and sharing different learning materials, such as: video, hypertext, questionnaires, evaluations and others, as well as providing activities with gamification elements, with the objective to provide a ludic and motivational learning process. *MeuTutor*®, according to Paiva *et al*. (2015), aims to offer personalized support to each student.

MeuTutor® provides a series of gamification elements chose to be used (counter-tailored version), according to a series of studies related to gamification elements applied to education and its consequences for student's learning (*e.g*. Paiva *et al*. (2015 *a*), Paiva *et al*. (2015 *b*) and Challco *et al*. (2015)). The main gamification elements used in *MeuTutor*®, as well as the description of each element, are displayed on Table **30**.

Table 30 - Gamification elements in *MeuTutor*®

Game Element	Description
1- Points (XP)	*MeuTutor*® provides to the students Experience Points (XP) according to their participation in the activities proposed by the system, with each activity executed by the students (*e.g*. view a video or response a question) generating points to them.
2- Levels/Stages	*MeuTutor*® provides to the students a series of levels/stages according to the chosen course and topics defined by the professor. Initially, the student has only the first

	levels/stages "opened" and the next levels/stage will be released according to their performance.
3- Badges	*MeuTutor*® provides different badges to the students through their experience into the systems, with these badges being provided when the students complete an proposed activity, such as, watching a series of videos and responding correctly a questionnaire about a determined topic, among others.
4- Leaderboards	*MeuTutor*® provides to the students a leaderboard with their amount of points and place in the systems, as well as the number of points and place of their main "opponents".
5- Trophies	*MeuTutor*® provides to the students prizes and rewards at each completed level/stage.
6- Progress bars	*MeuTutor*® provides to the students a progress bar according to their performance in the system. The progress bar increases with each activity completed by the student.
7- Timeline/Storyline	*MeuTutor*® provides to the students a storyline in the form of a calendar, so the student can see their evolution in the system, from their first activities until their current stage.
8- Feedback	*MeuTutor*® provides to the students a feedback according to their performance in each activity. In this sense, for each activity where the student makes a mistake, he will receive a feedback with an explanation about the related question.
9- Ranking and leaderboards	*MeuTutor*® provides a ranking with leaderboards based on the students' performance in the system.
10- Background history	*MeuTutor*® provides five different background histories to be chosen in the students' first access in the system.
11- Avatar	*MeuTutor*® provides five different avatars associated with each background histories before they're addressed.

4.3.2. Tailoring the System *MeuTutor*®

The tailoring was done in terms of graphical interface, changing the gamification design model (game design elements), according to the students' gamer type, and based on the process and architectural design proposed in this study. To identify the student's gamer type it was attached the *BrainHex* questionnaire into the system. After the students answer the *BrainHex* questionnaire, they also receive immediately their gamer type, with some information about it (according to the *BrainHex* study). The students were asked if they agree or not with their gamer type, like the original *BrainHex* questionnaire.

It was used the PHP programming languages (originally stooding for Personal Home Page, but it now stands for the recursive acronym PHP: Hypertext Preprocessor), HTML (HyperText Markup Language), standard markup language for creating web pages and web applications, and CSS (Cascading Style Sheets), the style sheet language used for describing the presentation of a document written in a markup language. To test the tailoring process, it was used a local server named XAMPP, a free and open source web server with a cross-platform solution stack package.

The original system (with default game design elements) is composed of six different screens: (*i*) the chosen avatar and history, (*ii*) homepage, (*iii*) tree of activities, (*iv*) individual activity, (*v*) exercise, and (*vi*) student's profile. In the first moment (first access on the system), the student can choose his avatar (among five different options), and a history associated with the avatar (Figure 58 presents this screen). In the second moment, after choosing the avatar, the student access the system homepage, and in this screen the student can access his courses or see his profile. This screen presents the game design elements points, trophies, ranking, progress bar and timeline (Figure 59 presents this screen).

In the third screen, the student can access the tree of activities with the available activities. This screen presents the game design element progress bar (see Figure 60). After choosing a specific activity, in the fourth screen the student has access to the activity, like, for instance: watching a video, answering a questionnaire, among others. This screen presents the gamification elements progress bar and badges (see Figure 61). Next, the student can access a specific exercise related to the topic before chosen it (Figure 62). Finally, in the sixth screen, the student accesses his profile and has the option to change his profile picture, nickname, etc. This screen organizes the game design elements: level (with progress bar), ranking (with leaderboards) and trophies (Figure 63).

To organize the system operation, we will see below the screens sequence before the presentation.

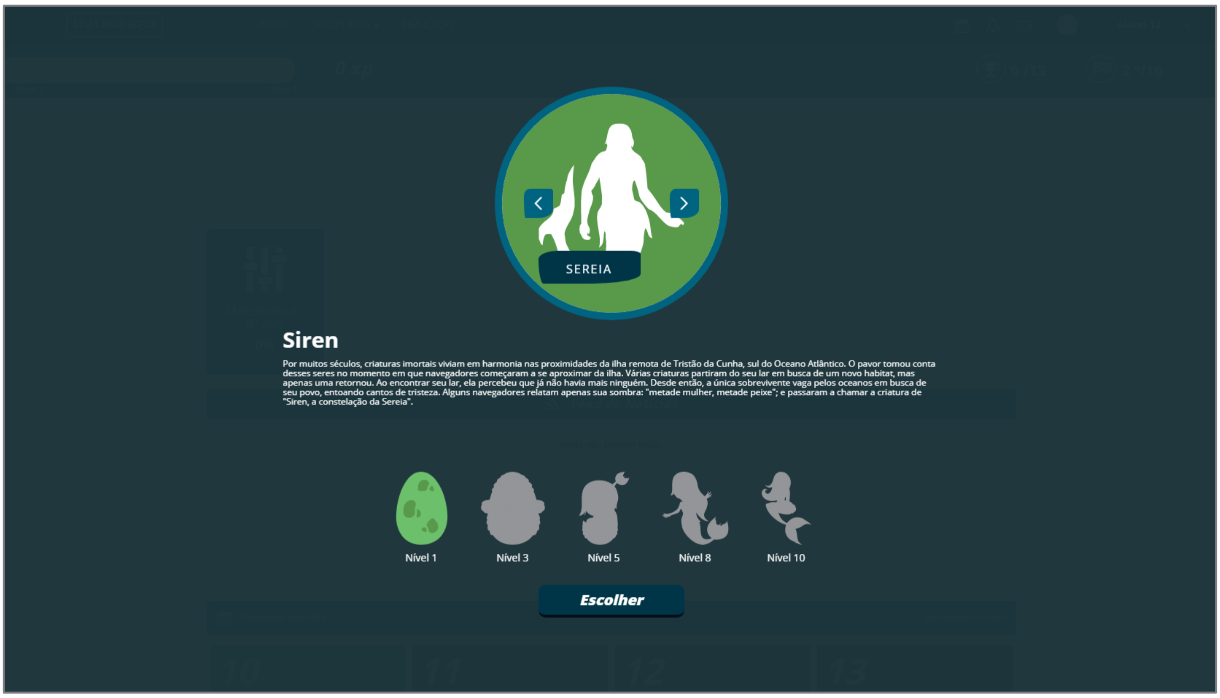


Figure 58 - General History

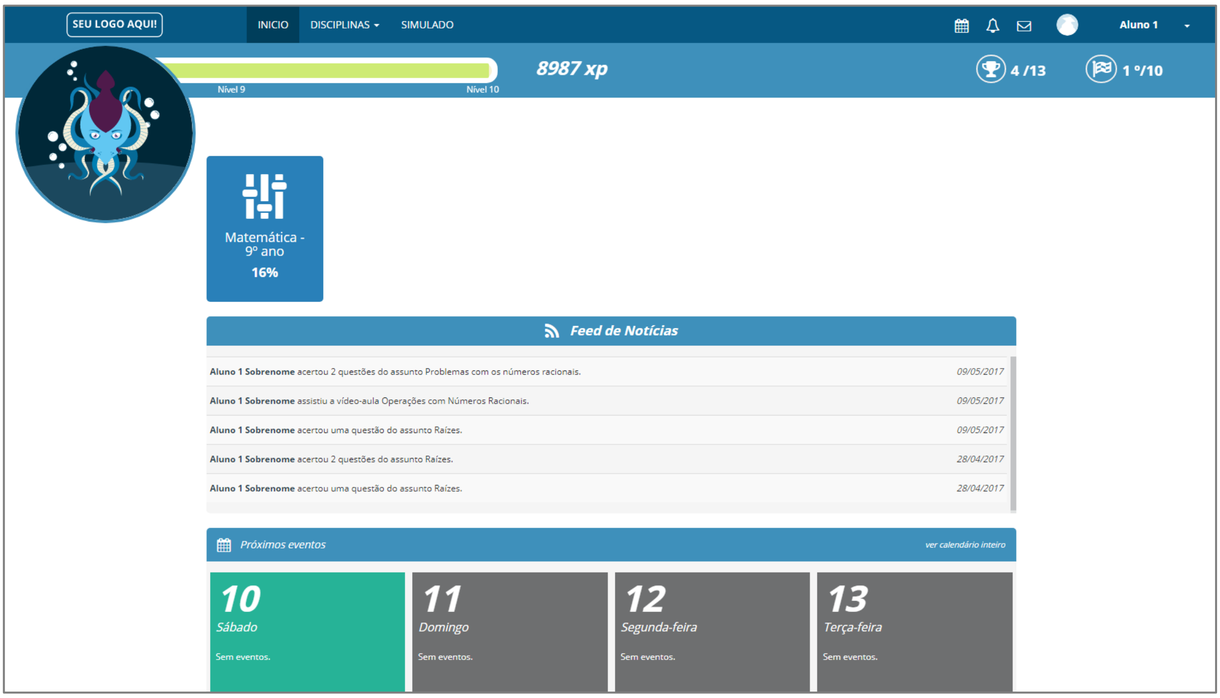


Figure 59 – *MeuTutor*® home page

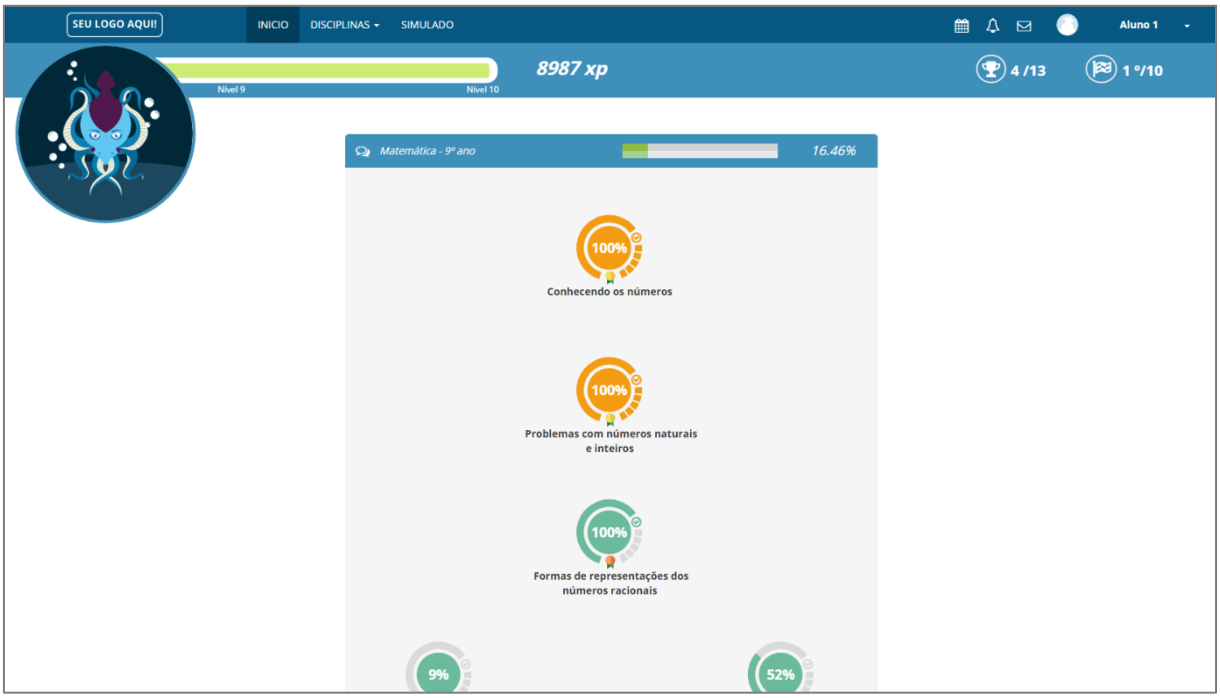


Figure 60 - Activities tree

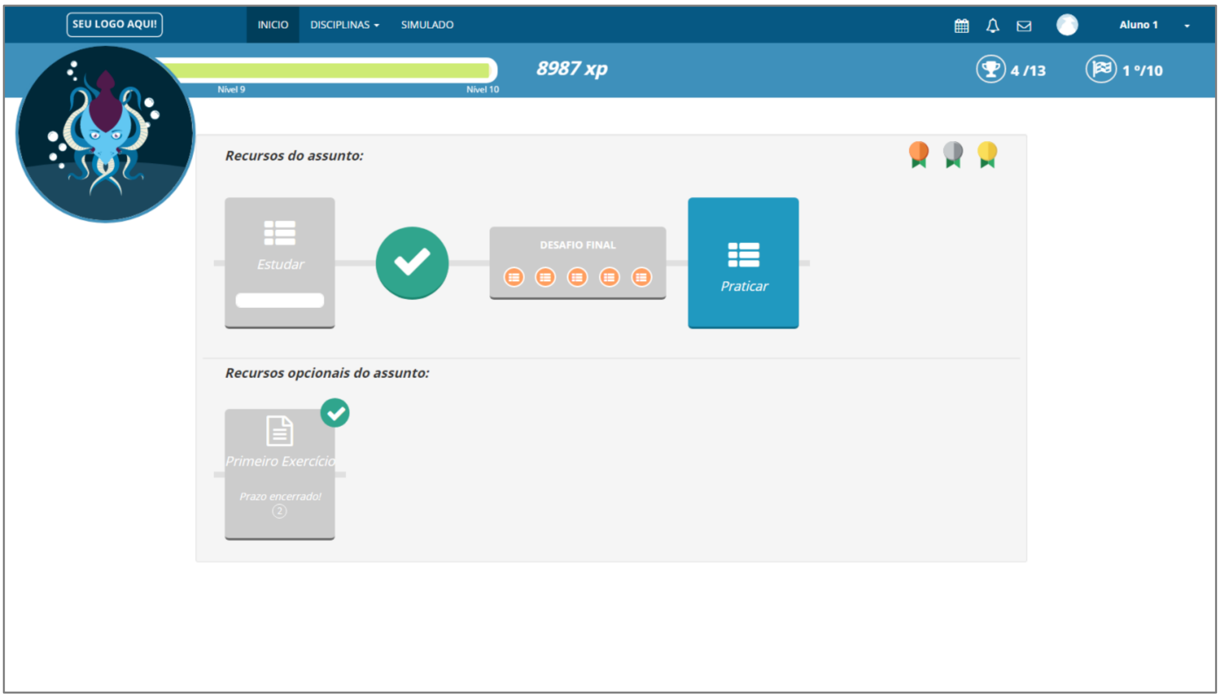


Figure 61 - List of resources

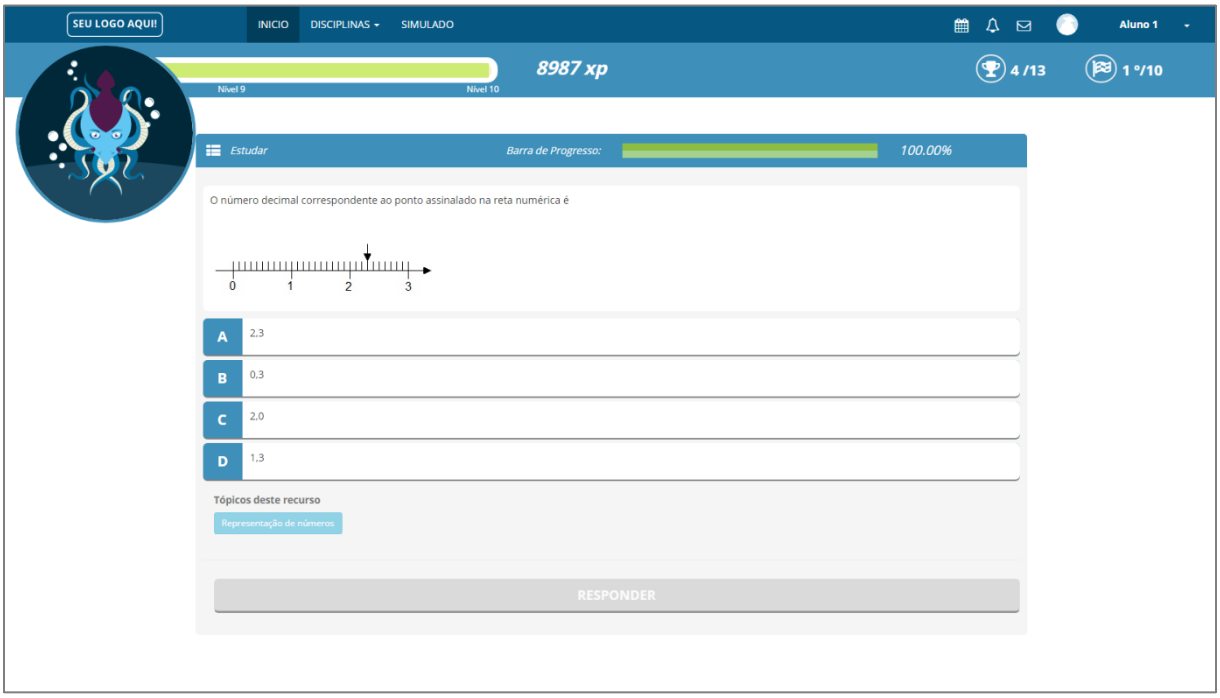


Figure 62 - Specific Resources

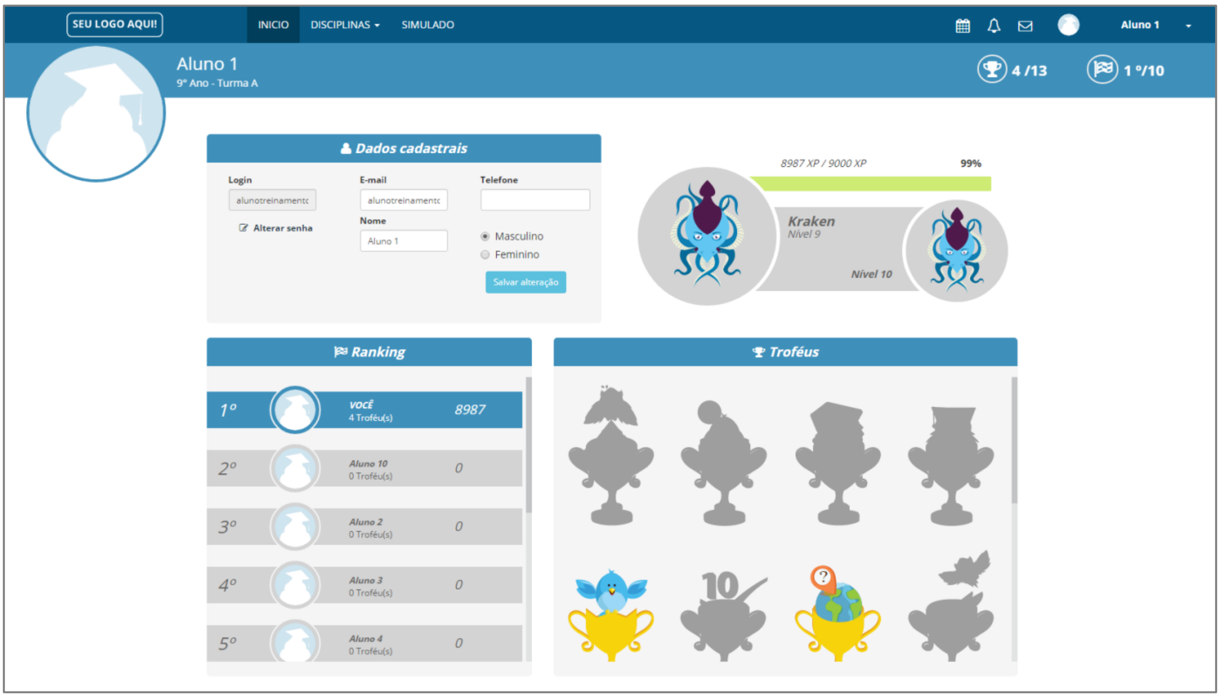


Figure 63 – Student’s profile

In the *MeuTutor* tailoring process we first associate the original system architectural design with our architectural design. This was important when we associated the gamification elements to each *BrainHex* gamer type. Second, we implemented a tailored model, taking the gamification elements provided by the system and associating these gamification elements to each student gamer type. Finally, we identified the students' gamer types using the *BrainHex* gamer type and provided the different versions of the system, with the adapted interface to each student.

4.3.2.1. Tailored System to the Achiever Students

After the tailoring process, the achiever students' interface was changed according to the proposed architectural design and process, as it follows: *i*) the history was removed from the first screen; *ii*) the progress bar, timeline, and ranking were removed from the home page; *iii*) the ranking (with leader boards), levels (with progress bar) were removed from the student's profile. On the other hand, the points and trophies were kept on the homepage, and the badges were kept on the screen of the activities. The profile kept only the trophies. The Figure 64, Figure **65** and Figure **66**, will present the main screens of the achiever students' system.

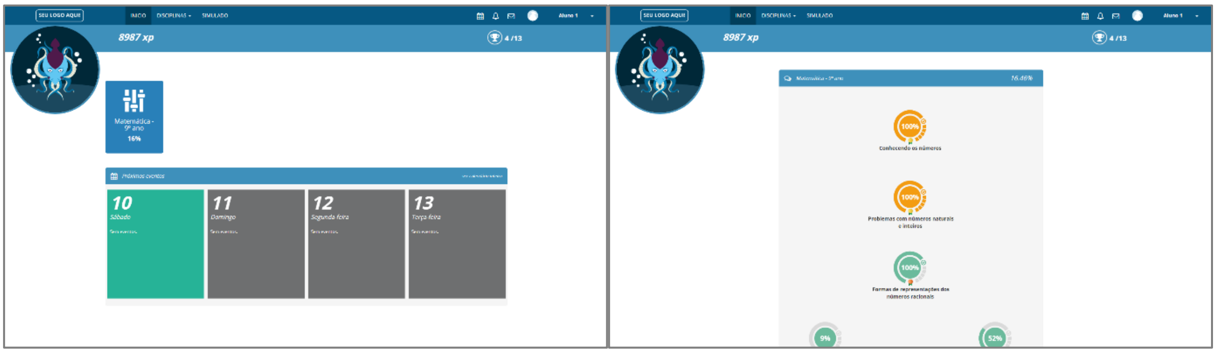


Figure 64 – Tailored homepage and tree of activities of the Achiever Gamer Type

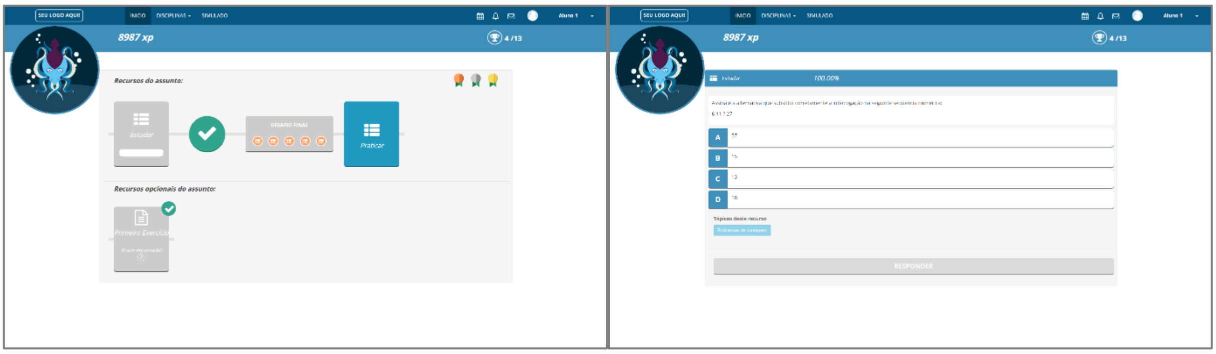


Figure 65 – Tailored resources and specific activities pages of the Achiever Gamer Type

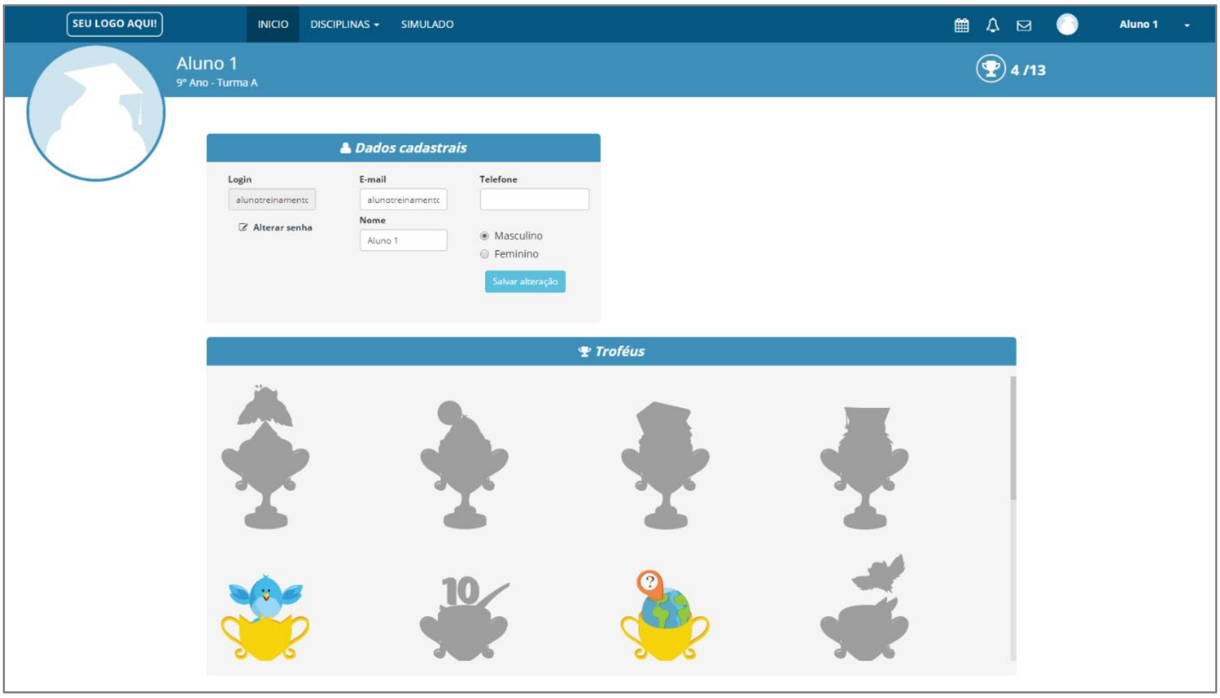


Figure 66 - Tailored profile of the Achiever Gamer Type

4.3.2.2. Tailored System of the Conqueror Students

After the tailoring process, the conqueror students' interface was changed according to the proposed architecture and process, as it follows: *i*) the progress bar, points, and trophies were removed from the homepage, and *ii*) the progress bar, levels, and trophies were removed from the profile. On the other hand, the adapted history was kept on the first access, the timeline and ranking (with leaderboards) were kept on the homepage, and the badges were also kept on the screen of activities. The profile kept only the ranking (with leaderboards). Figure 67, Figure **68** and Figure **69**, will present the main screens of the Conqueror Student's System.

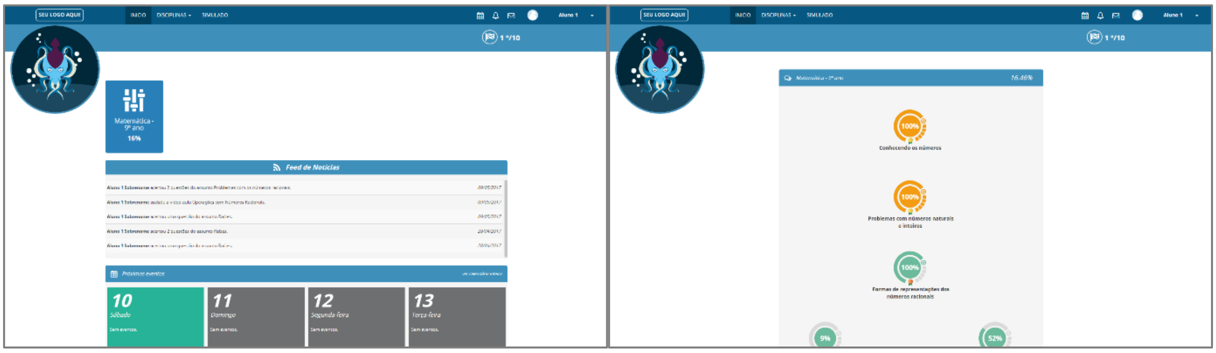


Figure 67 - Tailored homepage and tree of activities of the Conqueror Gamer Type

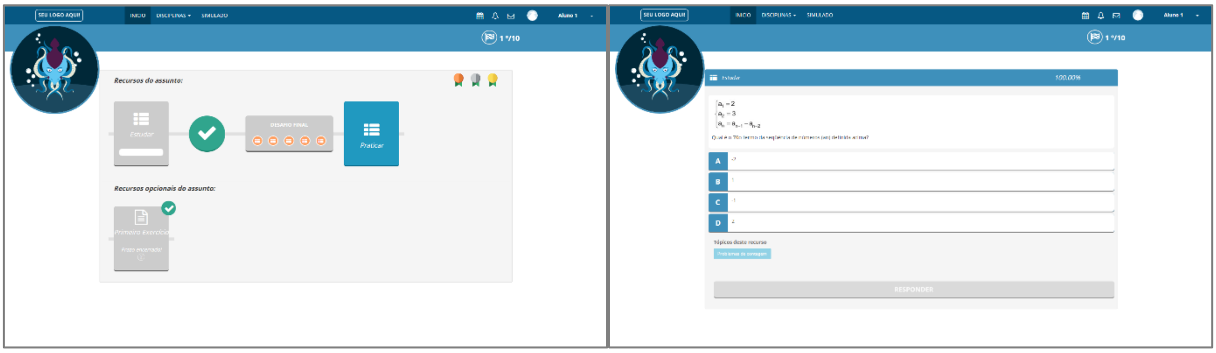


Figure 68 - Tailored resources and specific activities pages of the Conqueror Gamer Type

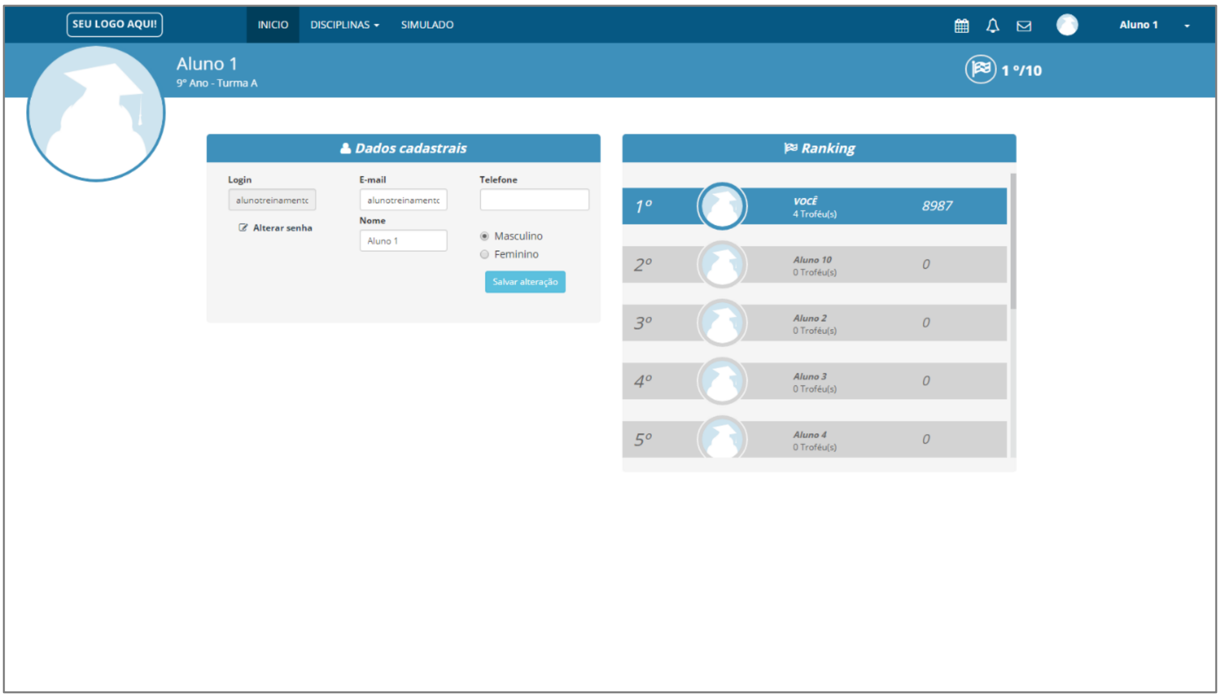


Figure 69 - Tailored profile of the Conqueror Gamer Type

4.3.2.3. Tailored System tof the Daredevil Students

After the tailoring process, the Daredevil students' interface was changed according to the proposed architectural design and process, as it follows: *i*) the points, trophies, and timeline were removed from the homepage; *ii*) badges were removed from the activities page; and *iii*) levels and trophies were also removed from the profile page. On the other hand, the adapted history was kept on the first access, and the ranking (with leaderboards) was kept on the homepage. The profile kept only the ranking (with leaderboards) and progress bar. Figure 70, Figure 71 and Figure 72, will present the main screens of the Conqueror Student's System.

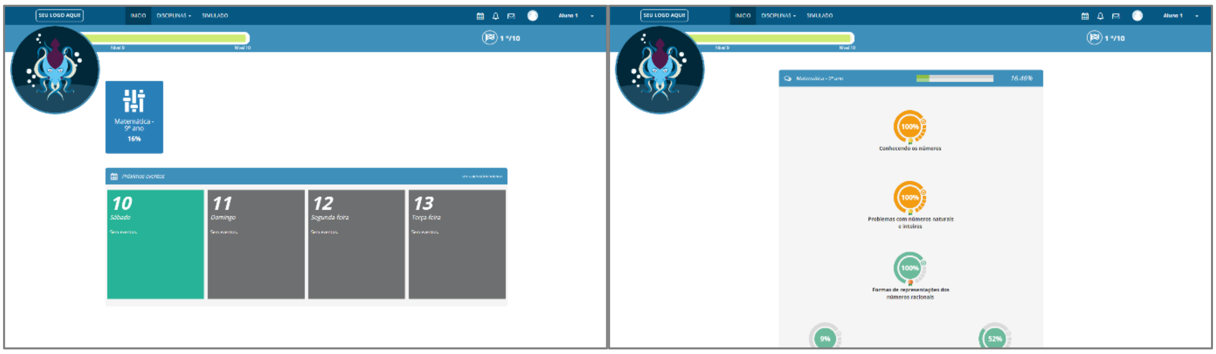


Figure 70 - Tailored homepage and tree of activities of the Daredevil Gamer Type

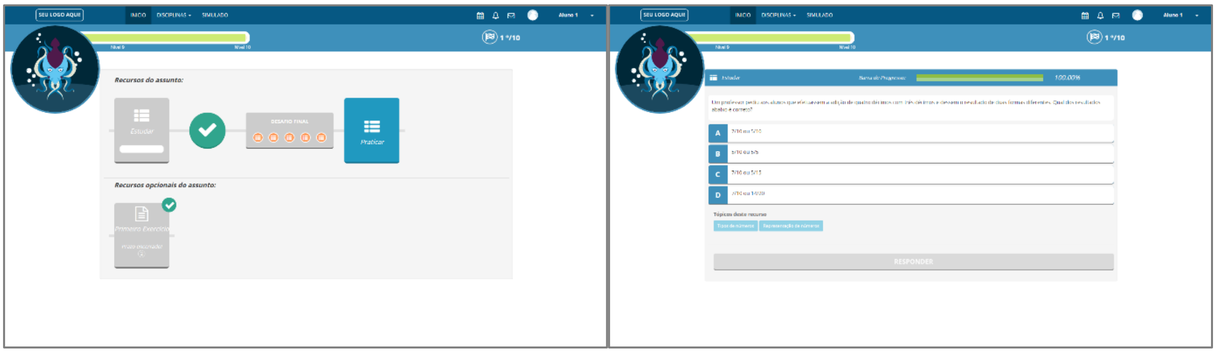


Figure 71 – Tailored resources and specific activities pages of the Daredevil Gamer Type

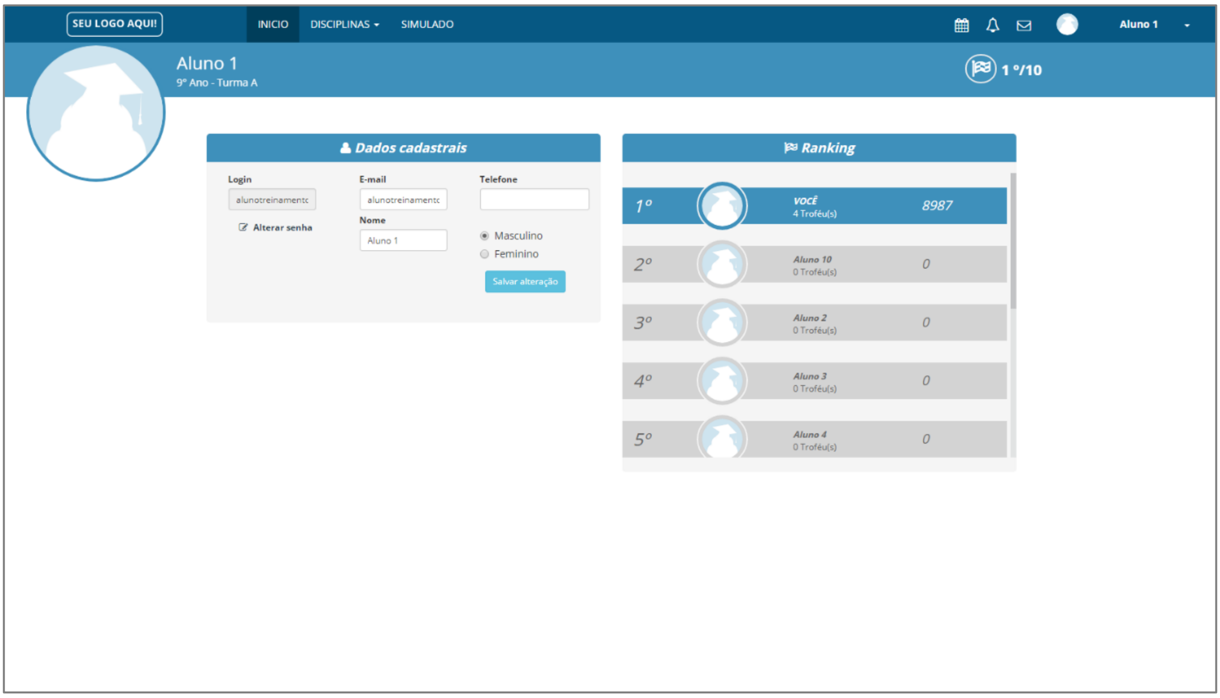


Figure 72 - Tailored profile of the Daredevil Gamer Type

4.3.2.4. Tailored System of the Mastermind Students

After the tailoring process, the Daredevil Students' Interface was changed, according to the proposed architecture and process, as it follows: *i*) trophies and timeline were removed from the homepage, and *ii*) levels and trophies were also removed from the profile page. On the other hand, the adapted history was kept on the first access; points, progress bar, and ranking (with leaderboards) were kept on the homepage, and the badges were kept on the activities page. The profile kept the ranking (with leaderboards) and progress bar. Figure **75**, Figure **76**, and Figure **77** will present the main screens of the Mastermind Students' System.

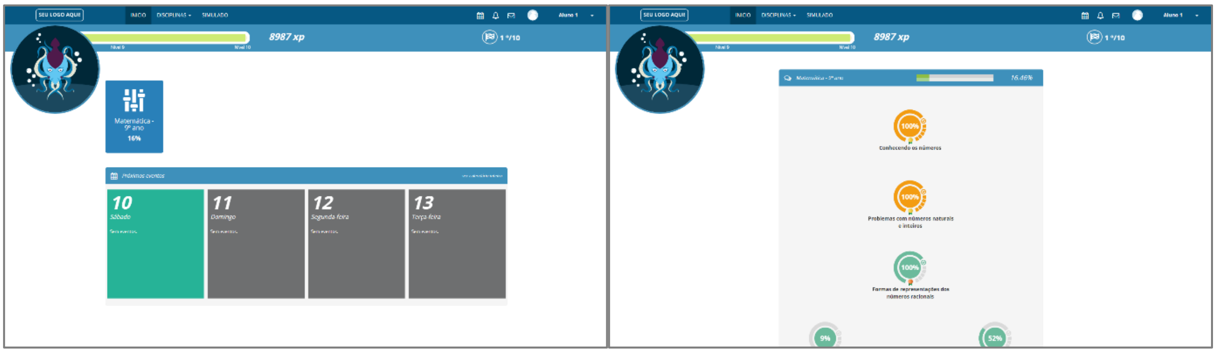


Figure 73 - Tailored homepage and tree of activities of the Mastermind Gamer Type

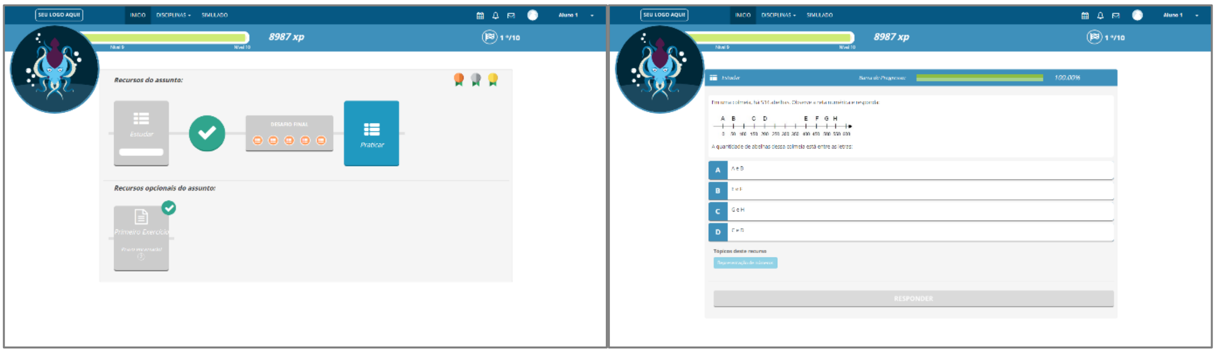


Figure 74 - Tailored resources and specific activities pages of the Mastermind Gamer Type

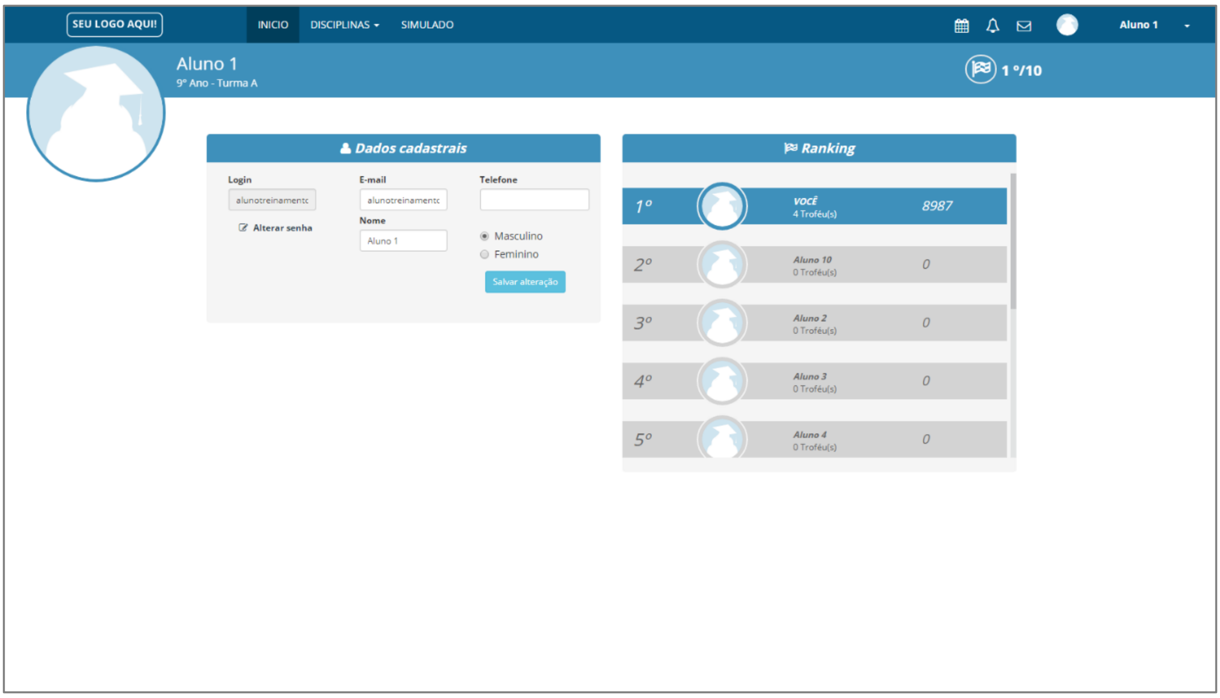


Figure 75 - Tailored profile of the Mastermind Gamer Type

4.3.2.5. Tailored System of the Seeker Students

After the tailoring process, the Seeker students' interface was changed, according to the proposed architectural design and process, as it follows: *i*) adapted history was removed from first access; *ii*) ranking with leaderboards; and *iii*) prizes to be chosen. In this case, the Seeker students must select the prizes. For instance, when the Seeker student wins a trophy, he can choose a specific trophy to his collection.

4.3.2.6. Tailored System for the Socializer Students

After the tailoring process, the Daredevil students' interface was changed, according to the proposed architectural design and process, as it follows: *i*) adapted history was removed from first access; *ii*) timeline, progress bar, points, and trophies were removed from home page; *iii*) badges were removed from activities page; and *iv*) levels, progress bar, and trophies were removed from profile page. In this profile, the system kept only the ranking with leaderboards. Figure 76, Figure **77** and Figure **78** present the main screens of Mastermind Students' System.

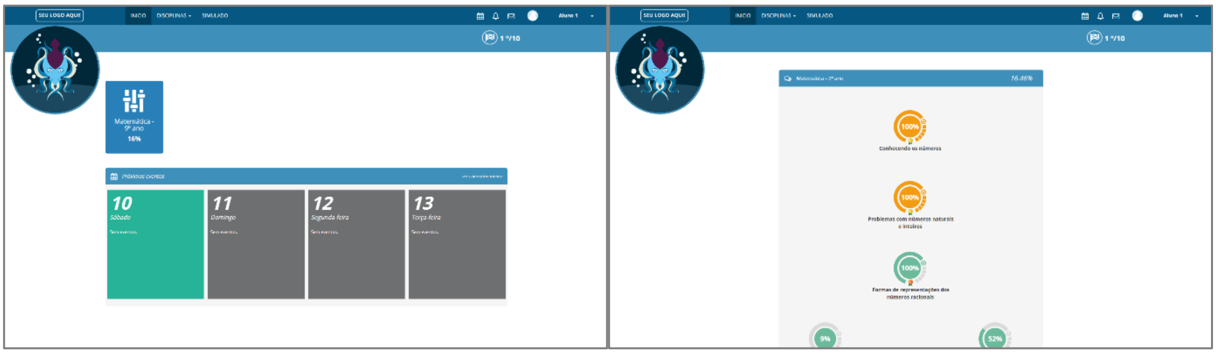


Figure 76 - Tailored homepage and tree of activities of the Socializer Gamer Type

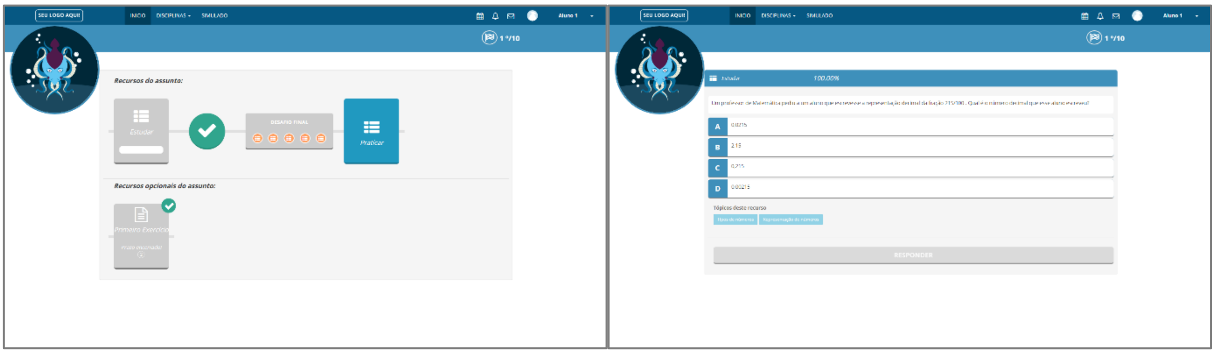


Figure 77 - Tailored resources and specific activities pages of Socializer Gamer Type

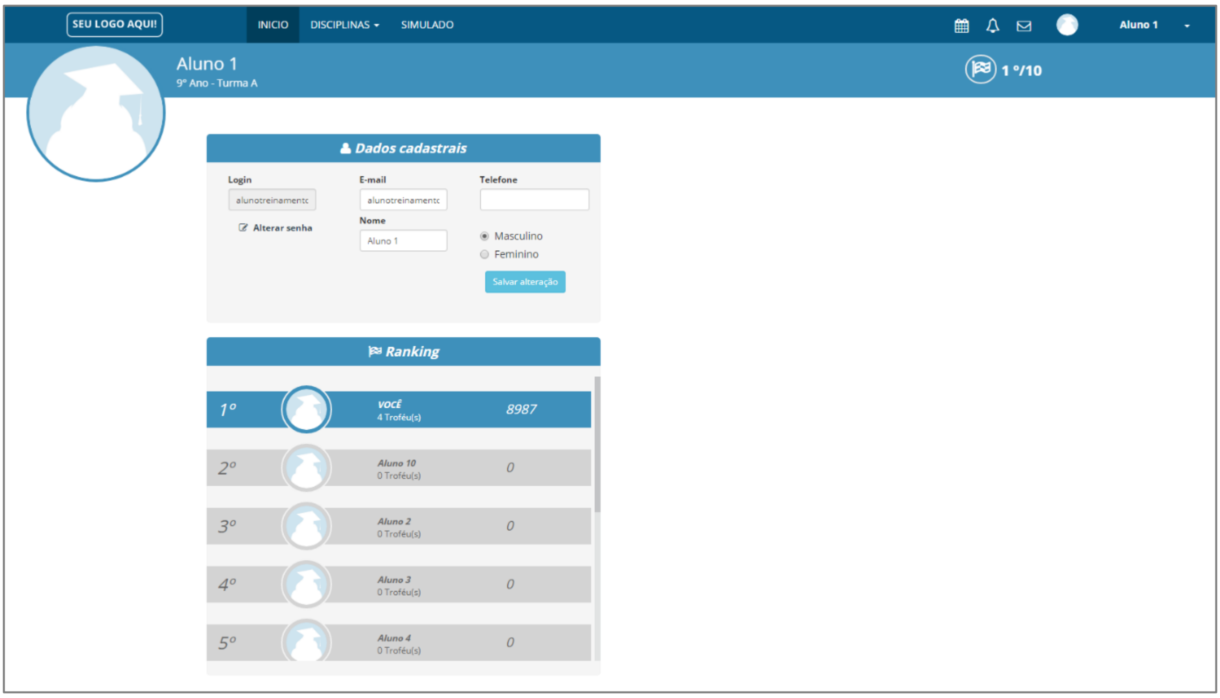


Figure 78 - Tailored profile of the Socializer Gamer Type

4.3.2.7. Tailored System for the Survivor Students

After the tailoring process, the survivor students' interface was changed, according to the proposed architectural design and process, as it follows: *i*) the adapted history was removed from first access; *ii*) timeline and trophies were removed from the home page; *iii*) badges were removed from the activities page; and *iv*) level and trophies were removed from the profile page. On the other hand, points, progress bar and ranking with leaderboards were kept on the home page and profile. Figure 79, Figure 80 and Figure 81, will present the main screens of the Mastermind Students' System.

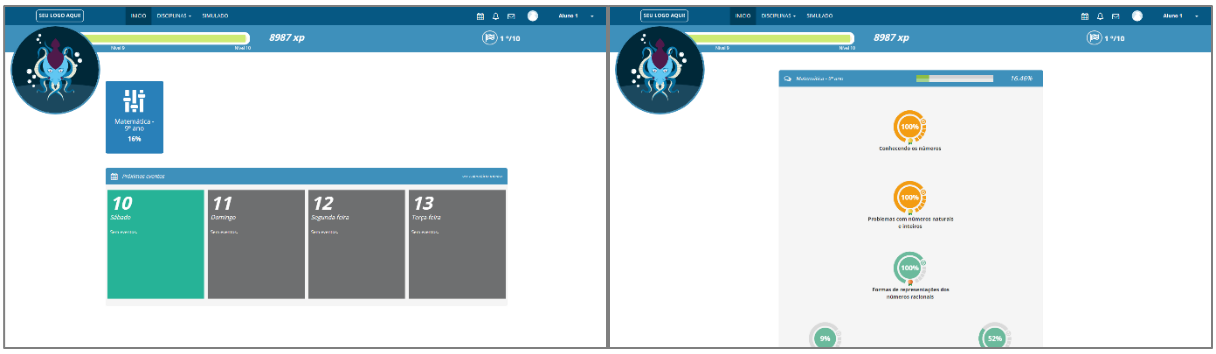


Figure 79 - Tailored homepage and tree of activities of the Survivor Gamer Type

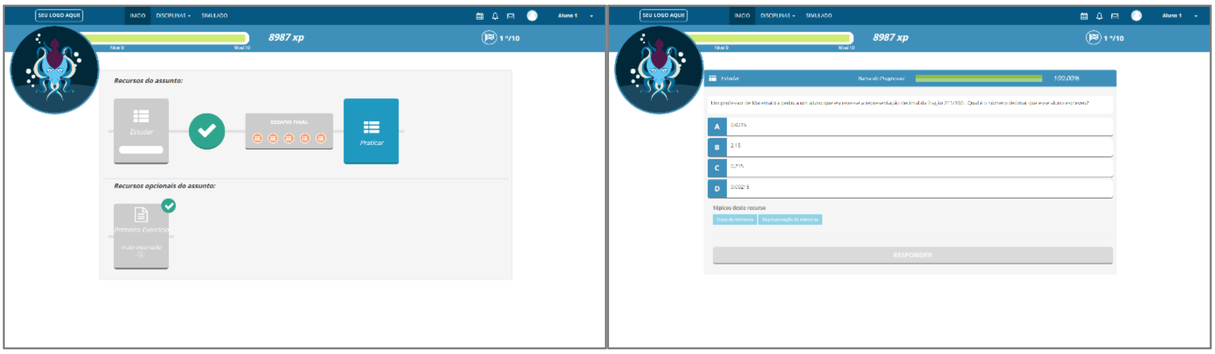


Figure 80 – Tailored resources and specific activities pages of the Survivor Gamer Type

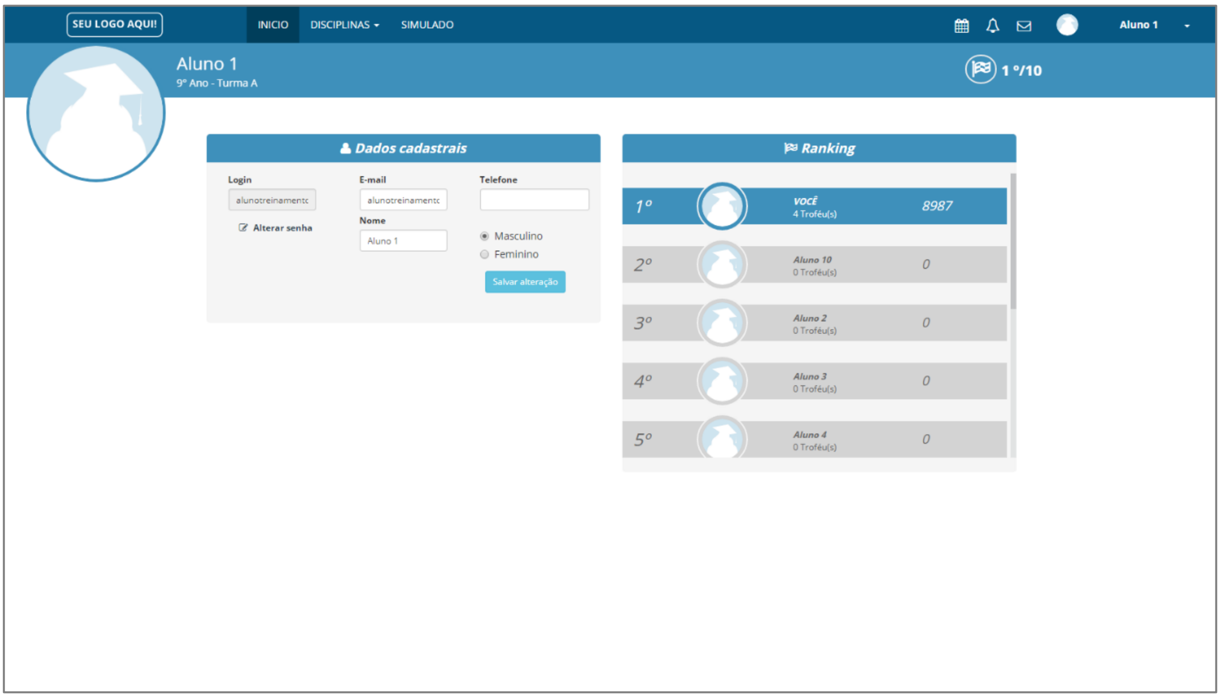


Figure 81 – Tailored profile of the Survivor Gamer Type

4.4. Guidelines to Tailor Gamified VLEs based on Gamer Types

To provide a better solution to implement tailored gamified VLEs based on gamer types, we will provide in this section a guideline for the gamification designers and programmers to implement the systems. The guidelines will be divided into two different categories: (*i*) guideline to tailor new systems and (*ii*) guidelines to modify pre-existent systems.

One of the main challenges is to create new gamified VLEs adapted according to the students' gamer types. To implement this type of system we created a guideline to based on the results. The guideline is composed by five main steps: (*i*) selecting a gamification framework; (*ii*) designing the system architecture; (*iii*) implementing the tailored model; (*iv*) identifying the students' gamer types; and (*v*) providing the adapted interface. We also recommend evaluating the students' satisfaction with the system after they use it.

In the first step, we recommend beginning the project by selecting a gamification framework to design the general gamification model of the system. This gamification framework will help the gamification designers to implement the general gamification design, according to the goals of the system. Many different gamification frameworks are available to be used to implement the gamified systems (to a comprehensive review about gamification design frameworks, see Mora *et al*. (2015)).

In the second step, we recommend designing the architectural base of the system. In this step, it is important to associate the general system architectural base with our architectural proposal to provide the different versions of the system. This step consists of associating the general system architectural design and process with our proposed architectural design and process.

In the third step, we recommend the implementation of the tailored model. This model should be developed based on our process, to select the best gamification elements for each gamer type. In this step is important to provide the ten most used educational gamification elements (Nah *et al*. 2014), associating these gamification elements to each *BrainHex* gamer type.

Finally, we recommend identifying the students' gamer types using the *BrainHex* player model (or equivalent) and providing the adapted system interface based on the students' gamer types. In this step is important to consider the *BrainHex* player type to identify the students' gamer types. However, recent studies have provided theoretical correlations between the different player types (*e.g*. Hamari and Tuunanen 2014). Figure 82 presents the diagram to implement new adapted Gamified VLEs.

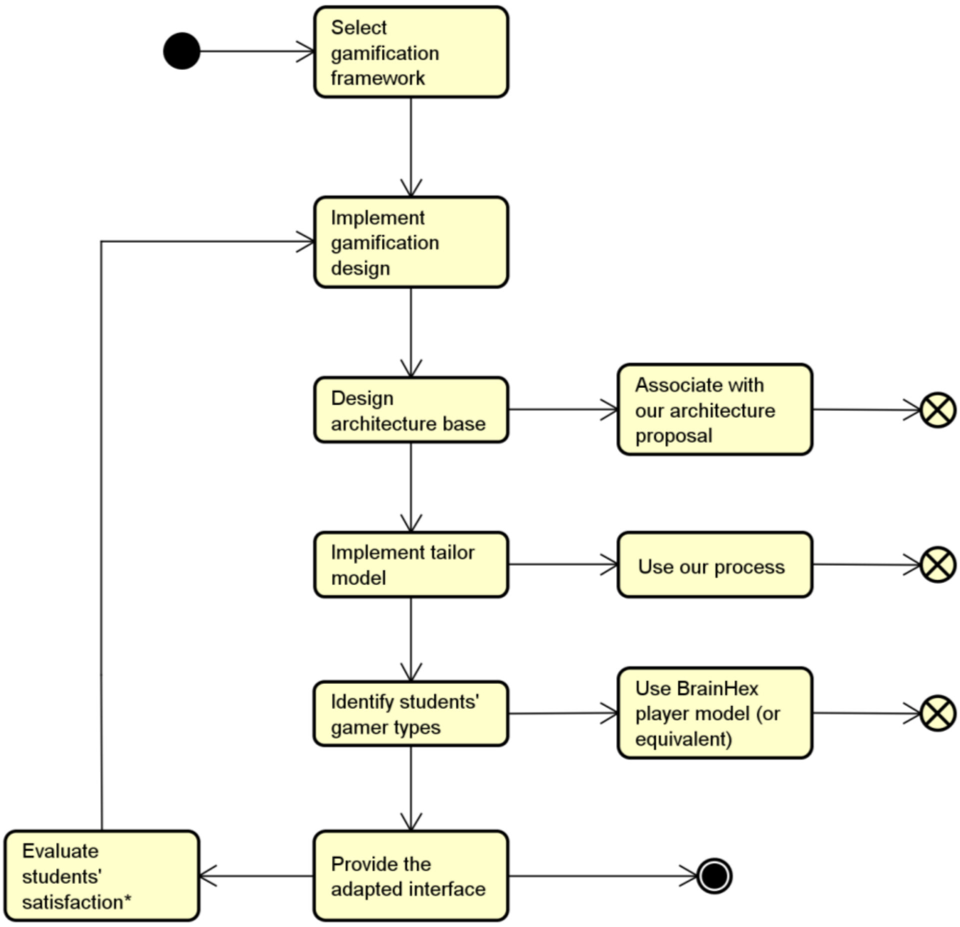


Figure 82 - Guideline to tailor new gamified VLEs based on gamer types

Another big challenge is to adapt existent systems; this is a big challenge because these systems were not originally designed to provide an adapted gamification model to the students. In this sense, it can be hard to tailor these systems. However, we want to provide a guideline to adapt the gamification design of existent Gamified VLEs based on the students' gamer types. We recommend conducting this process in four main steps: (*i*) identifying the students' gamer types; (*ii*) associating our architectural design with the original system architectural design; (*iii*) implementing the tailored model; and (*iv*) providing the adapted interface (in terms of gamification elements).

In the first step, we recommend using the *BrainHex* player model (or equivalent) to identify the students' gamer type. This step should be conducted considering the *BrainHex* player model to identify the students' gamer types (similar player models should be adapted).

In the second step, we recommend associating our architectural design with the original system architectural design. To provide the different versions of system, we recommend implementing the tailor model, based on our process. In this step it is important to identify what will be needed to design new gamification elements. For instance, in the original system, some gamification elements (*i.e*. ranking or points) that are significant for some specific gamer types may not have been created. In this case, it is important to create these gamification elements, to provide a better personalization.

Finally, we recommend providing an adapted interface for each gamer type. The adapted interface can be changed slowly to avoid abrupt changes in the system interface (new studies need to be done to identify the consequences of abrupt changes in gamified interfaces). Figure 83 presents the diagram for the adapted Gamified VLEs.

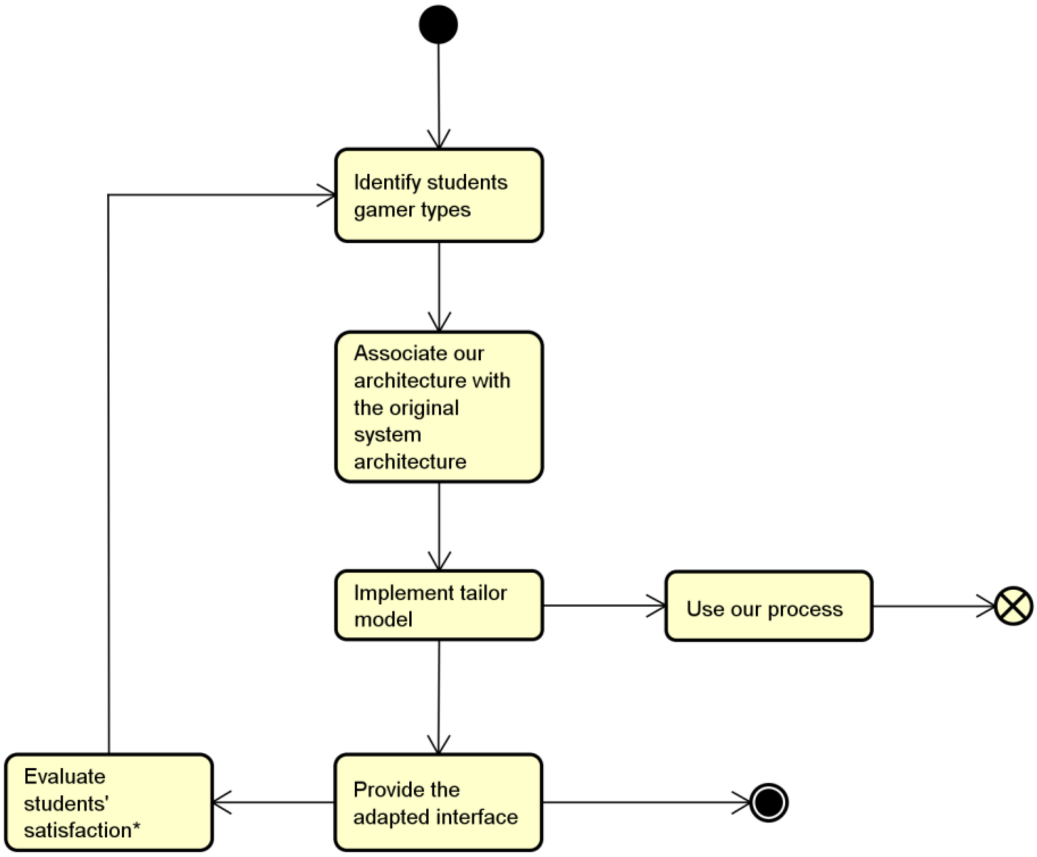


Figure 83 - Guideline to adapt gamified VLEs based on gamer types

5. Validation

As it is presented in the Methodology section, the validation study is conducted in three different steps: academic validation, static validation, and dynamic validation (which is not within the scope of this study), according to the *Empirically-Based Technology Transfer* methodology (Gorschek *et al*. 2006). To conduct the validation, a Experiment Design will be executed in each step. In this study, we conducted two different experiments, the first evaluating our proposal, and the second identifying the better gamification elements to motivate each student's gamer type.

5.1. Experiment Design

The Experiment Design has the objective of describing or explaining the information variation under hypothetical conditions to reflect such variation. The term is generally associated with true experiments in which the design introduces conditions that directly affect the information variation. In this study, the *Goal Question Metric (GQM)* (Basili *et al*. 1994) approach is adopted. The GQM provides a framework to empirically validate the several types of solutions.

5.1.1. Goal Question Metric (GQM)

The Goal/Question/Metric (GQM) (Basili *et al*. (1994); Briand *et al*. (1996); Solingen and Berghout 1999) method assumes that for an organization to measure in an accurate way it must:

1. Specify the goals for itself and its projects;
2. Trace those goals to the data that is intended to define those goals operationally; and
3. Provide a framework for interpreting the data regarding the goals that were stablished.

The result of the application of the GQM method is the specification of a measurement model targeting a particular set of issues and rules for the interpretation of the measured data (Wohlin *et al*. 2012). The resulting measurement model has three levels, as illustrated by the hierarchical structure in Figure **84**:

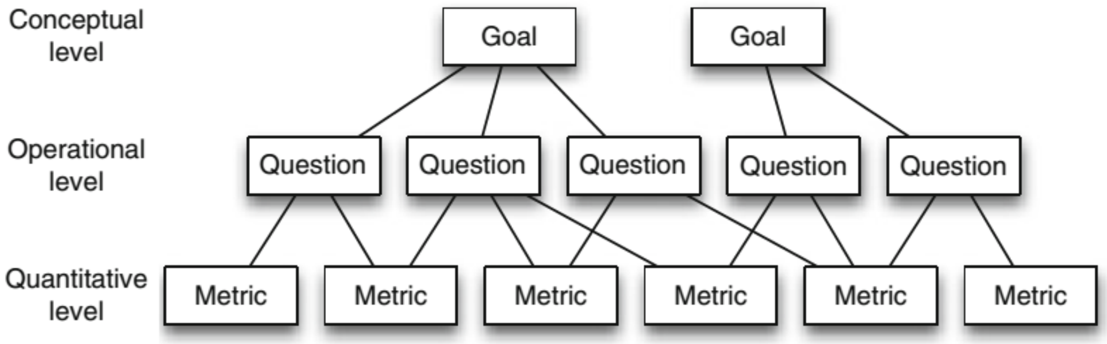


Figure 84 - GQM model structure

- **Conceptual level (Goal):** A goal is defined for an object, for a variety of reasons, regarding the several models of quality, from different points of view, related to a specific environment. The objects of measurement are: products, processes, and resources (Wollin *et al*. 2012).
- **Operational level (Question):** A set of questions is used to characterize the way the assessment/achievement of a specific goal is going to be performed based on some characterization model. Questions try to characterize the measurement objects (product, process, and resource) regarding the selected quality aspect and to determine its quality from the selected point of view (Wollin *et al*. 2012).
- **Quantitative level (Metric):** A set of data is associated with every question to answer it in a quantitative way (either objectively or subjectively) (Wollin *et al*. 2012).

The process of setting goals is critical to the successful application of the GQM method. Goals are formulated based on (1) policies and strategies of the organization, (2) descriptions of processes and products, and (3) organization models. When goals are formulated, questions are developed based on these goals. Once the questions have been developed, we proceed to associate the questions with the appropriate metrics (Wollin *et al*. 2012).

5.2. Experiment Design (Students' Flow Experience)

This section presents the experiment design of the academic validation, following the Empirically-Based Technology Transfer methodology (Gorschek *et al*. 2006).

5.2.1. Problem Definition

This experiment has the objective of comparing the effects of a gamified VLE (tailored based on the students' gamer types) with the counter-tailored version of the same gamified VLE, in terms of engagement and flow. The experiment was conducted with Brazilians elementary school students. The experiment is characterized as a "comparative and controlled experiment" (Wohlin *et al*. 2012).

5.2.2. Goals of the Experiment

The main goal of this experiment is to evaluate the effectiveness of the gamified VLE tailored based on the students' gamer types (through the process proposed in this study), in comparison with the counter-tailored version of the system. The specific goals are presented as it follows:

- Measuring students' concentration during their interactions with the system;
- Measuring students' flow state during their interactions with the system.

5.2.3. Research Questions

RQ1. Is the tailored system based on the students' gamer types more effective to keep the students engaged during the activities than the counter-tailored system?

RQ2. Is the tailored system based on the students' gamer types more effective to lead the students to the flow state during the activities than the counter-tailored system?

5.2.4. Hypothesis

$H_{1.0.0}$: The *Achiever students' concentration* in the *tailored system* is less or equal than the *Achiever students' concentration* in the *counter-tailored system*.

$H_{1.0.1}$: The *Achiever students' concentration* in the *tailored system* is greater than the *achiever students' concentration* in the *counter-tailored system*.

$H_{1.1.0}$: The *Conqueror students' concentration* in the *tailored system* is less or equal than the *Conqueror students' concentration* in the *counter-tailored system*.

$H_{1.1.1}$: The *Conqueror students' concentration* in the *tailored system* is greater than the *conqueror students' concentration* in the *counter-tailored system*.

$H_{1.2.0}$: The *Daredevil students' concentration* in the *tailored system* is less or equal than the *Daredevil students' concentration* in the *counter-tailored system*.

$H_{1.2.1}$: The *Daredevil students' concentration* in the *tailored system* is greater than the *Daredevil students' concentration* in the *counter-tailored system*.

$H_{1.3.0}$: The *Mastermind students' concentration* in the *tailored system* is less or equal than the *Mastermind students' concentration* in the *counter-tailored system*.

$H_{1.3.1}$: The *Mastermind students' concentration* in the *tailored system* is greater than the *Mastermind students' concentration* in the *counter-tailored system*.

$H_{1.4.0}$: The *Seeker students' concentrationnt* in the *tailored system* is less or equal than the *Seeker students' concentration* in the *counter-tailored system*.

$H_{1.4.1}$: The *Seeker students' concentration* in the *tailored system* is greater than the *Seeker students' concentration* in the *counter-tailored system*.

$H_{1.5.0}$: The *Socializer students' concentration* in the *tailored system* is less or equal than the *Socializer students' concentration* in the *counter-tailored system*.

$H_{1.5.1}$: The *Socializer students' concentration* in the *tailored system* is greater than the *Socializer students' concentration* in the *counter-tailored system*.

$H_{1.6.0}$: The *Survivor students' concentration* in the *tailored system* is less or equal than the *Survivor students' concentration* in the *counter-tailored system*.

$H_{1.6.1}$: The *Survivor students' concentration* in the *tailored system* is greater than the *Survivor Students' concentration* in the *counter-tailored system*.

$H_{2.0.0}$: The *Achiever students' flow experience* in the *tailored system* is less or equal than the *achiever students' flow experience* in the *counter-tailored system*.

$H_{2.0.1}$: The *Achiever students' flow experience* in the *tailored system* is greater than the *achiever students' flow experience* in the *counter-tailored system*.

$H_{2.0.0}$: The *Achiever students' flow experience* in the *tailored system* is less or equal than the *Achiever students' flow experience* in the *counter-tailored system*.

$H_{2.0.1}$: The *Achiever students' flow experience* in the *tailored system* is greater than the *Achiever students' flow experience* in the *counter-tailored system*.

$H_{2.1.0}$: The *Conqueror students' flow experience* in the *tailored system* is less or equal than the *Conqueror students' flow experience* in the *counter-tailored system*.

$H_{2.1.1}$: The *Conqueror students' flow experience* in the *tailored system* is greater than the *Conqueror students' flow experience* in the *counter-tailored system*.

$H_{2.2.0}$: The *Daredevil students' flow experience* in the *tailored system* is less or equal than the *Daredevil students' flow experience* in the *counter-tailored system*.

$H_{2.2.1}$: The *Daredevil students' flow experience* oin the *tailored system* is greater than the *Daredevil students' flow experience* in the *counter-tailored system*.

$H_{2.3.0}$: The *Mastermind students' flow experience* in the *tailored system* is less or equal than the *Mastermind students' flow experience* in the *counter-tailored system*.

$H_{2.3.1}$: The *Mastermind students' flow experience* in the *tailored system* is greater than the *Mastermind students' flow experience* in the *counter-tailored system*.

$H_{2.4.0}$: The *Seeker students' flow* experience in the *tailored system* is less or equal than the *Seeker students' flow experience* in the *counter-tailored system*.

$H_{2.4.1}$: The *seeker students' flow experience* iin the *tailored system* is greater than the *Seeker students' flow experience* in the *counter-tailored system*.

$H_{2.5.0}$: The *Socializer students' flow experience* on the *tailored system* is less or equal than *socializer students' flow experience* on the *counter-tailored system*.

$H_{2.5.1}$: The *Socializer students' flow experience* on the *tailored system* is greater than *socializer students' flow experience* on the *counter-tailored system*.

$H_{2.6.0}$: The *survivor students' flow experience* on the *tailored system* is less or equal than *survivor students' flow experience* on the *counter-tailored system*.

$H_{2.6.1}$: The *Survivor students' flow experience* in the *tailored system* is greater than *survivor students' flow experience* in the *counter-tailored system*.

5.2.4.1. Formal Definition of the Hypothesis

The formal definition of the hypothesis has the objective to organize the hypothesis in a mathematical formulation. Table **31** organizes our formal definition of the hypothesis.

Table 31 - Formal Definition of the Hypothesis

Hypothesis	Null Hypothesis	Alternative Hypothesis
$H_{1.0}$	H_0: E (TS (Ac)) ≤ E (cTS (Ac))	H_1: E (TS (Ac)) > E (cTS (Ac))
$H_{1.1}$	H_0: E (TS (Cn)) ≤ E (cTS (Cn))	H_1: E (TS (Cn)) > E (cTS (Cn))
$H_{1.2}$	H_0: E (TS (Dr)) ≤ E (cTS (Dr))	H_1: E (TS (Dr)) > E (cTS (Dr))
$H_{1.3}$	H_0: E (TS (Ms)) ≤ E (cTS (Ms))	H_1: E (TS (Ms)) > E (cTS (Ms))
$H_{1.4}$	H_0: E (TS (Sk)) ≤ E (cTS (Sk))	H_1: E (TS (Sk)) > E (cTS (Sk))
$H_{1.5}$	H_0: E (TS (Ss)) ≤ E (cTS (Ss))	H_1: E (TS (Ss)) > E (cTS (Ss))
$H_{1.6}$	H_0: E (TS (Sv)) ≤ E (cTS (Sv))	H_1: E (TS (Sv)) > E (cTS (Sv))
$H_{2.0}$	H_0: F (TS (Ac)) ≤ F (cTS (Ac))	H_0: F (TS (Ac)) > E (cTS (Ac))
$H_{2.1}$	H_0: F (TS (Cn)) ≤ F (cTS (Cn))	H_0: F (TS (Cn)) > F (cTS (Cn))
$H_{2.2}$	H_0: F (TS (Dr)) ≤ F (cTS (Dr))	H_0: F (TS (Dr)) > E (cTS (Dr))
$H_{2.3}$	H_0: F (TS (Ms)) ≤ F (cTS (Ms))	H_0: F (TS (Ms)) > F (cTS (Ms))
$H_{2.4}$	H_0: F (TS (Sk)) ≤ F (cTS (Sk))	H_0: F (TS (Sk)) > E (cTS (Sk))
$H_{2.5}$	H_0: F (TS (Ss)) ≤ F (cTS (Ss))	H_0: F (TS (Ss)) > F (cTS (Ss))
$H_{2.6}$	H_0: F (TS (Sv)) ≤ F (cTS (Sv))	H_0: F (TS (Sv)) > F (cTS (Sv))

Subtitle: Ac: Achiever, Cn: Conqueror, Dr: Daredevil, Ms: Mastermind, Sk: Seeker, Ss: Socializer, Sv: Survivor, E: Concentration, F: Flow, TS: Tailored System, cTS: Counter-tailored System.

5.2.5. Factors and Response Variables

According to the hypothesis previously defined, we have seven different factors (also named independent variables):

- **Achiever**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Conqueror**: A *BrainHex* class representing a specific gamer type used in this experiment;

- **Daredevil**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Mastermind**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Seeker**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Socializer**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Survivor**: A *BrainHex* class representing a specific gamer type used in this experiment;

According to the hypothesis and factors previously defined, we have two different responsive variables (also named dependent variables):

- **Concentration**: concentration level of the students, identified through the concentration questionnaire;
- **Flow**: flow state level of the students, identified through the flow state questionnaire.

5.2.6. Level of Factors

According to the factors previously defined, we have identified the level of each factor. Table 32 presents the levels associated with the factors.

Table 32 - Level of Factors

Factors	**Levels**
Achiever	Tailored system
	Counter-tailored system
Conqueror	Tailored system
	Counter-tailored system
Daredevil	Tailored system
	Counter-tailored system
Mastermind	Tailored system
	Counter-tailored system
Seeker	Tailored system
	Counter-tailored system

Socializer	Tailored system
	Counter-tailored system
Survivor	Tailored system
	Counter-tailored system

5.2.7. Experimental Units

After identifying and organizing the factors and levels, we have identified the experimental units:

- Achiever students using the counter-tailored system;
- Achiever students using the tailored system;
- Conqueror students using the counter-tailored system;
- Conqueror’ students using the tailored system;
- Daredevil students using the counter-tailored system;
- Daredevil students using the tailored system;
- Mastermind students using the counter-tailored system;
- Mastermind students using the tailored system;
- Seeker students using the counter-tailored system;
- Seeker students using the tailored system;
- Socializer students using the counter-tailored system;
- Socializer students using the tailored system;
- Survivor’ students using the counter-tailored system;
- Survivor’ students using the tailored system;

5.2.8. Execution Plan

1. Data collection;
2. Metrics definition;
3. Execution of the experiment;
4. Metrics extraction;
5. Statistical analysis of data.

5.2.9. Data Collection

We collected data from 111 Brazilian elementary school students. The research data were stored using the pseudonym and association with questionnaire data and data logs. Data were stored in a password-protected computer system and to be available only for the investigators. A secure Cabinet was used to store the data for the long term (for more details, read the document approved by the Behavioural Research Ethics Board (Beh-REB) from the University of Saskatchewan (Appendix A)).

5.2.10. Metrics Definition

The metrics definition was conducted in partnership with two academic professionals with expertise in Statistical and Compartmental Science.

5.2.11. Execution of the Experiment

The experiment was conducted in a controlled environment (a laboratory with 20 computers with Windows 7 installed and free access to the internet), following a structure previously defined. First, the students responded the *BrainHex* questionnaire (The appendix C presents the original *BrainHex* player model and the appendix D presents the Brazilian version of *BrainHex* used in our study) to identify their gamer type.

In the second step, students were divided in seven different groups according to their gamer types, inside each gamer type group; each group of students was randomly divided into two different groups (experimental and control group) to use the store lines following the structure presented in Figure 85.

In the third step, the students of the experimental group used the tailored version and responded to the FSS 2 (Appendix E will present the original FSS 2 and the Appendix F will present the FSS translated to the Portuguese language used in this study). At the same time, the control group used the counter-tailored version and responded the FSS 2. Next, the experimental group repeated the process using the counter-tailored system and the control group used the tailored system.

In the fourth step, the students' answers were organized in tables (*.csv* files) and separated according to each gamer type and version of system (tailored and counter-tailored version), like the flow experience of the achiever students in the tailored and counter-tailored version.

In the fifth step, the answers were organized into each constructed flow, according to the original DFS-2 factorial structure (see Figure 86 and Figure 87) validated by Hamari and Koivisto (2014). Then, we calculated the individual and general way which each flow experience was built.

Finally, in the sixth step, we calculated the normality of our data using seven different statistical techniques and the statistical difference between the flow experiences of each gamer type in the two different versions of the system. The data were organized in tables and boxplots to better present our finds. The Figure 85 below will present the complete experiment organization.

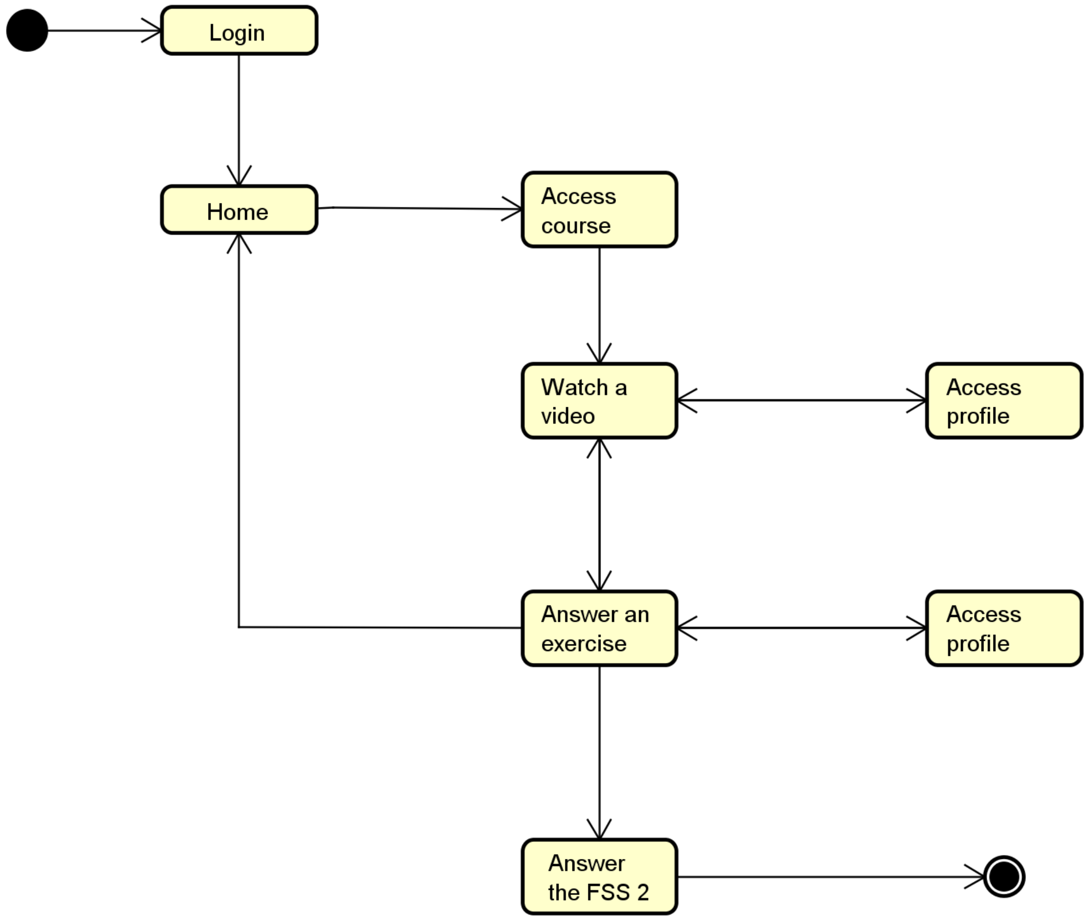


Figure 85 - Activities Diagram

5.2.12. Metric Extraction

The metrics were extracted through the analysis of data previously collected, using different statistical software tools and the application of different statistical tests.

5.2.13. Statistical Analysis of the Data

The DFS-2 scale consists of structures based on the nine flow dimensions defined by Csíkszentmihályi (1990). Thus, the structures included in the DFS-2 are the following: time (transformation) (T), challenge-skill balance (CSB), merging of action and awareness (MAA), clear goals (G), feedback (F), concentration (C), control (CTRL), loss of self-consciousness (LSC), and autotelic experience (A). Each of the nine structures contains four items. Together the structures form a 36-item scale for measuring the flow experience. The DFS-2 relies on self-reported data. Therefore, similarly to previous DFS-2 studies, the items were measured on a Likert scale ranging from strong disagreement (1 on the Likert scale) to strong agreement (5 on the Likert scale) with the statement.

After organizing our data in tables, we calculated the individual and general mean for each flow experience structure following the original DFS-2 factorial structure presented in the Figure 86 (challenge/skill balance: 1, 10, 19 and 28; merging actions – awareness: 2, 11, 20 and 29; clear goals: 3, 12, 21, 30; feedback: 4, 13, 22 and 31; concentration: 5, 14, 23 and 32; control: 6, 15, 24 and 33; loss of self – consciousness: 7, 16, 25 and 34; time: 8, 17, 26 and 35; autoletic experience: 9, 18, 27 and 36).

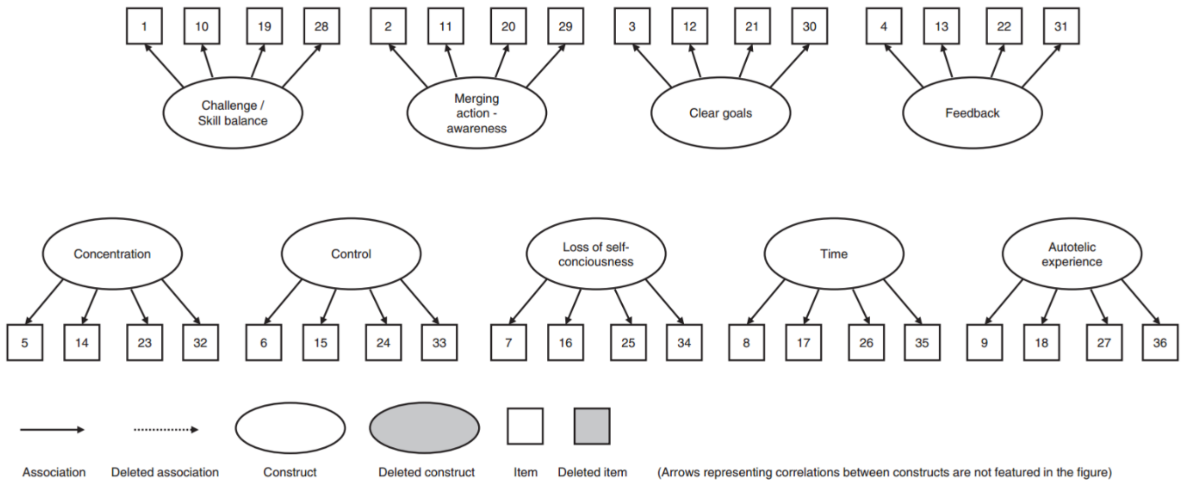


Figure 86 - DFS-2 original factorial structure

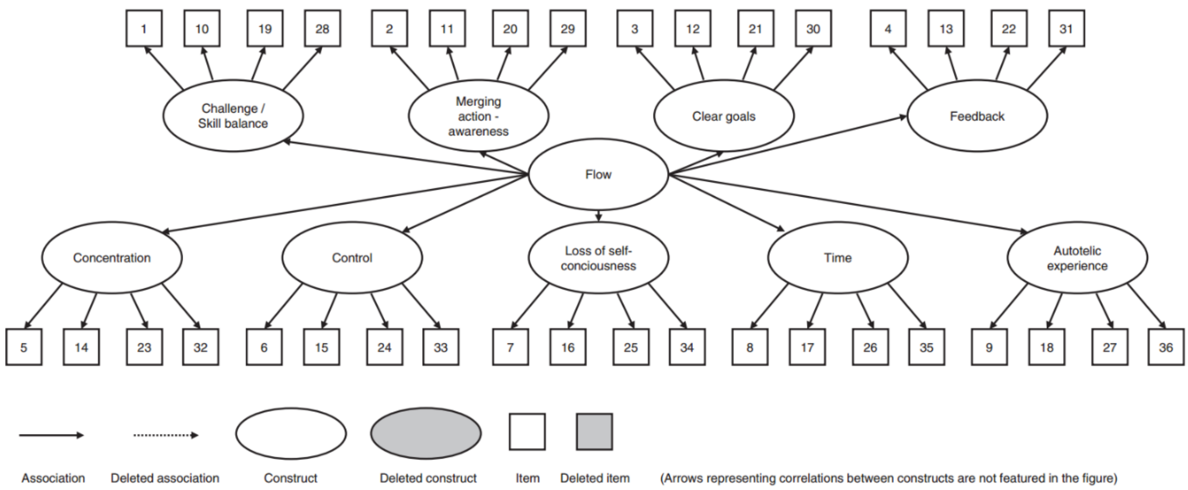


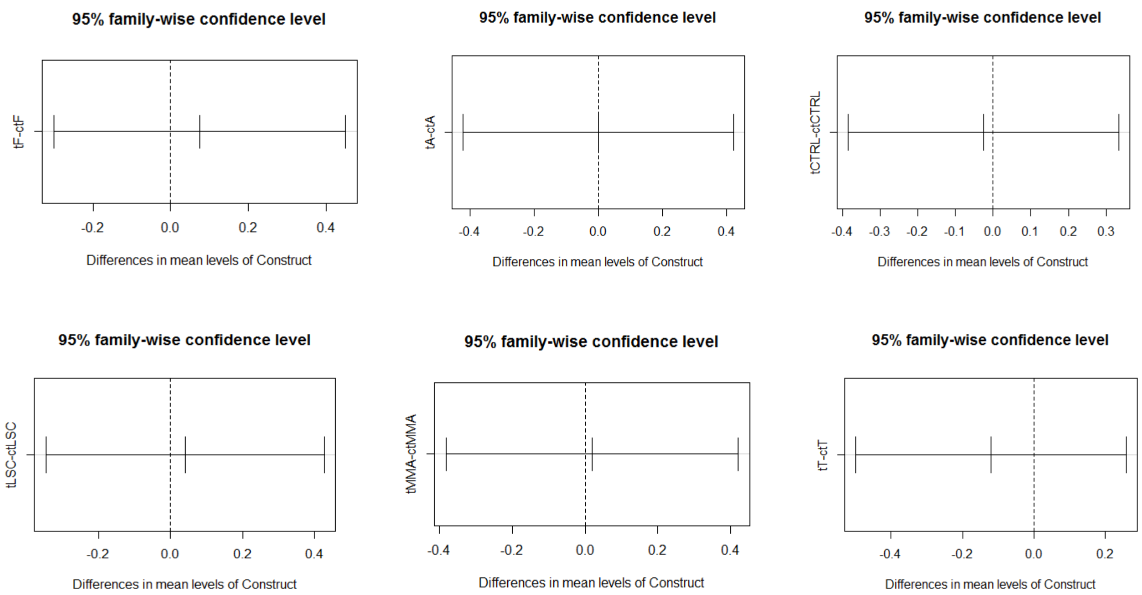
Figure 87 - DFS-2 s-order original factorial structure

To investigate the flow experience differences of each gamer type in each version of the implemented system, we calculate each flow experience structure individually (Time transformation, Challenge-Skill Balance, Merging Action & Awareness, Clear Goals, Feedback, Concentration, Control, Loss of Self Consciousness and Autotelic experience). For each flow experience structure, we calculate the mean, median, standard deviation, average variation, maximum shared variation, and average shared variation. Table **33** presents the result of achievers using the tailored system and the Figure **89** (the blue line represents the students' flow experience in the counter-tailored system and the red line represents the flow experience in the tailored version) presents the result of achievers using the counter-tailored system.

Table 33 – Achiever's flow experience

Constructs	Counter-tailored version				Tailored version				Anova
	M	$\tilde{x}$	σ_X	$var(X)$	M	$\tilde{x}$	σ_X	$var(X)$	
CSB	3.565	3.75	0.9712841	0.9433929	3.59	3.5	0.9282417	0.8616327	0.896
MMA	3.42	3.5	1.079068	1.164388	3.44	3.5	0.9320813	0.8687755	0.921
G	3.76	3.875	0.8496098	0.7218367	3.675	4	0.8737236	0.7633929	0.623
F	3.525	3.5	0.946597	0.8960459	3.6	3.75	0.9435603	0.8903061	0.692
C	3.6	3.625	0.9049185	0.8188776	3.595	3.75	0.79842	0.6374745	0.977
CTRL	3.565	3.625	0.9830321	0.966352	3.54	3.5	0.8212112	0.6743878	0.891
LSC	3.535	3.75	0.9871754	0.9745153	3.575	3.5	0.9705484	0.9419643	0.839
T	3.24	3.5	0.9871108	0.9743878	3.415	3.5	0.9225215	0.8510459	0.531
A	3.55	3.875	1.086795	1.181122	3.55	3.75	1.038789	1.079082	1

Indices: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, $var(X)$= Average Variation Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.



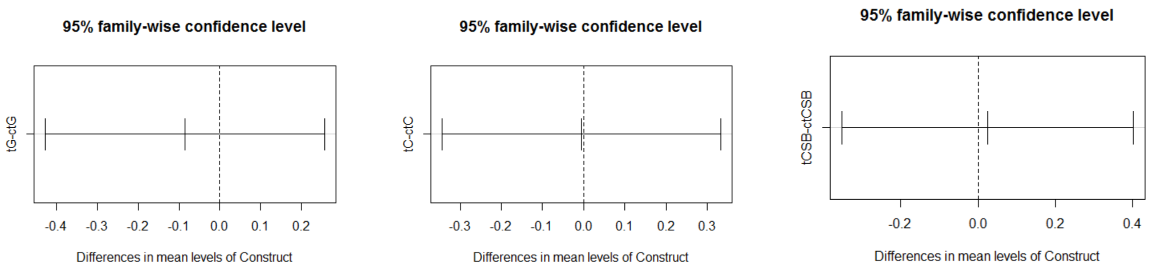


Figure 88 - Plot of ANOVA analisys for Achiever' students

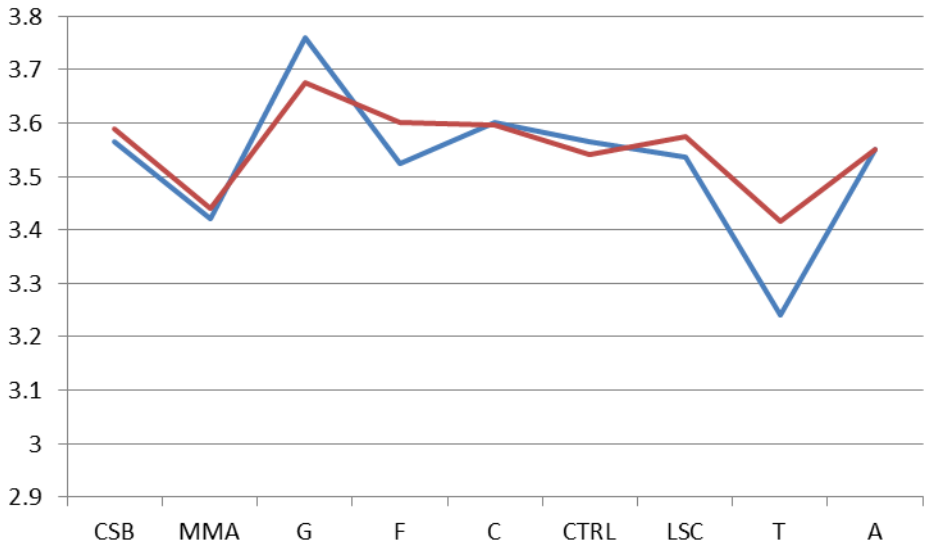


Figure 89 – Averange of Achiever's flow experience

The results indicate that the Achiever students' concentration was similar in both versions of the system, which means that the students' concentration in the tailored version was not bigger then the students' concentration in the counter-tailored version. On the the other hand, in the other flow experience constructs, in some cases the tailored version presented better results (*e.g.* Time transformation, in which the tailored version was significant better than the counter-tailored verson).

Table 34 - Conquerors' flow experience

Construct	Counter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	$var(X)$	M	$\tilde{x}$	σ_X	$var(X)$	
CSB	3.741667	4	0.8445651	0.7132902	3.608333	3.625	0.8218024	0.6753592	0.538

MMA	3.141667	3	1.037411	1.076221	3.141667	3.125	0.984105	0.9684626	1
G	3.85	4	1.075992	1.157759	3.766667	3.875	0.9189887	0.8445402	0.748
F	3.6	3.5	0.8920144	0.7956897	3.658333	3.5	0.9704321	0.9417385	0.809
C	3.775	3.875	0.8889892	0.7903017	3.816667	3.875	0.8328734	0.6936782	0.852
CTRL	3.675	3.75	0.8860752	0.7851293	3.691667	3.5	0.9484182	0.8994971	0.944
LSC	3.541667	3.625	0.9146399	0.8365661	3.633333	3.5	0.9776232	0.9557471	0.709
T	3.375	3.25	0.9232392	0.8523707	3.7	3.75	0.7525818	0.5663793	0.14*
A	3.758333	3.875	1.03283	1.066739	3.616667	3.75	1.047849	1.097989	0.6

Index: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, *var*(*X*)= Average Variation Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant (p<.0.5)

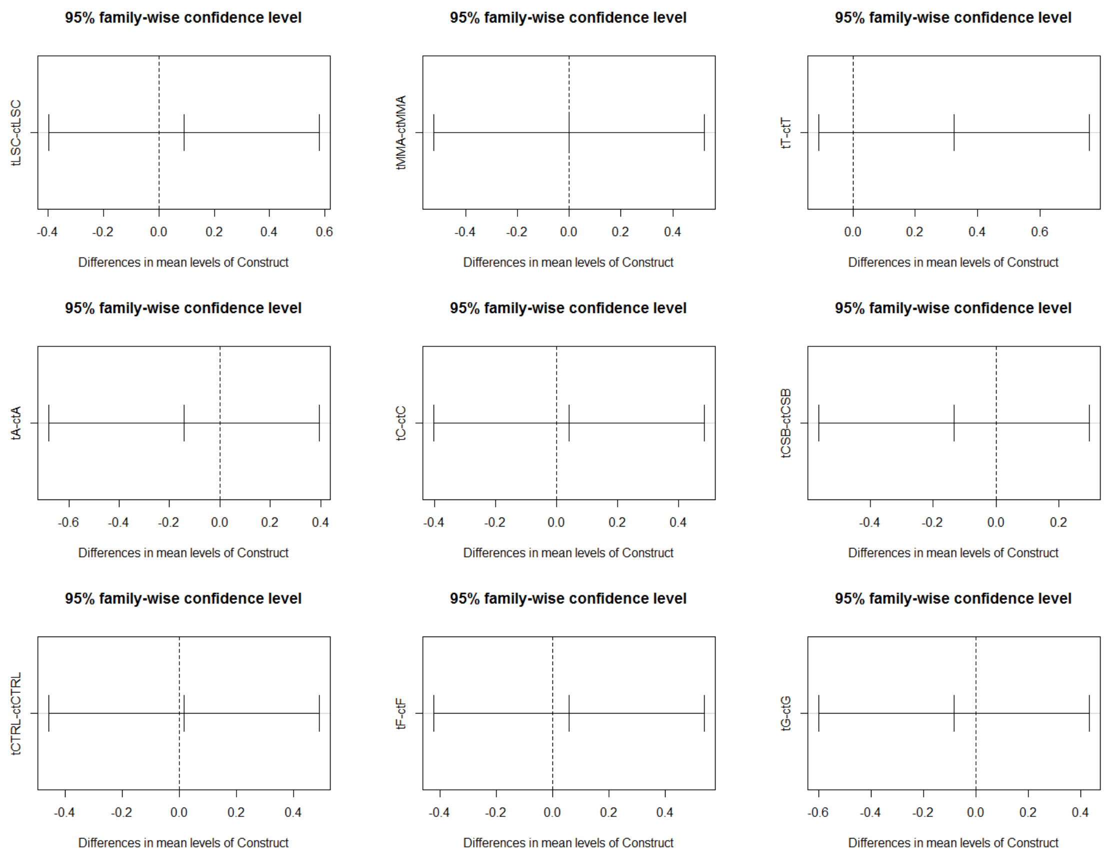


Figure 90 - Plot of ANOVA analisys for Conqueror' students

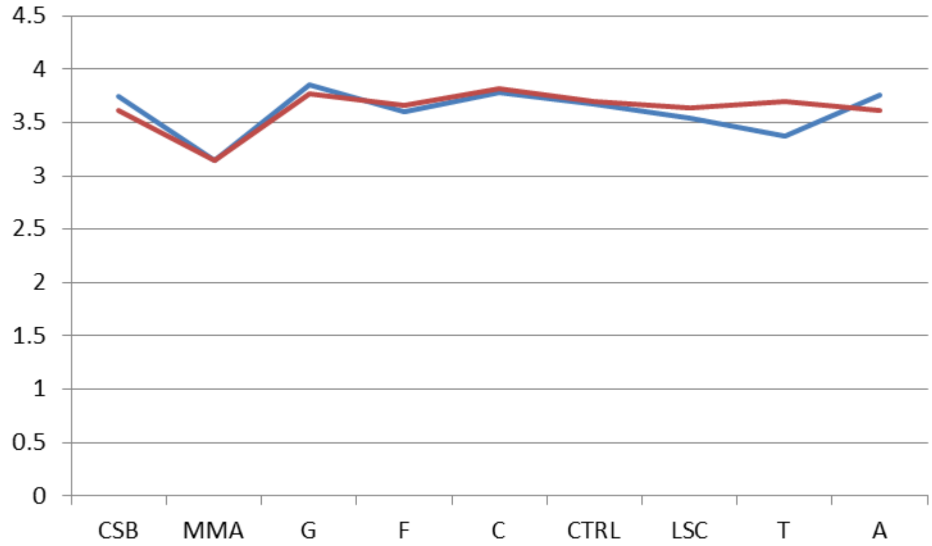


Figure 91 - Conquerors' flow experience

For the Conquerors, the concentration was significant better in the tailored version, in comparison with the counter-tailored systems. On the majority of the other constructs, the difference was not significant. However, in similar fashion with the Achivers, the time transformation was significantly better in the tailored version of the system. For the conqueros, the autoletic experience was better in the counter-tailored system.

Table 35 - Daredevils' flow experience

Construct	Counter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	*var*(*X*)	M	$\tilde{x}$	σ_X	*var*(*X*)	
CSB	3.4	3.25	1.24499	1.55	3.25	2.75	1.224745	1.5	0.852
MMA	3	2.5	1	1	3.1	3.25	1.098294	1.20625	0.884
G	4.05	3.75	0.6937218	0.48125	3.35	3.25	1.126388	1.26875	0.271*
F	3.7	3.75	0.7373941	0.54375	3.55	3.25	0.8909265	0.79375	0.779
C	3.2	3.25	1.036822	1.075	2.95	2.75	1.021641	1.04375	0.711
CTRL	3.15	3.5	1.294218	1.675	2.65	2.5	0.4873397	0.2375	0.442*
LSC	2.95	2.75	0.798436	0.6375	3.05	3.25	1.12361	1.2625	0.875
T	3.05	3.25	0.647109	0.41875	3.2	3.25	0.8177714	0.66875	0.756
A	2.8	2.25	0.9905806	0.98125	3.3	3.25	0.5968668	0.35625	0.362*

Indices: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, *var*(*X*)= Average Variation Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant (p<.0.5)

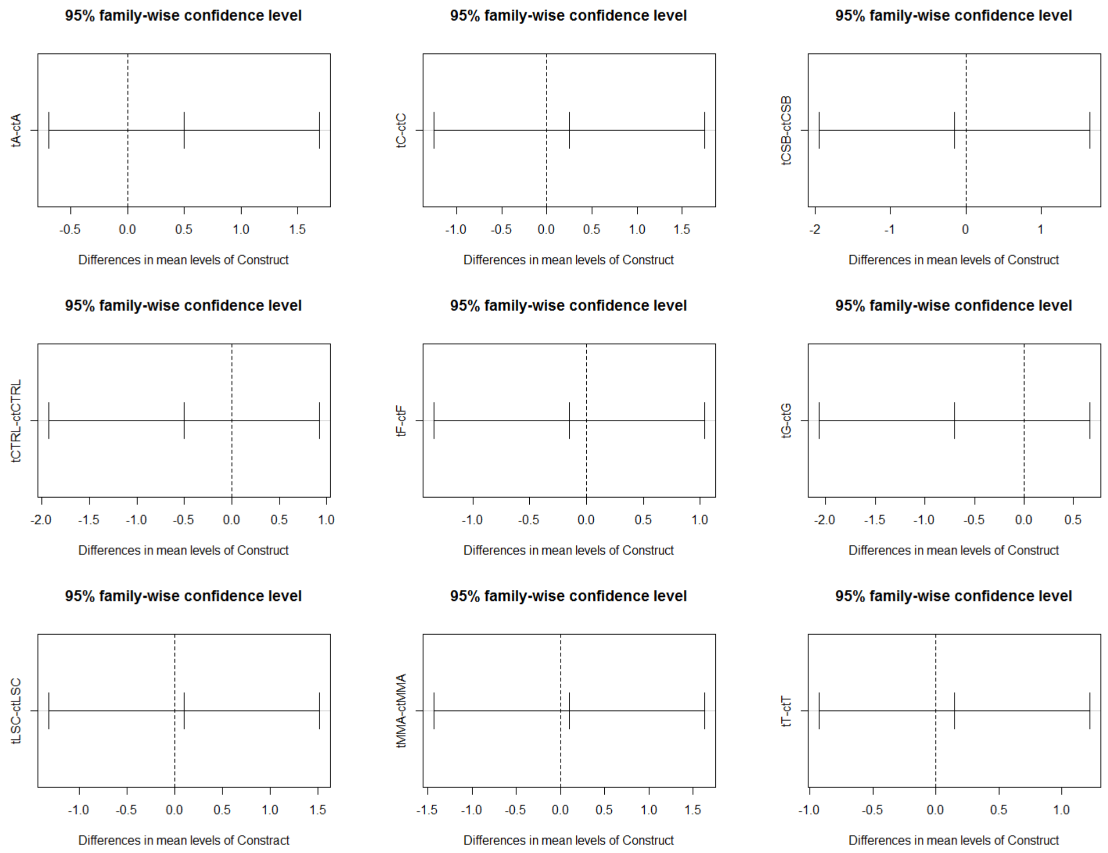


Figure 92 - Plot of ANOVA analisys for Daredevil' students

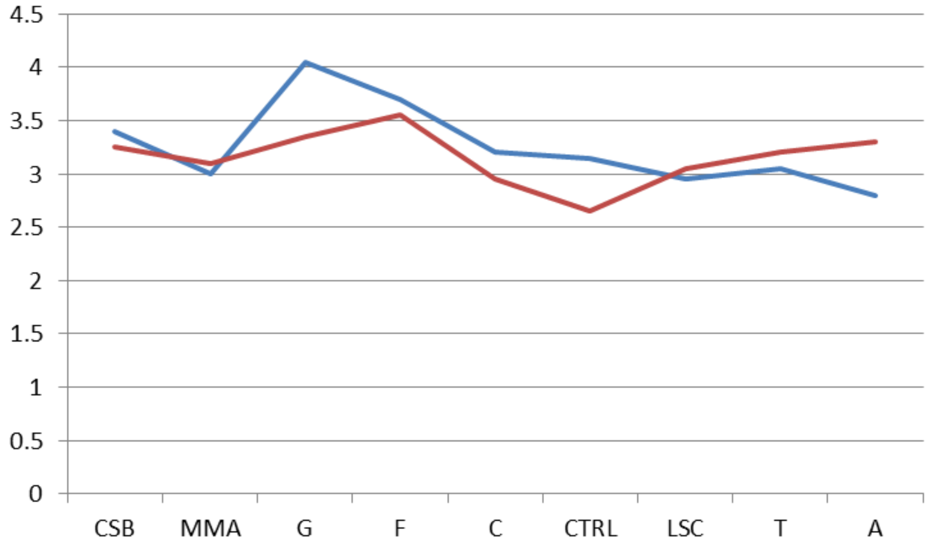


Figure 93 - Daredevils' flow experience

The Deredevil students presented significant difference in terms of concentration. Different then the Achievers and Conquerors, the Daredevil’s concentration was better in the tailored system. On most of the other flow experience constructs, the Daredevils had a better experience in the counter-tailored version. Only in terms of autoletic experience the Daredevils had a better experience in the tailored version of the system.

Table 36 - Masterminds' flow experience

Constructs	Counter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	$var(X)$	M	$\tilde{x}$	σ_X	$var(X)$	
CSB	2.625	2.625	0.595119	0.3541667	3.125	3.25	1.050793	1.104167	0.439*
MMA	2.875	2.625	0.7772816	0.6041667	3.0625	3	0.5153882	0.265625	0.702
G	3	3.25	0.6770032	0.4583333	3.4375	3.25	0.8508574	0.7239583	0.452*
F	3.1875	3.125	0.6884463	0.4739583	3.25	3.375	0.8897565	0.7916667	0.915
C	3.25	3.25	0.6123724	0.375	3.4375	3.5	0.9437293	0.890625	0.75
CTRL	2.9375	2.875	1.068	1.140625	3.3125	3.25	1.390069	1.932292	0.684
LSC	3.25	3.375	0.6123724	0.375	3.5625	3.625	0.4269563	0.1822917	0.435*
T	3.125	3.25	0.6291529	0.3958333	3.25	3.25	0.9128709	0.8333333	0.829
A	2.9375	3.25	1.007782	1.015625	3.375	3.625	0.9682458	0.9375	0.554

Index: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, $var(X)$= Average Variance Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant ($p<.0.5$)

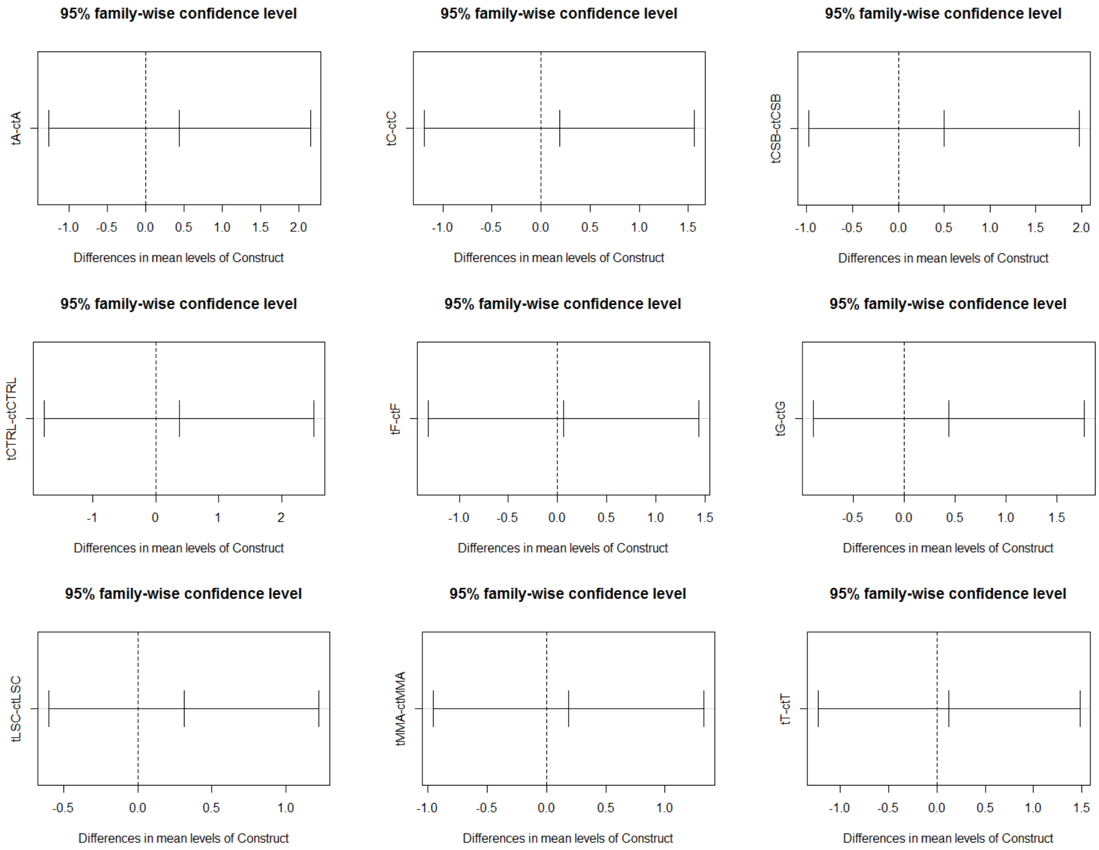


Figure 94 - Plot of ANOVA analisys for Mastermind' students

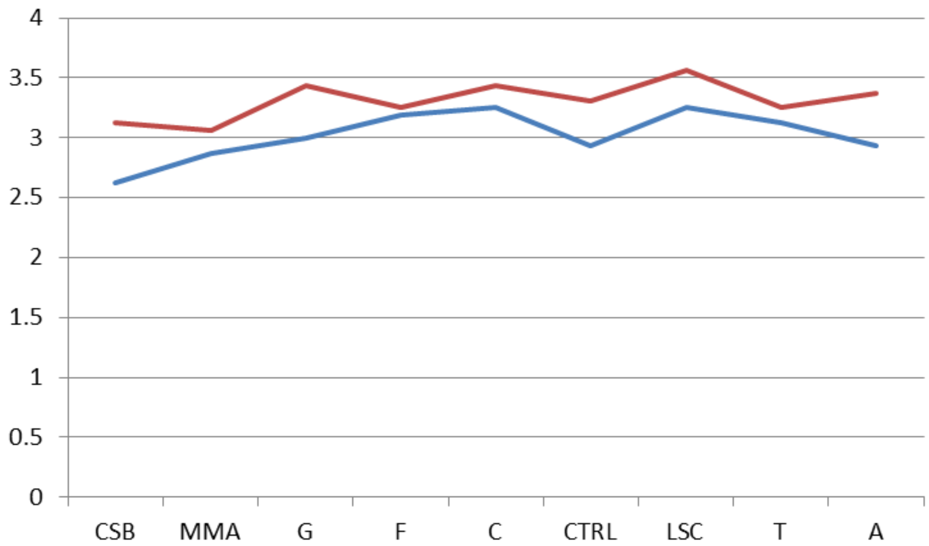


Figure 95 - Masterminds' flow experience

The Masterminds were the only ones that presented a positive significant difference in all of the flow experience consructs. For this gamer type, the flow experience was significantly better in the tailored version of the system, indicanting that the gamer type was prefered and needed a tailored version based on its prefereces in terms of gamification elements.

Table 37 - Seekers' flow experience

Construct	Counter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	$var(X)$	M	$\tilde{x}$	σ_X	$var(X)$	
CSB	3.785714	3.875	0.6493869	0.4217033	3.821429	4	0.9116161	0.831044	0.906
MMA	3.375	3.375	0.8865989	0.7860577	2.982143	3	0.5839544	0.3410027	0.178*
G	4.053571	4.125	0.6735281	0.4536401	3.803571	3.75	0.8388326	0.7036401	0.393*
F	4.160714	4.375	0.6836493	0.4673764	4	4.125	0.7403222	0.5480769	0.556
C	4.142857	4.125	0.6629935	0.4395604	3.964286	4.25	0.97988	0.9601648	0.577
CTRL	4.053571	4.125	0.7479367	0.5594093	3.892857	4.125	0.8918126	0.7953297	0.61
LSC	3.982143	4	0.6538664	0.4275412	3.267857	3.375	0.9779506	0.9563874	0.0316*
T	3.785714	3.75	0.7129108	0.5082418	3.410714	3.375	0.8638417	0.7462225	0.221*
A	3.821429	4.125	0.8170572	0.6675824	3.821429	4.25	1.025767	1.052198	1

Index: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, $var(X)$= Average Variance Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant ($p<.0.5$)

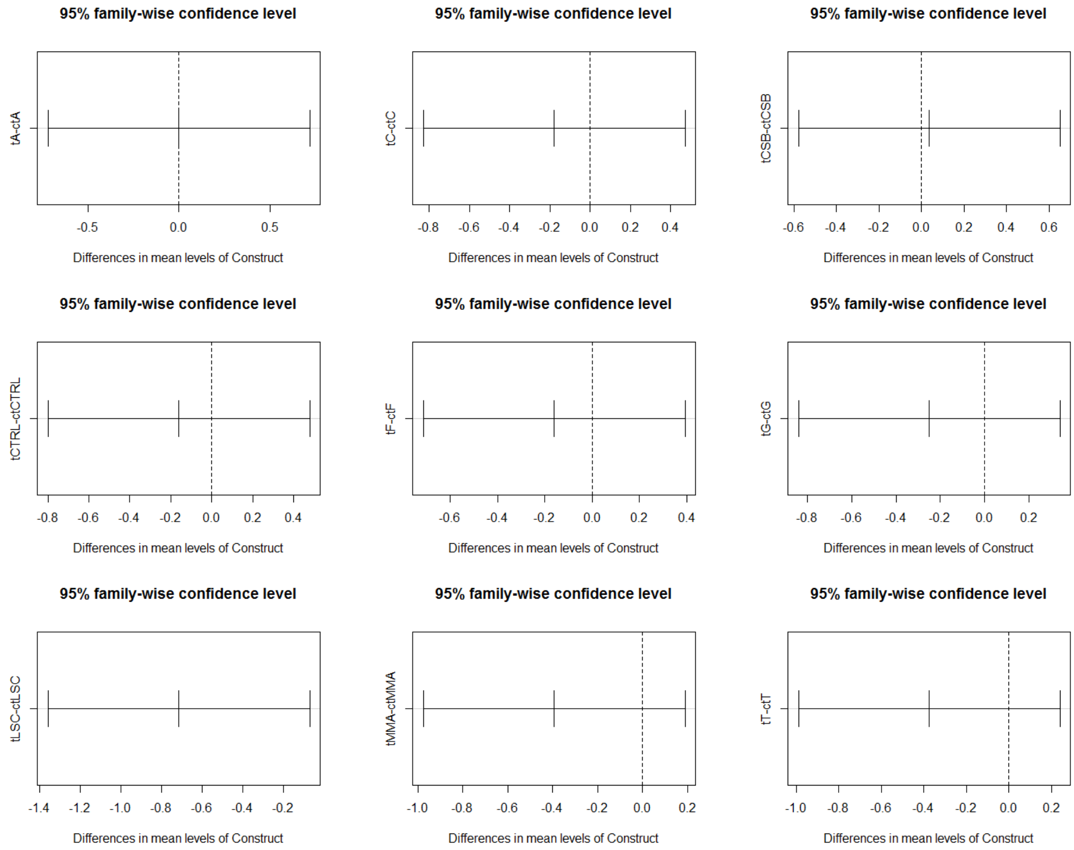


Figure 96 - Plot of ANOVA analisys for Seeker' students

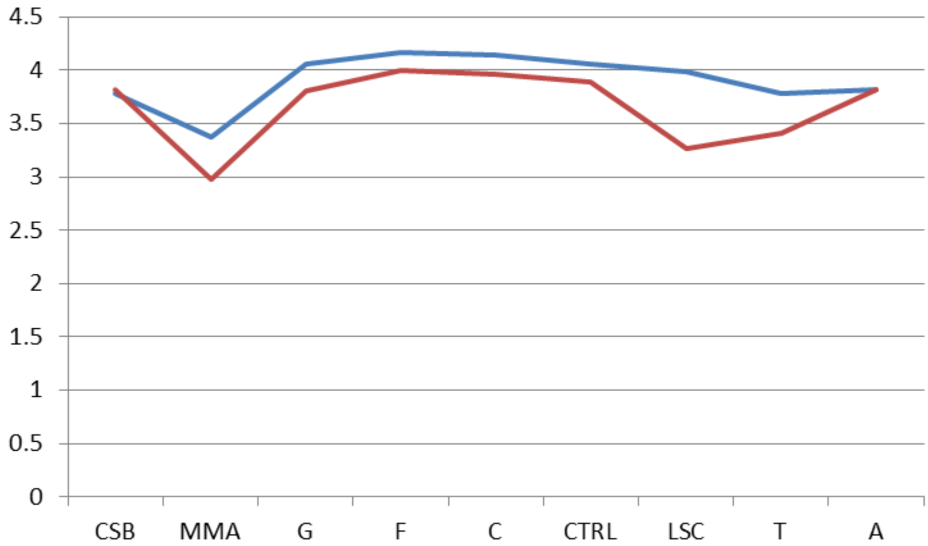


Figure 97 - Seekers' flow experience

The Seekers also presented a significative difference in most of the flow experience constructs. However, different then the Masterminds, the Seekers presented a better experience in the counter-tailored system. Therefore, the Seekers' flow experience and concentration was better in the counter-tailored version in general, comparing to the tailored system.

Table 38 - Socializers' flow experience

Constructs	Conuter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	$var(X)$	M	$\tilde{x}$	σ_X	$var(X)$	
CSB	3.692308	3.75	0.6547411	0.4286859	3.5625	3.5	0.5551924	0.3082386	0.6
MMA	3.865385	4.25	0.8991627	0.8084936	3.645833	3.75	0.6946086	0.4824811	0.504
G	3.923077	4	1.037749	1.076923	3.854167	3.75	0.6524284	0.4256629	0.846
F	3.807692	3.75	0.4911068	0.2411859	3.791667	3.75	0.3667011	0.1344697	0.928
C	3.865385	4	0.7042681	0.4959936	3.583333	3.5	0.6061553	0.3674242	0.296*
CTRL	3.673077	4	0.7172329	0.5144231	4.020833	4	0.7265918	0.5279356	0.241*
LSC	3.115385	3.25	1.087885	1.183494	2.979167	2.75	0.875541	0.766572	0.735
T	3.769231	3.5	0.7250111	0.525641	3.604167	3.75	1.068444	1.141572	0.653
A	3.634615	3.75	0.7332532	0.5376603	3.666667	3.75	0.8348471	0.6969697	0.919

Index: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, $var(X)$= Average Variation Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant ($p<.0.5$)

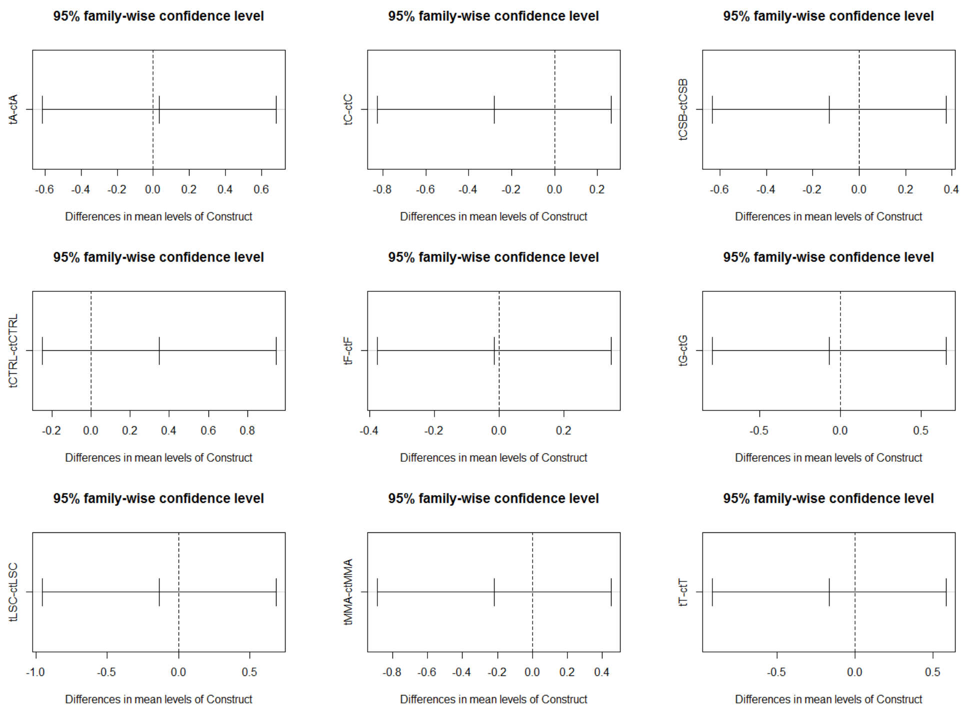


Figure 98 - Plot of ANOVA analisys for Socializer' students

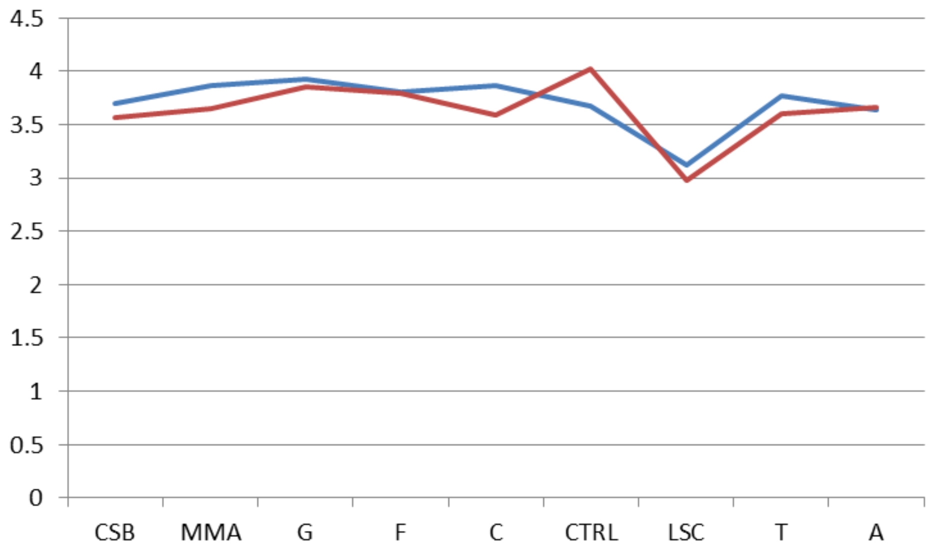


Figure 99 - Socializers' flow experience

The socializer students do not present a uniform distribution in terms of flow experience constructs. In other words, for some flow experience constructs, the experience of the socializer was better in the counter-tailored system, and, in other cases, their experience was better in the tailored version of the system (*e.g.* control and autoletic experience).

Table 39 - Survivors' flow experience

Constructs	Counter-tailored system				Tailored system				Anova
	M	$\tilde{x}$	σ_X	*var*(*X*)	M	$\tilde{x}$	σ_X	*var*(*X*)	
CSB	3.85	3.875	0.8913161	0.7944444	3.875	3.625	0.8014743	0.6423611	0.948
MMA	3.7	3.75	0.6851602	0.4694444	3.15	3	0.7923243	0.6277778	0.114*
G	3.85	3.75	0.8096639	0.6555556	3.575	3.5	0.9721825	0.9451389	0.501
F	3.5	3.625	0.7728015	0.5972222	3.975	4	0.7857233	0.6173611	0.19*
C	3.55	3.375	0.8482007	0.7194444	3.8	4.25	0.9486833	0.9	0.542
CTRL	3.575	3.625	0.8979142	0.80625	3.75	3.75	0.8333333	0.6944444	0.657
LSC	3.525	3.25	0.7945124	0.63125	3.925	4.125	0.6241661	0.3895833	0.227*
T	3.65	3.375	0.7187953	0.5166667	3.45	3.75	1.212206	1.469444	0.659
A	3.825	4	0.8979142	0.80625	4	4.25	0.9354143	0.875	0.675

Index: μ = Mean, $\tilde{x}$ = Median, σ_X= standard deviation, *var*(*X*)= Average Variance Extracted.
Constructs: T = Time transformation, CSB = Challenge-Skill Balance, MAA = Merging Action & Awareness, G = clear Goals, F = Feedback, C Concentration, CTRL = Control, LSC = Loss of Self Consciousness, A = Autotelic experience.
* Incignificant ($p<.0.5$)

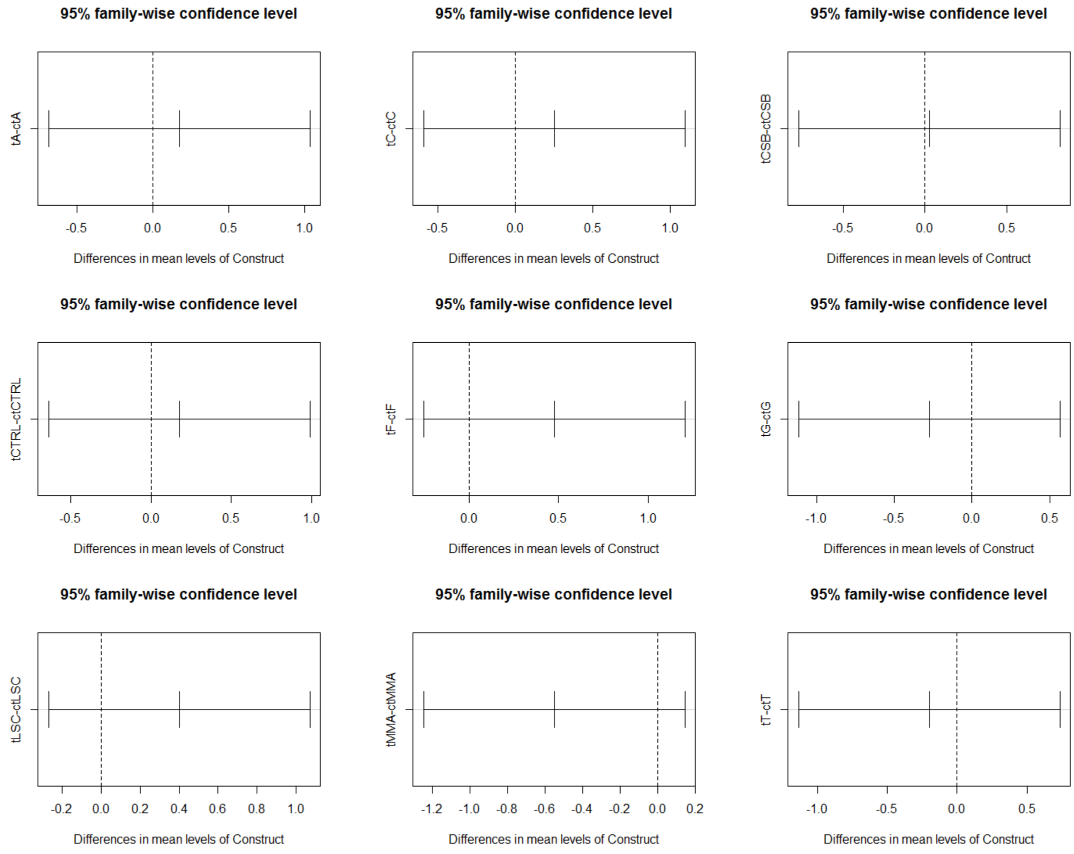


Figure 100 - Plot of ANOVA analisys for Survivor' students

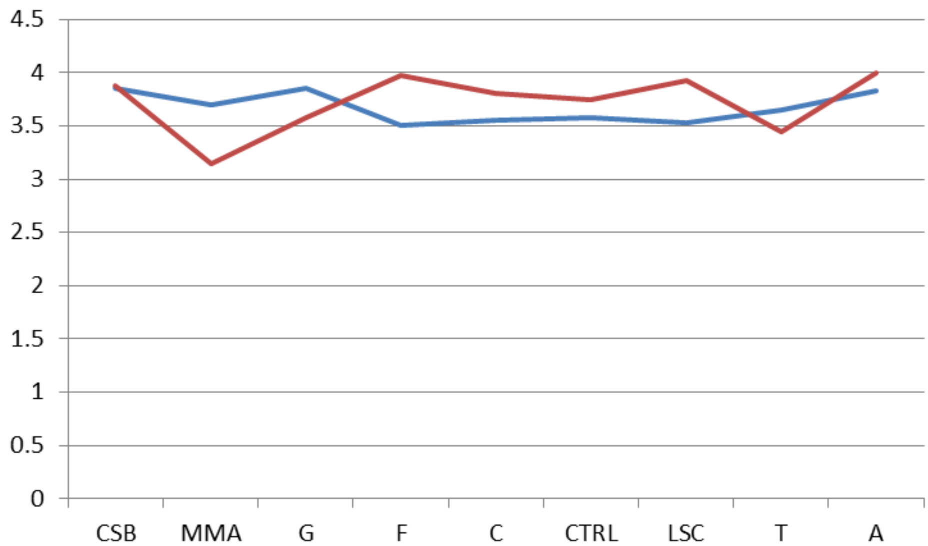


Figure 101 - Survivors’ flow experience

The survivors also didn't present a uniform distribution in terms of flow experience constructs. As such, for some flow experience constructs the tailored system was better than the counter-tailored system, while in other flow experience constructs the counter-tailored system was better than the tailored system.

5.2.14. Instrumentation

To conduct this experiment, different instruments were used. We present these instruments as it follows:

- *BrainHex* questionnaire;
- Flow State Scale 2 (FSS 2);
- Concentration Scale (part of FSS 2);
- RStudio.

5.2.15. Threats to Validity

This section describes concerns that must be discussed in future versions of this study and other aspects that must be considered in order to maximize the results of the evaluation performed in this section. In general, the evaluation was designed to minimize the threats discussed in this section. To organize this section, the validity threats were divided using the Internal, External, Construct and Conclusion categories (Wohlin *et al*., 2012).

Internal: As the experiment involved active human participation, it was also prone to a number of internal threats, such as: (*i*) history – it is possible that the moment in which the experiment occurred may have affected the results, but this threat was minimized by letting the participants take part in the experiment without interference of the other students and their teachers; (*ii*) maturation – since the participants used the system in the course of more than 30 minutes to answer the questionnaire, and they answered the survey more than one time during the experiment, it is possible that they were bored or tired while answering the survey; and (*iii*) positive or negative bias – as this experiment was conducted with participants without experience in this kind of evaluation, it is likely that the participants did not have a basis for comparison. To minimize this threat, the two versions of the system (tailor and counter-tailored) were evaluated by the students in different moments.

External: The participants of the experiment are representative only in an academic context. As previously described, the participants were high school students from one research group. In this way, we might not be able to maximize the results of this experiment into different contexts. The subjects of this evaluation should be expanded to other academic settings to obtain more generic results.

Constructs: The threats of this category are mainly related to two aspects of our experiments. This experiment measures many different items from different aspects, and some constructs may not be measured by the questions. To minimize these threats, we selected methodologies and instruments empirically validated and commonly used in the scientific empirical studies from the technological and educational community. The system used in this experiment has a interface design (in terms of gamification elements and pedagogical model), so the students' experience in the system can be influenced by the system design beyond the gamification elements.

Conclusion: The sample size of this experiment was of 111 students. However, this was a blocking factorial experiment, and some groups may have a small sample, with insignificant statistical power. The elementary students that were participants of the experiment could have been anxious in the moment that they answered the questionnaire, and they may have answered it without the proper attention. To mitigate this, we used only instruments previously validated in different domains, including gamification domains.

5.3. Experiment Design (Students' Preferences about Gamification Elements)

Our second experiment was conducted to identify the better gamification elements for each gamer type.

5.3.1. Problem definition

This experiment has the purpose of identifying the best gamification elements to better stimulate each gamer type. The experiment was conducted with elementary school students. The experiment is characterized as a "blocking factorial experiment", consisting of 10 factors, each one with possible values or "levels", and whose experimental units take on all of the possible combinations of these levels across such factors. (Wohlin *et al*. 2012 and Montgomery 2012).

5.3.2. Goals of the Experiment

The main goal of this experiment is to evaluate the effectiveness of the gamification elements to motivate students in Gamified VLEs, based on the students' gamer types. The specific goals are presented as follows:

- Identifying if the students' gamer types have different preferences about gamification elements in gamified VLEs.
- Identifying the best gamification elements to motivate each students' gamer type in gamified VLEs;

5.3.3. Research Questions

RQ1. Do the students have different preferences about gamification elements according to their gamer type?

RQ2. What are the best gamification elements to motivate each student gamer type?

5.3.4. Hypothesis

$H_{1.0.0}$: The *Achiever* students' preferences are similar for the *gamification elements*.

$H_{1.0.1}$: The *Achiever* students' preferences are different for the *gamification elements*.

$H_{2.1.0}$: The *Conqueror* students' preferences are similar for the *gamification elements*.

$H_{2.1.1}$: The *Conqueror* students' preferences are different for the *gamification elements*.

$H_{3.1.0}$: The *Daredevil* students' preferences are similar for the *gamification elements*.

$H_{3.1.1}$: The *Daredevil* students' preferences are different for the *gamification elements*.

$H_{4.1.0}$: The *Mastermind* students' preferences are similar for the *gamification elements*.

$H_{4.1.1}$: The *Mastermind* students' preferences are different for the *gamification elements*.

$H_{5.1.0}$: The *Seeker* students' preferences are similar for the *gamification elements*.

$H_{5.1.1}$: The *Seeker* students' preferences are different for the *gamification elements*.

$H_{6.1.0}$: The *Socializer* students' preferences are similar for the *gamification elements*.

$H_{6.1.1}$: The *Socializer* students' preferences are different for the *gamification elements*.

$H_{7.1.0}$: The *Survivor* students' preferences are similar for the *gamification elements*.

$H_{7.1.1}$: The *Survivor* students' preferences are different for the *gamification elements*.

5.3.4.1. Formal Hypothesis Definition

To facilitate the understanding of the gamification elements evaluated in this experiment, they were organized by number representing each element, as it follows: *1. Points; 2. Badges; 3. Trophies; 4. Levels; 5. Progress bar; 6. Ranking with leaderboards; 7. Timeline; 8. Background history; 9. Avatar; 10 Feedback*.

Table 40 - Formal Definition of the Hypothesis

Hypothesis	Null Hypothesis	Alternative Hypothesis
$H_{1.0}$	H_0: $\bar{x}$ *gE1 (Ac) = M gE2 (Ac) ... =* $\bar{x}$ *gE10 (Ac)*	H_1: $\bar{x}$ *gE1 (Ac) ≠ M gE2 (Ac) ... ≠* $\bar{x}$ *gE10 (Ac)*
$H_{1.1}$	H_0: $\bar{x}$ *gE1 (Cn) = M gE2 (Ac) ... =* $\bar{x}$ *gE10 (Cn)*	H_1: $\bar{x}$ *gE1 (Cn) ≠ M gE2 (Cn) ... ≠* $\bar{x}$ *gE10 (Cn)*
$H_{1.2}$	H_0: $\bar{x}$ *gE1 (Dr) = M gE2 (Dr) ... =* $\bar{x}$ *gE10 (Dr)*	H_1: $\bar{x}$ *gE1 (Dr) ≠ M gE2 (Dr) ... ≠* $\bar{x}$ *gE10 (Dr)*
$H_{1.3}$	H_0: $\bar{x}$ *gE1 (Ms) = M gE2 (Ms) ... =* $\bar{x}$ *gE10 (Ms)*	H_1: $\bar{x}$ *gE1 (Ms) ≠ M gE2 (Ms) ... ≠* $\bar{x}$ *gE10 (Ms)*
$H_{1.4}$	H_0: $\bar{x}$ *gE1 (Sk) = M gE2 (Sk) ... =* $\bar{x}$ *gE10 (Sk)*	H_1: $\bar{x}$ *gE1 (Sk) ≠ M gE2 (Sk) ... ≠* $\bar{x}$ *gE10 (Sk)*
$H_{1.5}$	H_0: $\bar{x}$ *gE1 (Ss) = M gE2 (Ss) ... =* $\bar{x}$ *gE10 (Ss)*	H_1: $\bar{x}$ *gE1 (Ss) ≠ M gE2 (Ss) ... ≠* $\bar{x}$ *gE10 (Ss)*
$H_{1.6}$	H_0: $\bar{x}$ *gE1 (Sv) = M gE2 (Sv) ... =* $\bar{x}$ *gE10 (Sv)*	H_1: $\bar{x}$ *gE1 (Sv) ≠ M gE2 (Sv) ... ≠* $\bar{x}$ *gE10 (Sv)*

Indice: $\bar{x}$ = Mean, *gE'X'* = Gamification element *(were 'X' represent the number of gamification element), Ac*: Achiever, *Cn*: Conqueror, *Dr*: Daredevil, *Ms*: Mastermind, *Sk*: Seeker, *Ss*: Socializer, *Sv*: Survivor.

5.3.5. Factors and Response Variables

According to the hypothesis previously defined, we have seven different factors (also named independent variables):

- **Achiever**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Conqueror**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Daredevil**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Mastermind**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Seeker**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Socializer**: A *BrainHex* class representing a specific gamer type used in this experiment;
- **Survivor**: A *BrainHex* class representing a specific gamer type used in this experiment;

According to the hypothesis and factors previously defined, we have 10 different response variables (also named dependent variables). These specific gamification elements (factors) were used because they are the 10 most used gamification elements in the C&E field (Nah *et al*. 2014):

- **Points**: gamification element;
- **Badges**: gamification element;
- **Trophies**: gamification element;
- **Levels**: gamification element;
- **Progress bar**: gamification element;
- **Ranking and leaderboards**: gamification element;
- **Timeline:** gamification element;
- **Background history:** gamification element;
- **Avatar:** gamification element;
- **Feedback:** gamification element.

5.3.6. Level of the Factors

According to the factors previously defined, we have identified the level of each factor. Table 32 presents the levels associated with the factors.

Table 41 - Level of Factors

Factors	**Levels**
Achiever	The individual gamification elements.
Conqueror	The individual gamification elements.
Daredavil	The individual gamification elements.
Mastermind	The individual gamification elements.
Seeker	The individual gamification elements.
Socializer	The individual gamification elements.
Survivor	The individual gamification elements.

5.3.7. Experimental Unities

After identifying and dividing the factors and levels, we have identified the experimental units:

- Achiever evaluating the 10 different gamification elements;
- Conqueror evaluating the 10 different gamification elements;
- Daredevil evaluating the 10 different gamification elements;
- Mastermind evaluating the 10 different gamification elements;
- Seeker evaluating the 10 different gamification elements;
- Socializer evaluating the 10 different gamification elements;
- Survivor evaluating the 10 different gamification elements;

5.3.8. Execution Plan

1. Data collection;
2. Metrics definition;
3. Execution of the experiment;
4. Metrics extraction;
5. Statistical analysis of data.

5.3.9. Data Collection

We collected data from 111 Brazilian elementary school students. The study matches the criteria for an adequate sample size. According to Bentler and Chou (1987) there must be a minimum ratio of 5 respondents per 1 construct in the model (for the model of the present study the threshold must be 111 respondents). Hair *et al*. (2010) suggest the same rule for factor analyses. Loehlin (1998) suggests that at least 100 participants are required for a complete sample size.

The research data were online collected through the *BrainHex* questionnaire and the individual questionnaire about gamification elements preferences and filed using the pseudonym and association with questionnaire data and data logs. Data were stored on a password-protected computer system and will be available only to the investigators. A secure Cabinet was used to store the data in a long term (for more details, consult the document approved by the Behavioural Research Ethics Board (Beh-REB) from University of Saskatchewan (Appendix A). Following the principals of factorial experiments, the gamification elements position was randomized in the questionnaire.

5.3.10. Metrics Definition

The metrics definitions were conducted in partnership with two academic professionals with expertise in Statistical and Compartmental Science. The main goal of this experiment is to observe whether significant differences exist across the gamer types regarding their perception of the several gamification elements in gamified VLEs and to develop guidelines for tailoring strategies for individual gamer types using gamified VLEs. This requires an examination of the relationship between ten gamification elements and the seven gamer types identified by *BrianHex*. To achieve this, we used several well-known statistical analysis, analytical tools, and procedures. The analysis of the results was a statistical one, beginning with the data organization (tables, boxplots, and others). The metrics definitions were conducted in three different steps:

The first step was to identify the valid answers. In order to identify inappropriate answers, we inserted "out of the curve" questions in the survey (inconsistent and unrelated issues) to see if the students were reading the questions carefully. Also were made available questions about the emotional state of the students during the survey, in order to identify if the students were bored or tired during survey. The inappropriate responses were desconsidered on the survey.

In the second step, we conducted the normalization tests of our data. With this goal in mind, we conducted seven different strong statistical tests commonly used in the community to calculate the normality of data. In the third step, different tests from descriptive statistics were used to identify answer factor and the significance of the differences between the gamification elements for each gamer type. Finally, in the fourth step, the significante data were organized in tables and graphics, in order to provide a guideline with the best gamification elements to each gamer type.

5.3.11. Execution of the Experiment

The experiment was conducted in a controlled environment (laboratory with 20 computers with Windows 7 installed and access to the internet). The experiment followed a structure previously defined. In the first moment, the students that accepted to be part of the experiment were invited to answer the *BrainHex* questionnaire to identify their gamer type. In the second step, the same students used the questionnaire to set their preferences in terms of gamification elements. In the third moment, the data of the questionnaires were synchronized with the students' nicknames (which are the same in both questionnaires) for future analyses of data.

5.3.12. Metrics Extraction

The metrics are extracted through an analysis of previously collected data, using different statistical softwares and the application of different statistical tests. Initially, the data were organized in comma-separated files (*.csv* files). The *.csv* files were joined together using the grouped algorithms to associate the *BrainHex* class with the answers related to the gamification elements preferences and discard the invalid responses, in the process of data treatment. The treated data with the validated answers in a *.csv* file was interpreted with the tool *RStudio*, where the statistical procedures and algorithms were applied.

Table 42 - Sample of experiment

Gamer type	**Sample**	**Male**	**Female**
Achiever	48	18	30
Conqueror	28	15	12
Daredevil	6	5	1
Mastermind	3	0	3
Seeker	16	5	11
Socializer	9	5	4
Survivor	12	4	8
Total	**122**	**52**	**69**

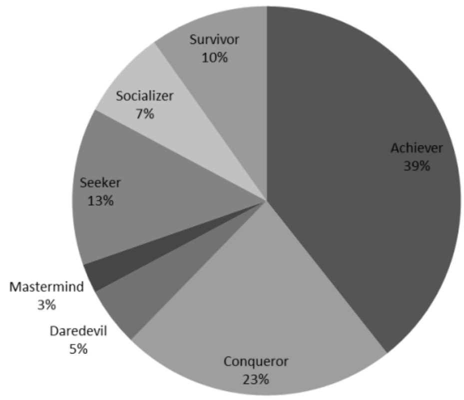


Figure 102 - Students gamer types

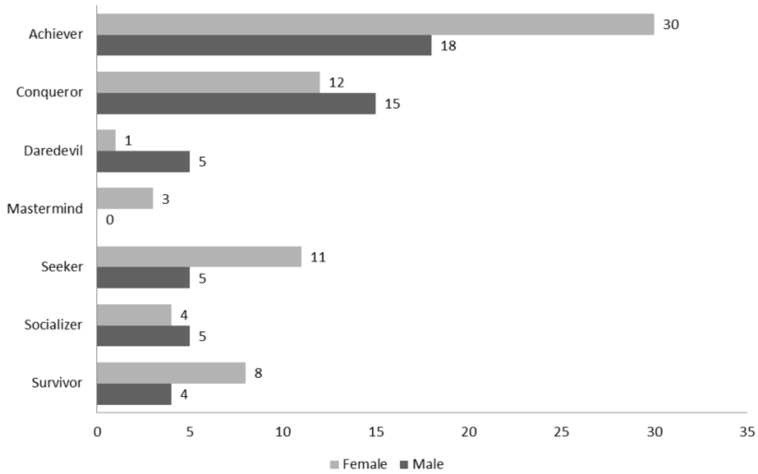


Figure 103 - Students gamer types and gender

Different of most of the experiments involving gamification and gamer types (*e.g*. Orji *el al*. (2014), Nack *et al*. (2014), Hamari (2015) and others), it is possible to perceive that a major part of this sample is composed by female students. However, the gender distribution is different according to the gamer types. In the achiever, mastermind, seeker, and survivor groups, most of the students are females, different from the original *BrainHex* sample (Nack *et al*. 2014). This situation can be explained because the college where this study was conducted had only female students until the year 2012, and it was the tradition of this school until now.

It is important to emphasize that the number of each gamer type group is different. Unfortunately, one specific gamer type does not have a significant number of students to obtain strong results. One gamer type (mastermind) has only three students (according to Bentler and Chou (1987), without statistical significance) and was disregarded in this study. Following, we will explain the specific results of each gamer type group.

To calculate the individual preferences of each gamer type in terms of gamification elements preferences, we initially used six different normalization testes: Shapiro-Wilk, Kolmogorov-smirnov, Skewness and Kurtosis, and graphical tests Boxplots, Histogram and QQ plots. These are commonly used in the community to ensure the type of data used and to choose the best tests to identify the answers to our research questions.

The Shapiro-Wilks test for normality is one of three general normality tests designed to detect all departures from normality (Shapiro and Wilk 1965). The test rejects the hypothesis of normality when the *p-value* is less than or equal to *0.05*. Failing the normality test allows you to state with 95% confidence that the data does not fit the regular distribution (Razali and Wah 2011).

Kolmogorov–Smirnov is a nonparametric test of continuous equality and one-dimensional distributions probability that can be used to compare a sample with distributions probabilty references (one-sample K–S test), or to compare two samples (two-sample K–S test) (Lopes *et al*. 2007). The test also rejects the hypothesis of normality when the *p-value* is less than or equal to *0.05*.

The Skewness-Kurtosis test for normality is one of three general normality tests designed to detect all departures from normality (Bai and Ng 2005). The normal distribution has a skewness of zero and kurtosis of three. The test is based on the difference between the data's skewness and zero and the data's kurtosis and three. The test rejects the hypothesis of normality when the *p-value* is less than or equal to *0.05*. Failing the normality test allows you to state with 95% confidence the data does not fit the normal distribution (Bai and Ng 2005).

In the descriptive statistics, the box plot or boxplot is a method for graphically depicting groups of numerical data through their quartiles. Box plots may also have lines extending vertically from the boxes (whiskers) indicating variability outside the upper and lower quartiles (McGill *et al*. 1978). Box plots are non-parametric, displaying variation in the samples of a statistical population without making any assumptions of the underlying statistical distribution.

Histogram is an accurate graphical representation of the numerical data distribution. It is an estimate of the distribution probability of a continuous variable (Pearson 1894). This allows the data inspection for its underlying distribution. In a histogram, it is the area of the bar that indicates the occurrences frequency for each bin. This means that the height position of the bar does not necessarily indicate how many scores ocurrences existed within each individual bin.

A QQ plot is a probability plot, which is a graphical method comparing two probabilities of distribution by plotting their quantiles against each other (Wilk and

Gnanadesikan 1968). A point (x, y) on the plot corresponds to one of the quantiles of the second distribution (y-coordinate) plotted against the same quantile of the first distribution (x-coordinate). Thus, the line is a parametric curve within the parameter, which is an interval number.

To identify the difference/variation on the students' perceptions in terms of gamification elements, after identifying the normality of our data, we used the one-way analysis of variation (ANOVA) and the Tukey's test. ANOVA is a technique that can be used to compare means of two or more samples (using the F distribution). This technique can be used only for a numerical answers data, which is named "Y" and is usually one variable, and numerical or categorical input data, named "X", which is always one variable, hence the "one-way" (Howell 2012).

Tukey's test is a single-step, multiple comparisons procedure and statistical test. It can be used on raw data or in conjunction with an ANOVA (post-hoc analysis) to find means that are significantly different from each other (Tukey 1949). Tukey's test compares the means of every treatment, applying simultaneously to the sets of all pairwise comparisons and identifying any difference between two means that is greater than the expected standard error. Next, we will present and analyses these tests for each gamer type.

5.3.12.1. Achiever student's preferences about gamification elements

Table 43 - Shapiro-Wilk test for achiever students

	w-value	***p-value***	**Hypothesis**
Points	*0.81935*	*3.668e-06*	H_0
Badges	*0.84588*	*1.693e-05*	H_0
Trophies	*0.8405*	*1.228e-05*	H_0
Levels	*0.89209*	*0.0003527*	H_1
Progress bar	*0.85983*	*4.009e-05*	H_0
Ranking and leaderboards	*0.79534*	*1.021e-06*	H_0
Timeline	*0.90842*	*0.00119*	H_1
History	*0.84119*	*1.279e-05*	H_0
Avatars	*0.77738*	*4.151e-07*	H_0
Feedback	*0.88658*	*0.0002384*	H_1

Table 44 - Kolmogorov-smirnov test for achiever students

	d-value	*p-value*	**Result**
Points	*0.22238*	*2.737e-06*	H_0
Badges	*0.19648*	*7.493e-05*	H_0
Trophies	*0.21031*	*1.358e-05*	H_0
Levels	*0.1792*	*0.0005227*	H_1
Progress bar	*0.23594*	*3.995e-07*	H_0
Ranking and leaderboards	*0.25019*	*4.599e-08*	H_0
Timeline	*0.13748*	*0.02371*	H_1
History	*0.22054*	*3.517e-06*	H_0
Avatars	*0.24918*	*5.383e-08*	H_0
Feedback	*0.14341*	*0.01486*	H_1

Table 45 - Skewness and Kurtosis test for achiever students

	Skewness	*Kurtosis*	**Result**
Points	*-1.012873*	*3.090171*	H_1
Badges	*-0.8691043*	*2.647773*	H_0
Trophies	*-0.8859728*	*2.859439*	H_0
Levels	*-0.3811162*	*2.028558*	H_0
Progress bar	*-0.6952918*	*2.283335*	H_0
Ranking and leaderboards	*-0.8374589*	*2.295812*	H_0
Timeline	*-0.1236503*	*2.032489*	H_0
History	*-0.9518337*	*3.021125*	H_0
Avatars	*-1.005894*	*2.657179*	H_1
Feedback	*-0.4552626*	*2.011694*	H_0

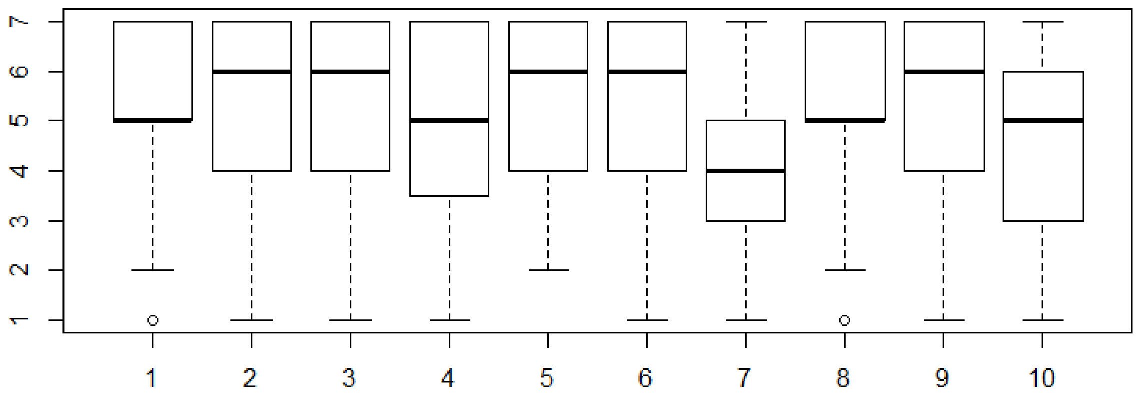


Figure 104 – Boxplots analyses for achiever students

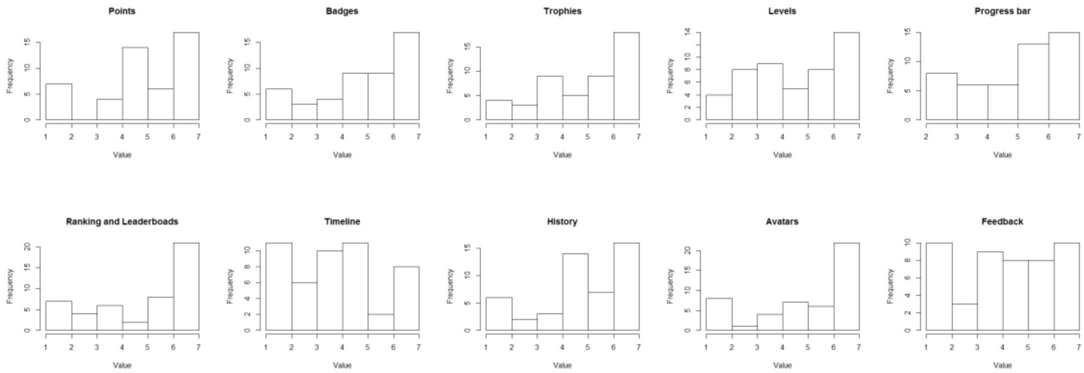


Figure 105 - Histogram analyses for achiever students

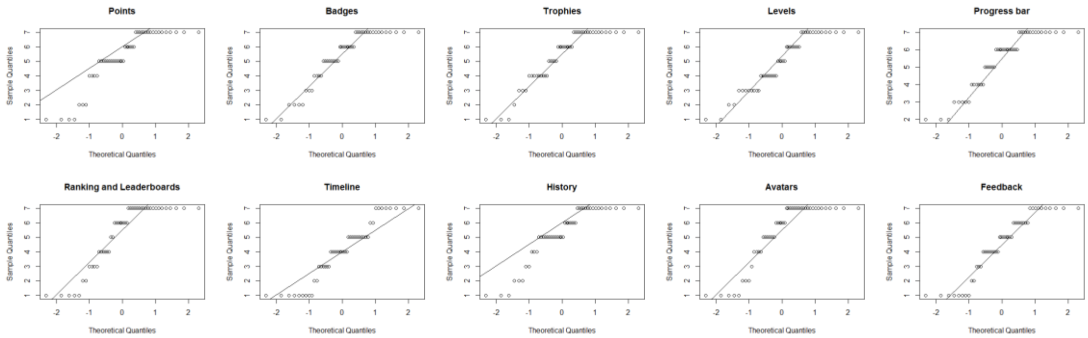


Figure 106 - QQ plots analyses for achiever students

The normality tests showed that most of our data presented a normal statistical distribution. In few cases the tests presented the possibility of unusual data. However, the indications of abnormalities were not sufficient to prove that the data was unusual, making it possible for us to consider that in these cases the data followed a normal distribution.

Like recent studies (*i.e.* Orji *et al*. 2014 and Nacke *et al*. 2011), is possible to perceive that to the achiever students there is no significant difference between the many gamification elements, since they enjoy most of it, with high preference for badges, trophies, and points, emphasizing that the achievers are competitive, preferring to win prizes during their activities. On the other hand, differently from the recent studies (*e.g.* Orji *et al*. 2013), results also indicated that the progress bar, avatars, history, and ranking can be interesting for this gamer type in a second moment. In other words, besides apparently these elements failing to keep the students interested, they also do not disturb them.

The elements levels, timeline, and feedback were not well accepted by the achievers in our study, confirming the results of previous studies, which showed that the achievers are not focused in following their own performance. This analysis is presented in Table **46**, displaying a general view of the student's preferences. Figure **109** presents a graphical analysis of the data, better explaining the different preferences of the students in terms of gamification elements. The ANOVA test indicates high index variation (0.00732) for Achiever students in terms of gamification elements preference.

Table 46 - Gamification elements preferences of the achiever students

Gamification elements	M	$\tilde{x}$	**Mod**	*var*(*X*)	σ_X
Points	*5.23*	*7.00*	*5.00*	*3.54211*	*1.882049*
Badges	*5.27*	*7.00*	*6.00*	*3.350621*	*1.83047*
Trophies	*5.31*	*7.00*	*6.00*	*3.283245*	*1.811973*
Levels	*4.94*	*7.00*	*5.00*	*3.293883*	*1.814906*
Progress bar	*5.38*	*7.00*	*6.00*	*2.537234*	*1.59287*
Ranking	*5.21*	*7.00*	*6.00*	*4.466312*	*2.113365*
Timeline	*4.04*	*5.00*	*4.00*	*3.955674*	*1.988888*
History	*5.23*	*7.00*	*5.00*	*3.286791*	*1.812951*
Avatars	*5.31*	*7.00*	*6.00*	*4.347074*	*2.084964*
Feedback	*4.48*	*7.00*	*5.00*	*4.297429*	*2.073024*

Index: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

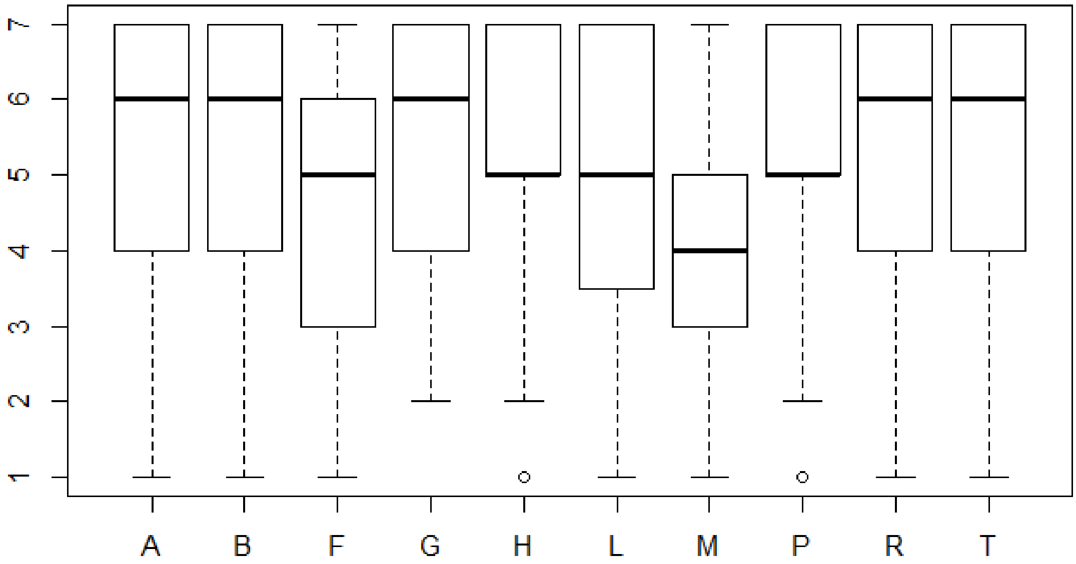


Figure 107 - Boxplot of the Achievers' preferences regarding the gamification element

Table 47 - Gamification elements variation correlation of the Achiever students

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	1.0000000	-	-	-	-	-	-	-	-	-
F	0.4994256	0.5754064	-	-	-	-	-	-	-	-
G	1.0000000	0.9999999	0.3899000	-	-	-	-	-	-	-
H	1.0000000	1.0000000	0.6506764	0.9999976	-	-	-	-	-	-
L	0.9940604	0.9975646	0.9754594	0.9821054	0.9991487	-	-	-	-	-
M	0.0385812	0.0532051	0.9821054	0.0231862	0.0722808	0.3899000	-	-	-	-
P	1.0000000	1.0000000	0.6506764	0.9999976	1.0000000	0.9991487	0.0722808	-	-	-
R	0.9999999	1.0000000	0.6871568	0.9999922	1.0000000	0.9995321	0.0837635	1.0000000	-	-
T	1.0000000	1.0000000	0.4994256	1.0000000	1.0000000	0.9940604	0.0385812	1.0000000	0.9999999	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

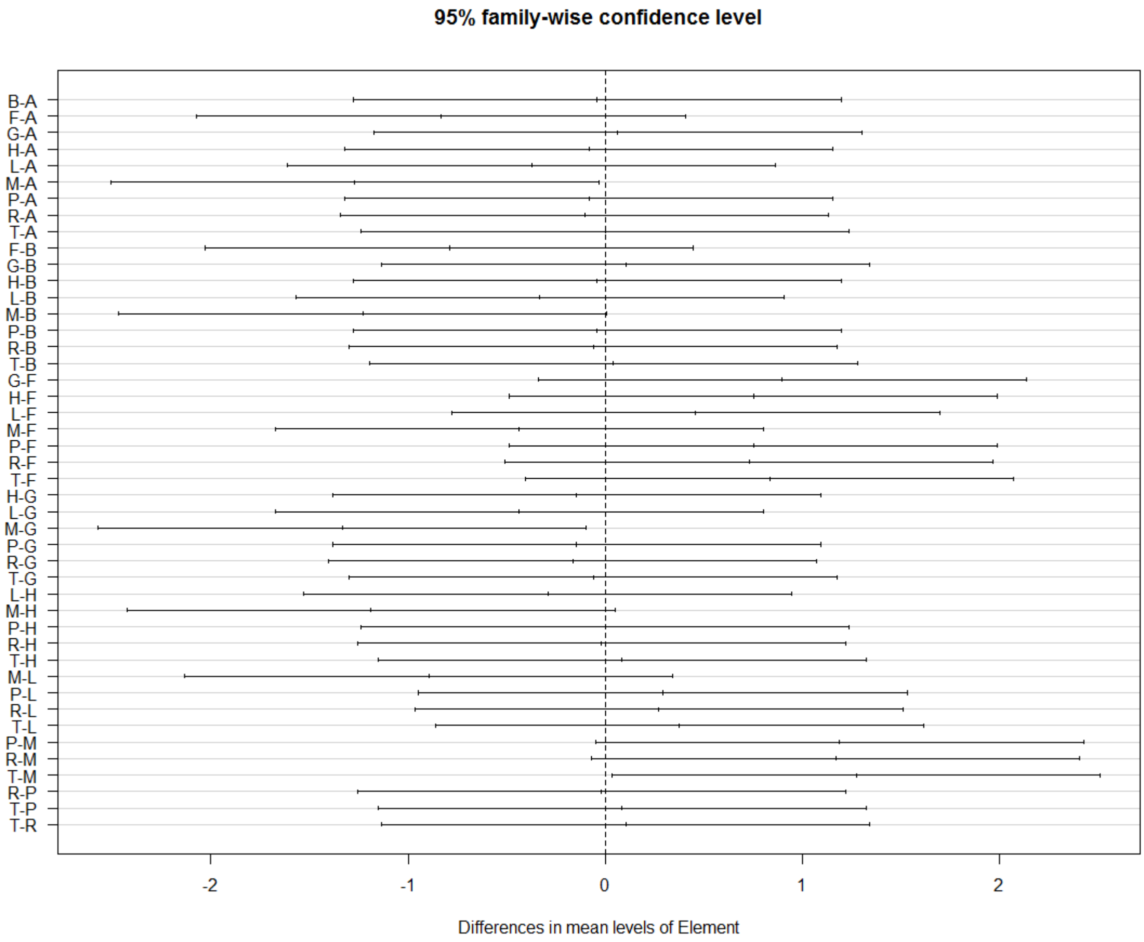


Figure 108 - Plot of gamification elements variation correlation of the Achiever students

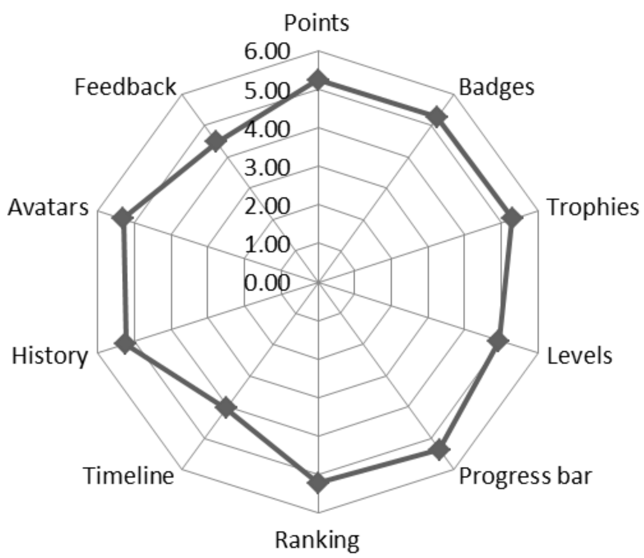


Figure 109 - Gamification elements preferences of the achiever students

5.3.12.2. Conqueror students preferences regarding the gamification elements

Table 48 - Shapiro-Wilk test for the Conqueror students

	w-value	***p-value***	**Result**
Points	*0.89467*	*0.008603*	H_1
Badges	*0.7516*	*1.672e-05*	H_0
Trophies	*0.86473*	*0.001882*	H_1
Levels	*0.84555*	*0.0007611*	H_1
Progress bar	*0.80193*	*0.0001155*	H_1
Ranking and leaderboards	*0.80227*	*0.0001171*	H_1
Timeline	*0.93671*	*0.09118*	H_0
History	*0.86037*	*0.001525*	H_1
Avatars	*0.79804*	*9.862e-05*	H_0
Feedback	*0.87397*	*0.002964*	H_1

Table 49 - Kolmogorov-smirnov test for the Conqueror students

	d-value	***p-value***	**Result**
Points	*0.16234*	*0.0568*	H_0
Badges	*0.30576*	*3.135e-07*	H_0
Trophies	*0.19745*	*0.006661*	H_0
Levels	*0.21829*	*0.001451*	H_1
Progress bar	*0.24492*	*0.0001576*	H_1
Ranking and leaderboards	*0.22073*	*0.0012*	H_1
Timeline	*0.13303*	*0.2312*	H_0
History	*0.18714*	*0.01321*	H_0
Avatars	*0.26253*	*3.071e-05*	H_0
Feedback	*0.18759*	*0.01283*	H_1

Table 50 - Skewness and Kurtosis test for the Conqueror students

	Skewness	***Kurtosis***	**Result**
Points	*-0.7596945*	*2.977266*	H_0
Badges	*-1.049197*	*2.699312*	H_1
Trophies	*-0.6939161*	*2.36521*	H_0
Levels	*-0.774905*	*2.499339*	H_0
Progress bar	*-1.116191*	*3.145221*	H_1
Ranking and leaderboards	*-1.32832*	*4.074531*	H_1

Timeline	*-0.1788952*	*2.099213*	H_0
History	*-0.6613058*	*2.308677*	H_0
Avatars	*-0.8387955*	*2.447613*	H_0
Feedback	*-0.2756436*	*1.678763*	H_0

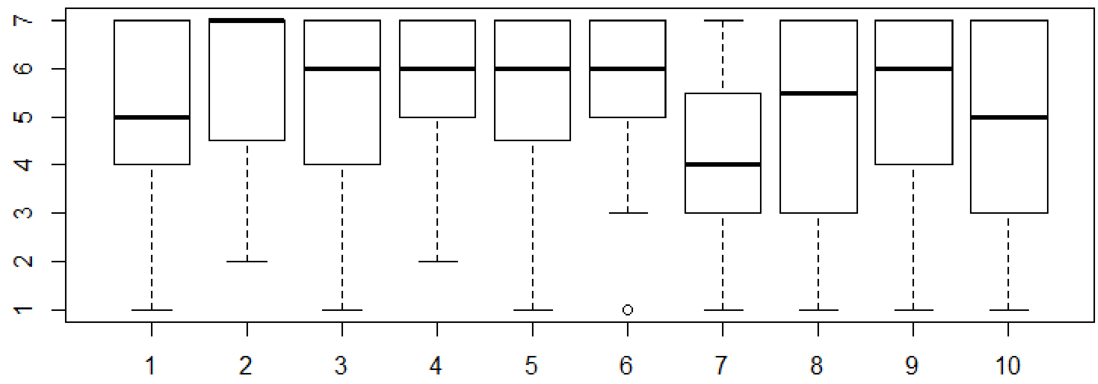


Figure 110 - Boxplots analyses for the Conquero' students

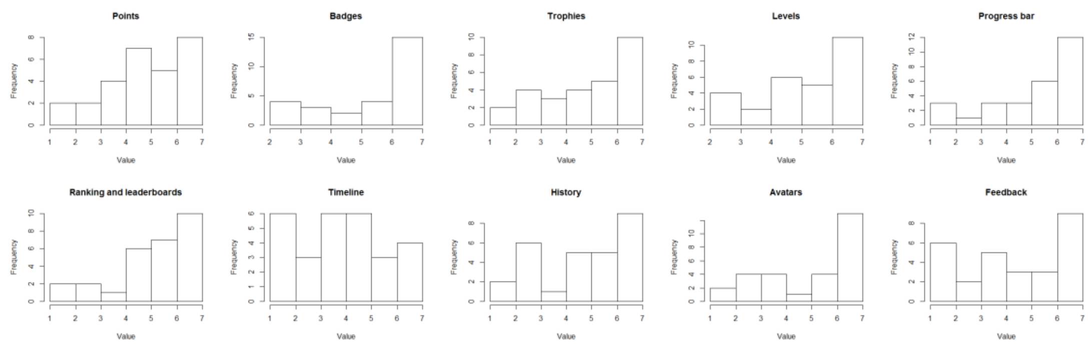


Figure 111 - Histogram analyses for the Conqueror students

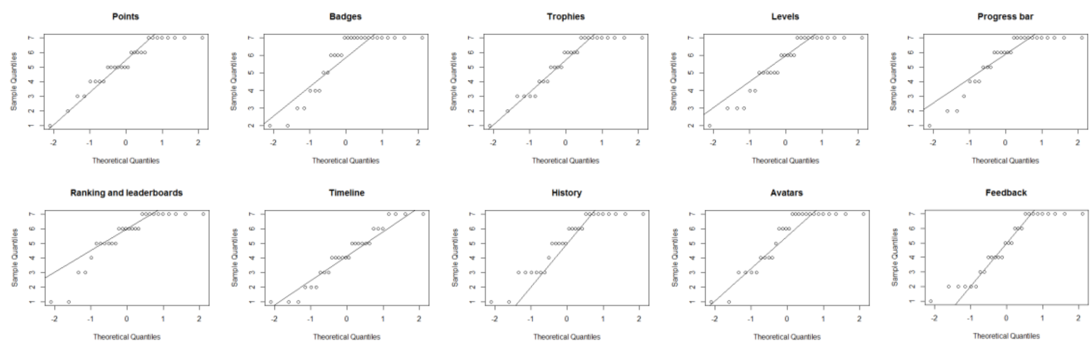


Figure 112 - QQ plots analyses for the Conqueror students

In these tests, most of the presented data displayed a normal statistical distribution. In few cases the tests presented the possibility of unusual data. However, the indications of abnormalities were not sufficient to prove that the data was unusual, making it possible for us to consider that in these specific cases the data followed a normal distribution.

Similar to the achievers, the conqueror students apparently enjoyed most of the gamification elements evaluated. The gamification elements timeline and feedback were also not well accepted by the conqueror students. This result is contradictory to the recent studies in this field, in terms of gamification elements preferences. The previous studies (*i.e.* Orji *et al*. (2013) and Orji *et al*. (2014)) identified that conquerors are better motivated by the rankings and badges elements. However, our results showed that conquerors can be also motivated for other gamification elements. On the other hand, our result is similar to some theories about player types (*i.e.* Bateman and Boon 2005), indicating that the conqueror is a type of player that enjoys adquiring and collecting different prizes. Table **51** presents a general view of the student's preferences and Figure **113** presents a graphical analysis of the data, better explaining the different preferences of students in terms of gamification elements. The ANOVA test indicates high index variation (0.0721) for Conqueror students in terms of gamification elements preference.

Table 51 - Gamification elements preferences of the Conqueror students

Gamification elements	M	$\tilde{x}$	**Mod**	*var*(*X*)	σ_X
Points	*5.21*	*7.00*	*5.00*	*2.693122*	*1.641073*
Badges	*5.75*	*7.00*	*7.00*	*2.861111*	*1.691482*
Trophies	*5.25*	*7.00*	*6.00*	*3.231481*	*1.797632*
Levels	*5.57*	*7.00*	*6.00*	*2.328042*	*1.525792*
Progress bar	*5.54*	*7.00*	*6.00*	*3.220899*	*1.794686*
Ranking	*5.50*	*7.00*	*6.00*	*3*	*1.732051*
Timeline	*4.21*	*4.00*	*4.00*	*3.507937*	*1.872949*
History	*5.07*	*7.00*	*5.50*	*3.624339*	*1.90377*
Avatars	*5.36*	*7.00*	*6.00*	*3.867725*	*1.966653*
Feedback	*4.75*	*7.00*	*5.00*	*4.12037*	*2.02987*

Indices: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

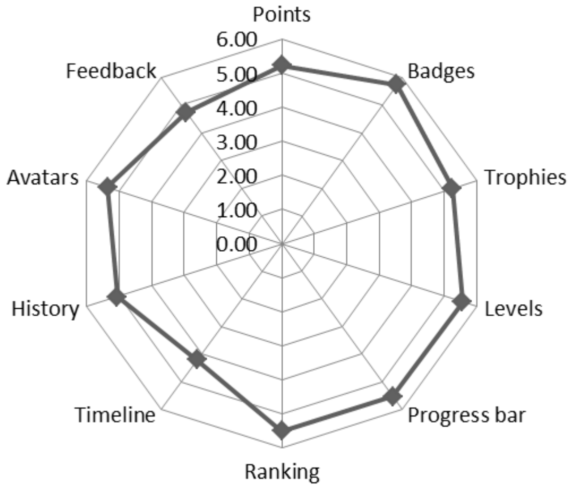


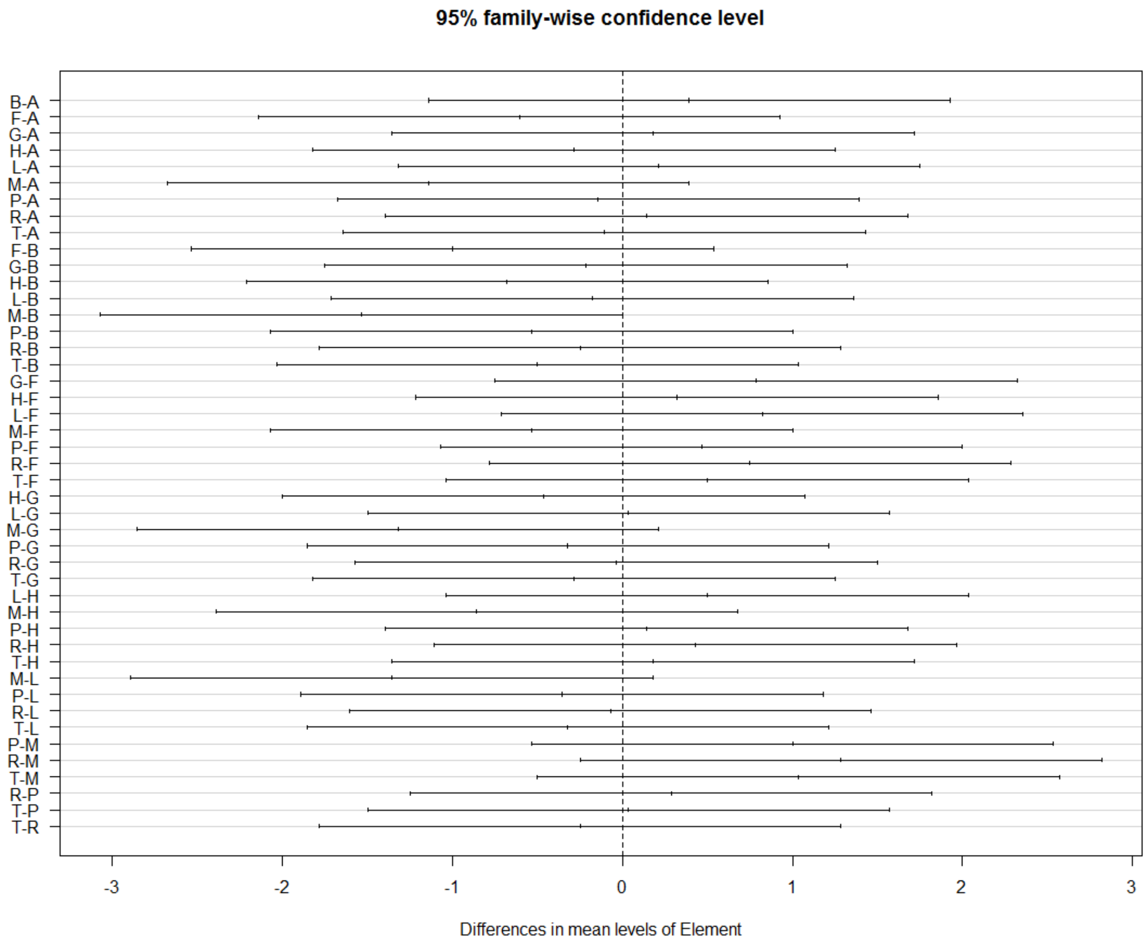
Figure 113 - Gamification elements preferences of the Conqueror students

Table 52 - Gamification elements varience correlation of Conqueror studnets

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	0.9983000	-	-	-	-	-	-	-	-	-
F	0.9612207	0.5454328	-	-	-	-	-	-	-	-
G	0.9999977	0.9999889	0.8314143	-	-	-	-	-	-	-
H	0.9998719	0.9235532	0.9996601	0.9939345	-	-	-	-	-	-
L	0.9999889	0.9999977	0.7912992	1.0000000	0.9896047	-	-	-	-	-
M	0.3459389	0.0501211	0.9831197	0.1615766	0.7471433	0.1354386	-	-	-	-
P	0.9999997	0.9831197	0.9939345	0.9996601	0.9999997	0.9992010	0.5454328	-	-	-
R	0.9999997	0.9999585	0.8669878	1.0000000	0.9966725	1.0000000	0.1912518	0.9998719	-	-
T	1.0000000	0.9896047	0.9896047	0.9998719	0.9999977	0.9996601	0.4932247	1.0000000	0.9999585	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

Table 53 - Plot of gamification elements variation correlation of the Conqueror students



5.3.12.3. Daredevil students preferences about gamification elements

Table 54 - Shapiro-Wilk test for the Daredevil students

	w-value	***p-value***	**Result**
Points	*0.84715*	*0.1492*	H_0
Badges	*0.95139*	*0.7515*	H_0
Trophies	*0.74145*	*0.01641*	H_1
Levels	*0.80126*	*0.06032*	H_0
Progress bar	*0.92409*	*0.5353*	H_0
Ranking and leaderboards	*0.945*	*0.6997*	H_0
Timeline	*0.96743*	*0.8748*	H_0
History	*0.80871*	*0.0703*	H_0
Avatars	*0.77248*	*0.03277*	H_1

Feedback	*0.83114*	*0.1099*	H_0

Table 55 - Kolmogorov-smirnov test for the Daredevil students

	d-value	***p-value***	**Result**
Points	*0.29715*	*0.09912*	H_0
Badges	*0.21379*	*0.5288*	H_0
Trophies	*0.31692*	*0.0599*	H_0
Levels	*0.27624*	*0.1612*	H_0
Progress bar	*0.26603*	*0.2023*	H_0
Ranking and leaderboards	*0.23806*	*0.3554*	H_0
Timeline	*0.19775*	*0.6531*	H_0
History	*0.26676*	*0.1991*	H_0
Avatars	*0.25113*	*0.2766*	H_0
Feedback	*0.2854*	*0.1307*	H_0

Table 56 - Skewness and Kurtosis test for the Daredevil students

	Skewness	***Kurtosis***	**Result**
Points	*-0.6896297*	*2.607686*	H_0
Badges	*0*	*2.580247*	H_0
Trophies	*-0.05656854*	*1.068*	H_0
Levels	*-0.9387234*	*2.609467*	H_0
Progress bar	*0.5058597*	*2.800238*	H_0
Ranking and leaderboards	*-0.5896974*	*2.522985*	H_0
Timeline	*0.099779*	*2.050242*	H_0
History	*-0.988645*	*2.567887*	H_0
Avatars	*-1.223028*	*3.057075*	H_1
Feedback	*-0.6495191*	*1.875*	H_0

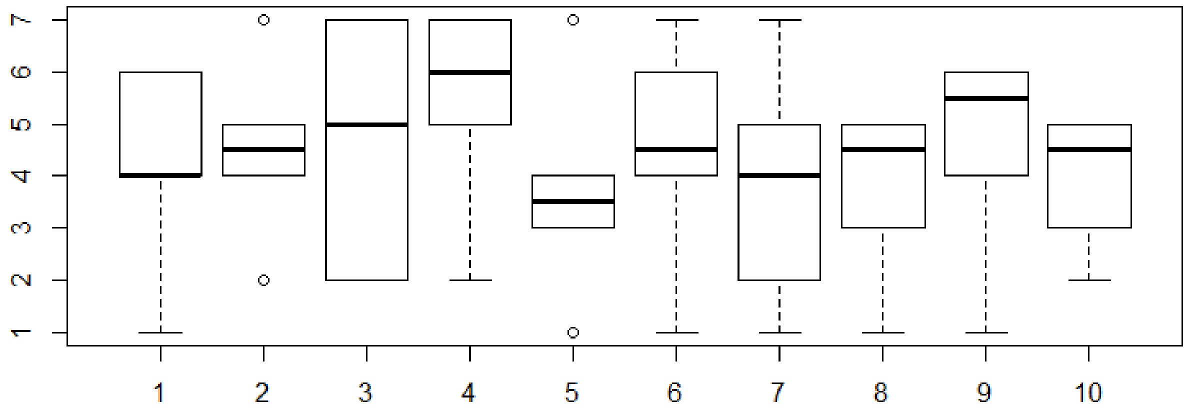


Figure 114 - Boxplots analyses for Daredevil students

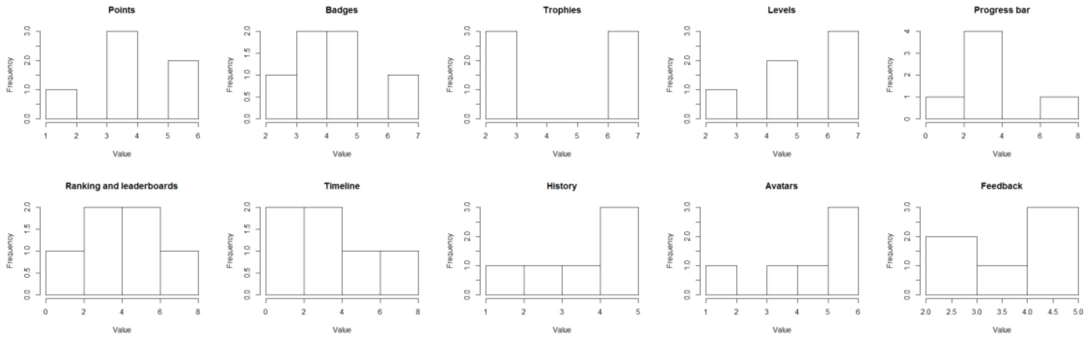


Figure 115 - Histogram analyses for Daredevil students

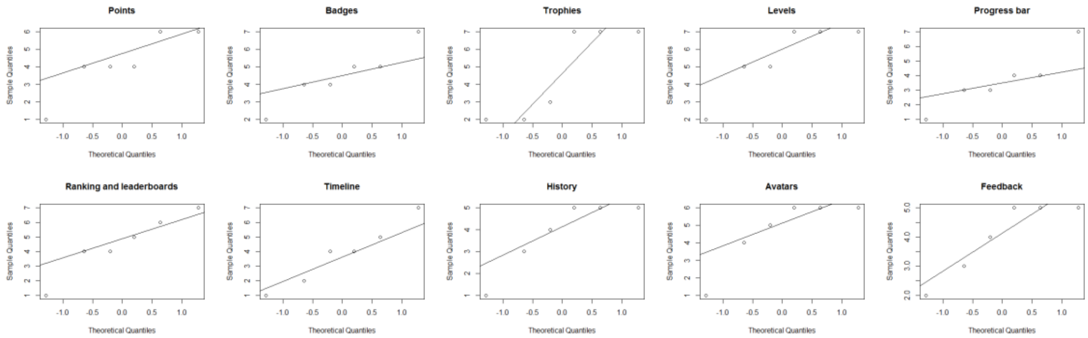


Figure 116 - QQ plots analyses for daredevil' students

To the normality tests of the Daredevils, most of the data presented a normal statistical distribution. Only few graphical tests presented the possibility of unusual data, making it possible for us to consider that in these cases the data followed a normal distribution.

Different from achievers and conquerors, daredevil students do not seem to enjoy most of the gamification elements, and our results indicated that the daredevils are not interested in many gamification elements, as they enjoy more the gamification element “level”. The gamification elements trophies and avatars were also enjoyable to this gamer type. Our result confirms findings of recent studies (*i.e*. Orji *et al*. (2013) and Orji *et al*. (2014)), that indicated that the daredevils enjoy monitoring their activities sequence and achievements, such as progress bar, levels, and avatar (with evolution). Our findings also indicated that in a second moment, daredevils can be motivated by rankings. Table 46 presents the general structure of data and Figure **117** synthesize the preferences of the daredevil students in terms of gamification elements. The ANOVA test indicates high index variation (0.878) for Daredevil students in terms of gamification elements preference.

Table 57 - Gamification elements preferences of the Daredevil students

Gamification elements	M	$\tilde{x}$	**Mod**	*var*(*X*)	σ_X
Points	*4.17*	*4.00*	*4.00*	*3.366667*	*1.834848*
Badges	*4.50*	*5.00*	*4.50*	*2.7*	*1.643168*
Trophies	*4.67*	*7.00*	*5.00*	*6.666667*	*2.581989*
Levels	*5.50*	*7.00*	*6.00*	*3.9*	*1.974842*
Progress bar	*3.67*	*3.00*	*3.50*	*3.866667*	*1.966384*
Ranking	*4.50*	*4.00*	*4.50*	*4.3*	*2.073644*
Timeline	*3.83*	*4.00*	*4.00*	*4.566667*	*2.136976*
History	*3.83*	*5.00*	*4.50*	*2.566667*	*1.602082*
Avatars	*4.67*	*6.00*	*5.50*	*3.866667*	*1.966384*
Feedback	*4.00*	*5.00*	*4.50*	*1.6*	*1.264911*

Indices: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

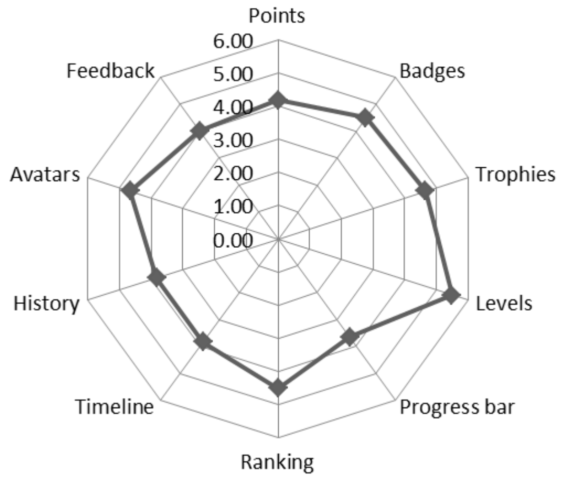


Figure 117 - Gamification elements preferences of the Daredevil students

Table 58 - Gamification elements variation correlation of the Daredevil students

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	1.0000000	-	-	-	-	-	-	-	-	-
F	0.9998356	0.9999855	-	-	-	-	-	-	-	-
G	0.9959429	0.9989992	0.9999996	-	-	-	-	-	-	-
H	0.9989992	0.9998356	1.0000000	1.0000000	-	-	-	-	-	-
L	0.9989992	0.9959429	0.9380734	0.8210274	0.8887133	-	-	-	-	-
M	0.9989992	0.9998356	1.0000000	1.0000000	1.0000000	0.8887133	-	-	-	-
P	0.9999855	0.9999996	1.0000000	0.9999855	0.9999996	0.9699319	0.9999996	-	-	-
R	1.0000000	1.0000000	0.9999855	0.9989992	0.9998356	0.9959429	0.9998356	0.9999996	-	-
T	1.0000000	1.0000000	0.9998356	0.9959429	0.9989992	0.9989992	0.9989992	0.9999855	1.0000000	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

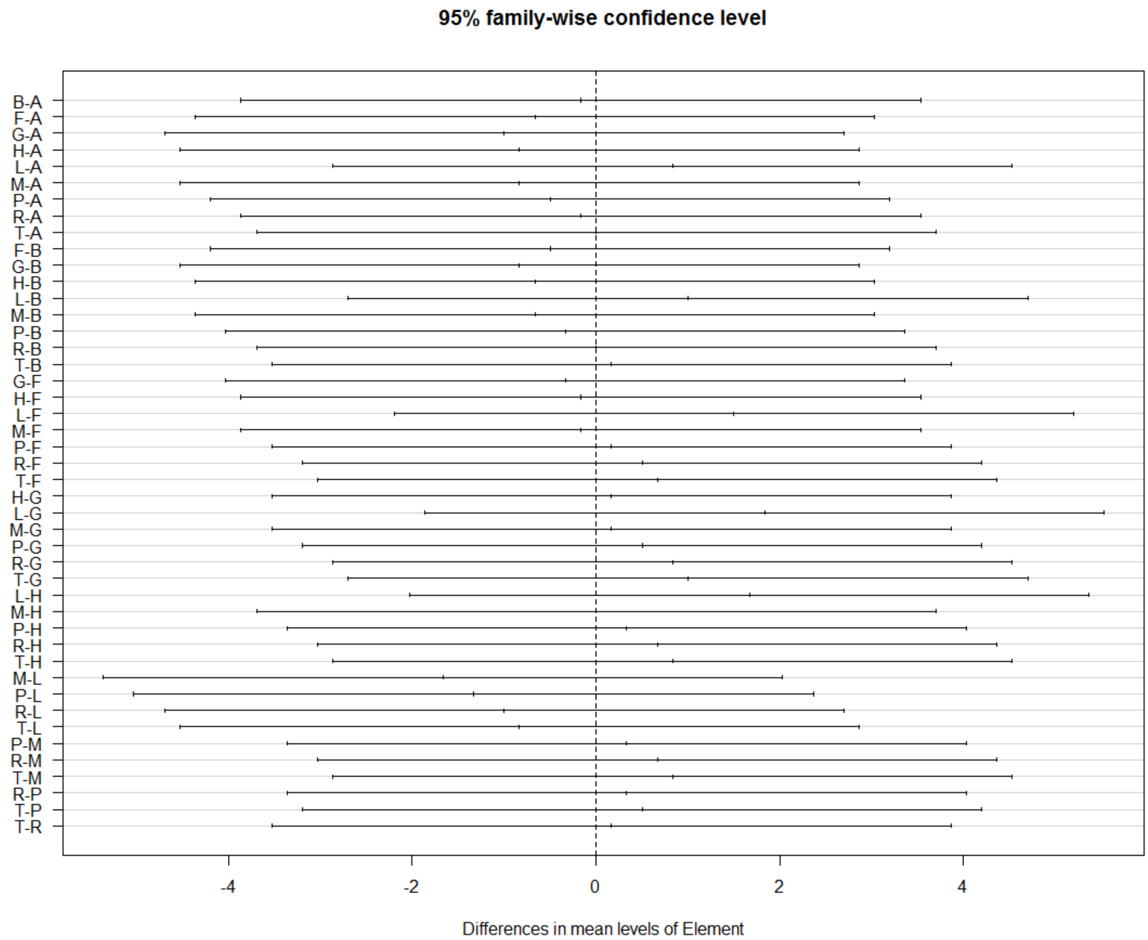


Figure 118 - Plot of gamification elements variation correlation of the Daredevil students

5.3.12.4. Mastermind students' preferences regarding gamification elements

Unfortunately, only three masterminds were identified in this study, and they don´t represent a significant number of students to support our hypothesis.

5.3.12.5. Seeker students' preferences regarding gamification elements

Table 59 - Shapiro-Wilk test for Seeker students

	w-value	***p-value***	**Result**
Points	*0.82216*	*0.005448*	H_1
Badges	*0.74879*	*0.0006144*	H_1
Trophies	*0.87859*	*0.0369*	H_1
Levels	*0.9017*	*0.08556*	H_0
Progress bar	*0.9065*	*0.1022*	H_0
Ranking and leaderboards	*0.82645*	*0.006251*	H_1
Timeline	*0.8467*	*0.01219*	H_1
History	*0.87319*	*0.03045*	H_1
Avatars	*0.86421*	*0.0222*	H_1
Feedback	*0.90293*	*0.08956*	H_0

Table 60 - Kolmogorov-smirnov test for Seeker students

	d-value	***p-value***	**Result**
Points	*0.25226*	*0.007606*	H_1
Badges	*0.22663*	*0.02746*	H_0
Trophies	*0.16089*	*0.3263*	H_0
Levels	*0.17483*	*0.2129*	H_0
Progress bar	*0.20159*	*0.0814*	H_0
Ranking and leaderboards	*0.24151*	*0.01331*	H_1
Timeline	*0.18388*	*0.1573*	H_0
History	*0.19813*	*0.09338*	H_0
Avatars	*0.21897*	*0.03896*	H_1
Feedback	*0.16379*	*0.3*	H_0

Table 61 - Skewness and Kurtosis test for Seeker students

	Skewness	***Kurtosis***	**Result**
Points	*-0.800442*	*2.550695*	H_0
Badges	*-1.394274*	*3.826667*	H_1
Trophies	*-0.8057735*	*2.926315*	H_0
Levels	*-0.6678448*	*2.411153*	H_0
Progress bar	*-0.5746163*	*2.602487*	H_0
Ranking and leaderboards	*-0.6555802*	*1.87947*	H_0
Timeline	*-0.1129766*	*1.431172*	H_0
History	*-0.184847*	*1.736356*	H_0
Avatars	*-0.4360996*	*1.877526*	H_0
Feedback	*-0.5374566*	*2.087935*	H_0

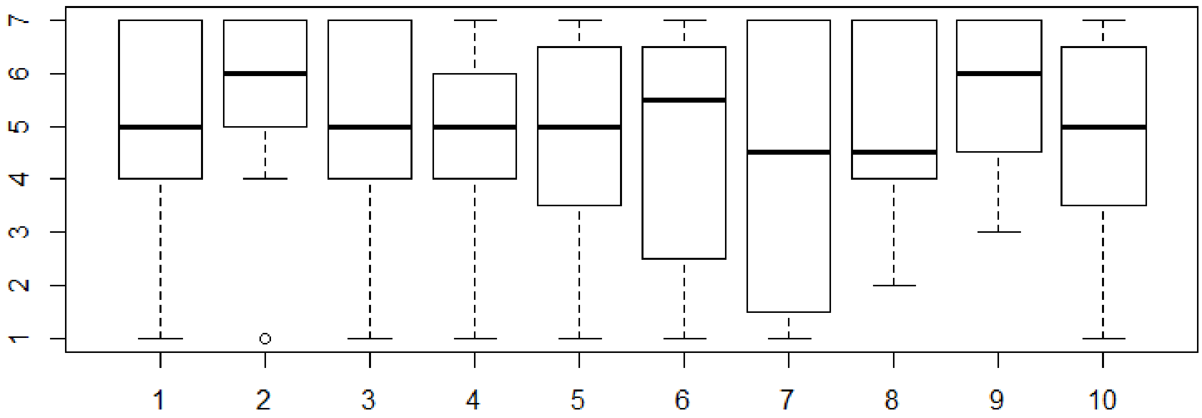


Figure 119 - Boxplots analyses for Seeker students

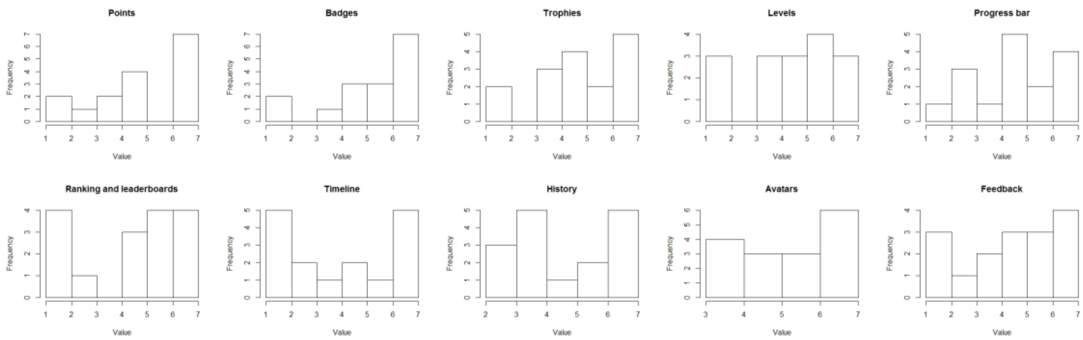


Figure 120 - Histogram analyses for Seeker students

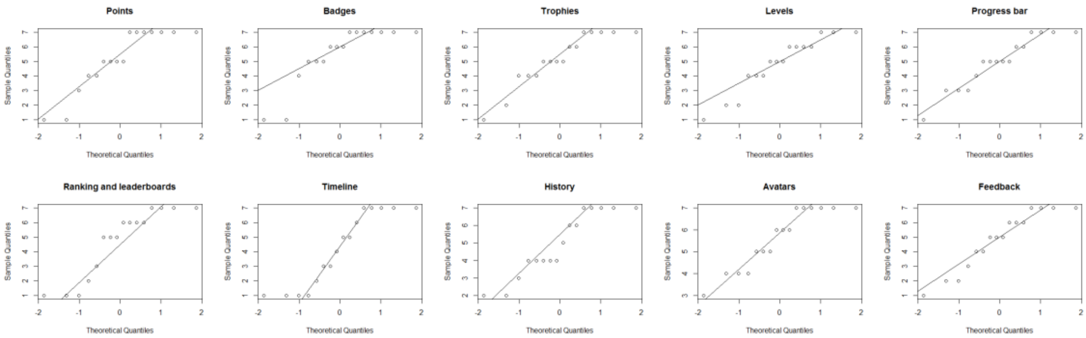


Figure 121 - QQ plots analyses for Seeker students

With the Seekers it was also not possible to confirm the unusal data. The seekers didn´t present a great interest for many gamification elements. They are more interested in points, badges, trophies, and avatars. At the same time, the statistical difference between these gamification elements is not significant, confirming the results of recent studies in this field (Orji et al. (2013) and Orji et al. (2014)) and pointing out for the fact that seekers are more interest in points, badges, and trophies, but especially in the opportunity of choosing their prizes (choose with badges or trophies intend to receive). Our findings also confirm the preferences of this gamer type in following an adapted history. Table 62 shows the general structure of data and Figure 115 synthesize the preferences of daredevil students in terms of gamification elements. The ANOVA test indicates high index variation (0.719) for Seeker students in terms of gamification elements preference.

Table 62 - Gamification elements preferences of seeker' students

Gamification elements	M	$\tilde{x}$	**Mod**	$var(X)$	σ_X
Points	*5.13*	*7.00*	*5.00*	*4.383333*	*2.093641*
Badges	*5.50*	*7.00*	*6.00*	*4*	*2*
Trophies	*5.13*	*7.00*	*5.00*	*3.316667*	*1.821172*
Levels	*4.81*	*6.00*	*5.00*	*3.495833*	*1.869715*
Progress bar	*4.94*	*5.00*	*5.00*	*3.129167*	*1.768945*
Ranking	*4.69*	*6.00*	*5.50*	*5.295833*	*2.301268*
Timeline	*4.19*	*7.00*	*4.50*	*6.1625*	*2.482438*
History	*4.94*	*7.00*	*4.50*	*3.2625*	*1.806239*
Avatars	*5.63*	*7.00*	*6.00*	*1.85*	*1.360147*
Feedback	*4.81*	*7.00*	*5.00*	*3.895833*	*1.973787*

Indices: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

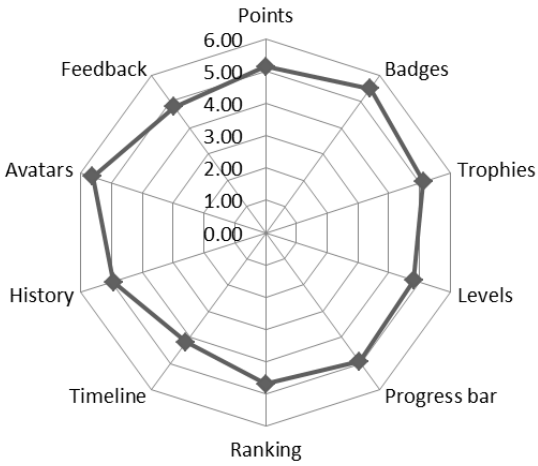


Figure 122 - Gamification elements preferences of the Seeker students

Table 63 - Gamification elements variation correlation of the Seeker students

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	1.0000000	-	-	-	-	-	-	-	-	-
F	0.9762006	0.9925978	-	-	-	-	-	-	-	-
G	0.9925978	0.9983782	1.0000000	-	-	-	-	-	-	-
H	0.9925978	0.9983782	1.0000000	1.0000000	-	-	-	-	-	-
L	0.9762006	0.9925978	1.0000000	1.0000000	1.0000000	-	-	-	-	-
M	0.5554057	0.6792121	0.9963521	0.9862264	0.9862264	0.9963521	-	-	-	-
P	0.9993636	0.9999412	0.9999876	0.9999999	0.9999999	0.9999876	0.9409082	-	-	-
R	0.9409082	0.9762006	1.0000000	0.9999982	0.9999982	1.0000000	0.9993636	0.9997862	-	-
T	0.9993636	0.9999412	0.9999876	0.9999999	0.9999999	0.9999876	0.9409082	1.0000000	0.9997862	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

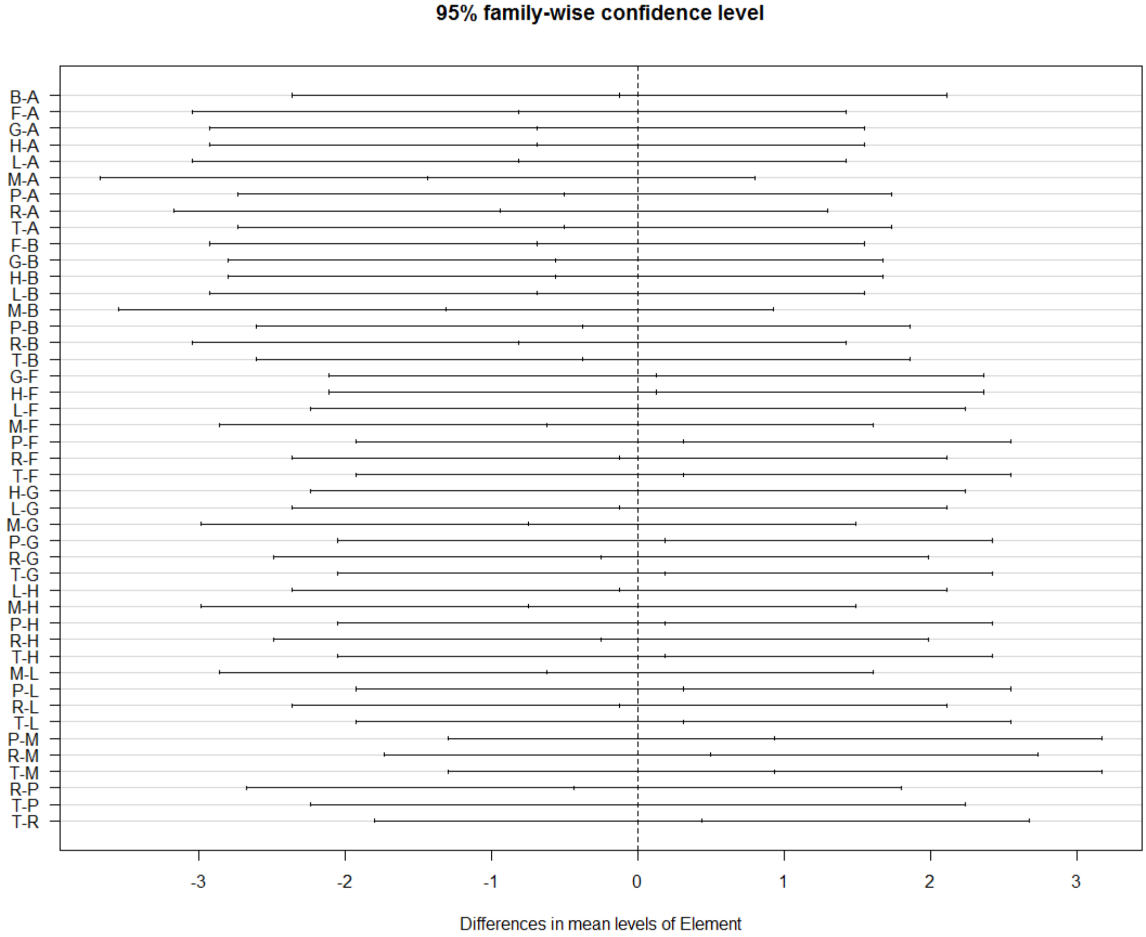


Figure 123 - Plot of gamification elements variation correlation of the Seeker students

5.3.12.6. Socializer students' preferences regarding gamification elements

Table 64 - Shapiro-Wilk test for Socializer students

	w-value	***p-value***	**Result**
Points	*0.81936*	*0.03389*	H_1
Badges	*0.91152*	*0.3267*	H_0
Trophies	*0.94361*	*0.6204*	H_0
Levels	*0.7569*	*0.006518*	H_1
Progress bar	*0.84363*	*0.06337*	H_0
Ranking and leaderboards	*0.65474*	*0.0004194*	H_1
Timeline	*0.9269*	*0.4524*	H_0
History	*0.82841*	*0.04286*	H_0

Avatars	*0.71861*	*0.00234*	H_1
Feedback	*0.9033*	*0.2717*	H_0

Table 65 - Kolmogorov-smirnov test for Socializer students

	d-value	***p-value***	**Result**
Points	*0.33002*	*0.005437*	H_1
Badges	*0.23688*	*0.154*	H_0
Trophies	*0.20944*	*0.3058*	H_0
Levels	*0.26694*	*0.06378*	H_0
Progress bar	*0.28023*	*0.0401*	H_1
Ranking and leaderboards	*0.35602*	*0.001628*	H_1
Timeline	*0.17608*	*0.5824*	H_0
History	*0.25407*	*0.09724*	H_0
Avatars	*0.2931*	*0.02488*	H_1
Feedback	*0.1773*	*0.5712*	H_0

Table 66 - Skewness and Kurtosis test for Socializer students

	Skewness	***Kurtosis***	**Result**
Points	*0.5813777*	*1.77*	H_0
Badges	*-0.34375*	*1.828125*	H_0
Trophies	*-0.3894916*	*2.193333*	H_0
Levels	*-0.2203614*	*1.192182*	H_0
Progress bar	*-0.8879234*	*2.37312*	H_0
Ranking and leaderboards	*-0.2236068*	*1.05*	H_0
Timeline	*0.1732174*	*1.706191*	H_0
History	*-0.7594315*	*2.587347*	H_0
Avatars	*-0.1123689*	*1.107823*	H_0
Feedback	*-0.5438441*	*2.246318*	H_0

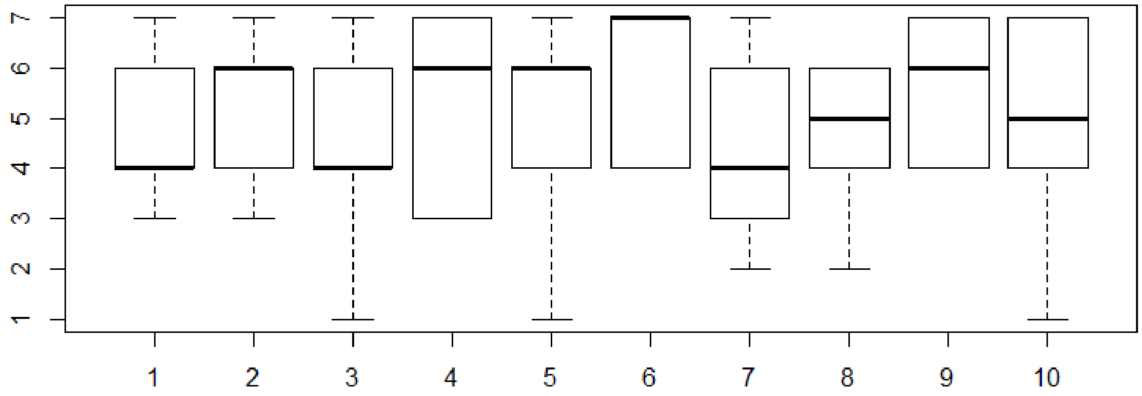


Figure 124 - Boxplots analyses for Socializer students

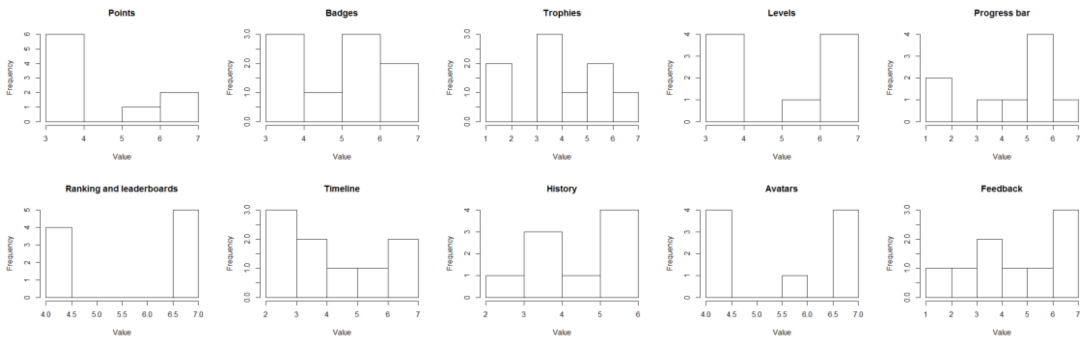


Figure 125 - Histogram analyses for Socializer students

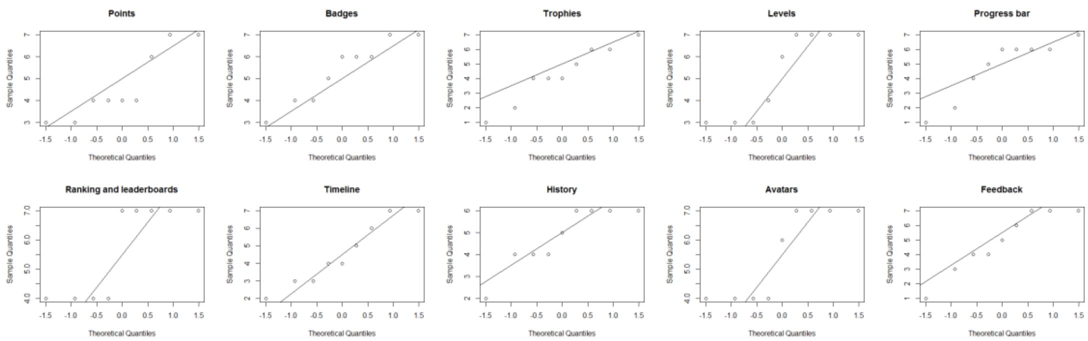


Figure 126 - QQ plots analyses for Socializer students

In these tests, most of the results showed that the data has a normal distribution. The Socializers exhibited a deep interest for four specific gamification elements: ranking, avatar, badges, and levels. In a similar way to the results of recent performed studies, our findings indicated an interest by the part of the socializers for rankings and levels. Recent findings indicated that socializers are more interested in displaying their performance to other people and sharing their achievements. However, the results of our research also indicated that the Socializers have a huge interest for other gamification elements, such as avatars and badges, pointing to a difference from the recent studies (*i.e*. Orji *et al*. (2013)). Table **67** presents the general structure of the data and Figure **127** synthesize the preferences of socializer students in terms of gamification elements. The ANOVA test indicates high index variation (0.809) for Seeker students in terms of gamification elements preference.

Table 67 - Gamification elements preferences of Socializer students

Gamification elements	M	$\tilde{x}$	**Mod**	*var*(*X*)	σ_X
Points	*4.67*	*4.00*	*4.00*	*2.5*	*1.581139*
Badges	*5.33*	*6.00*	*6.00*	*2*	*1.414214*
Trophies	*4.33*	*4.00*	*4.00*	*3.75*	*1.936492*
Levels	*5.22*	*7.00*	*6.00*	*3.694444*	*1.922094*
Progress bar	*4.78*	*6.00*	*6.00*	*4.194444*	*2.048034*
Ranking	*5.67*	*7.00*	*7.00*	*2.5*	*1.581139*
Timeline	*4.56*	*3.00*	*4.00*	*3.277778*	*1.810463*
History	*4.78*	*6.00*	*5.00*	*1.944444*	*1.394433*
Avatars	*5.56*	*7.00*	*6.00*	*2.277778*	*1.509231*
Feedback	*4.89*	*7.00*	*5.00*	*4.361111*	*2.088327*

Indices: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

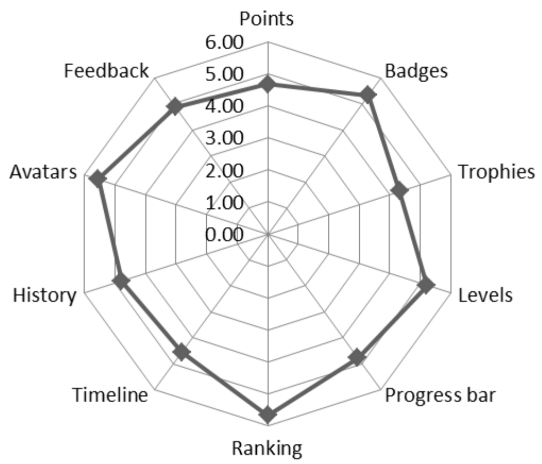


Figure 127 - Gamification elements preferences of the Socializer students

Table 68 - Gamification elements variation correlation of the Socializer students

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	0.9999998	-	-	-	-	-	-	-	-	-
F	0.9982443	0.9999353	-	-	-	-	-	-	-	-
G	0.9943601	0.9995884	1.0000000	-	-	-	-	-	-	-
H	0.9943601	0.9995884	1.0000000	1.0000000	-	-	-	-	-	-
L	0.9999945	1.0000000	0.9999945	0.9999353	0.9999353	-	-	-	-	-
M	0.9678826	0.9943601	0.9999945	0.9999998	0.9999998	0.9982443	-	-	-	-
P	0.9853663	0.9982443	0.9999998	1.0000000	1.0000000	0.9995884	1.0000000	-	-	-
R	1.0000000	0.9999945	0.9943601	0.9853663	0.9853663	0.9999353	0.9384115	0.9678826	-	-
T	0.8943114	0.9678826	0.9995884	0.9999353	0.9999353	0.9853663	0.9999998	0.9999945	0.8346782	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

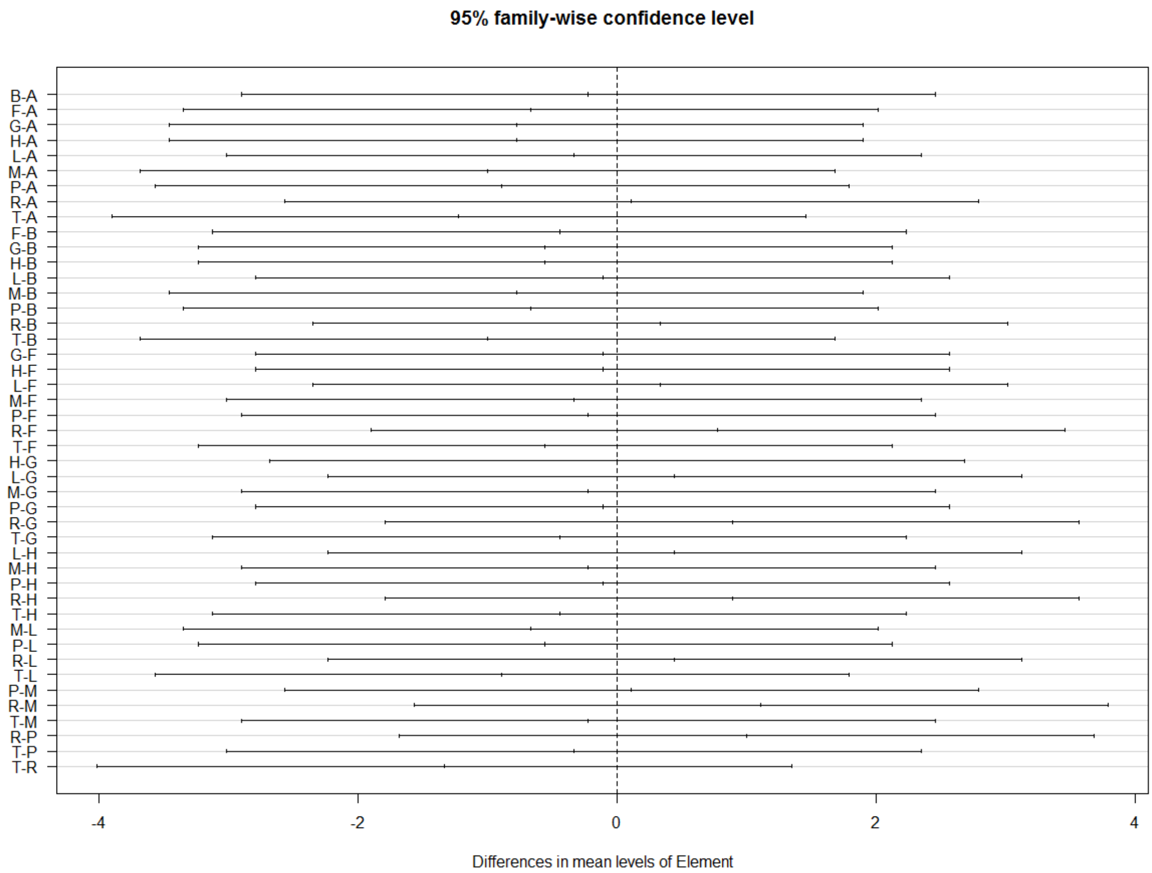


Figure 128 - Plot of gamification elements variation correlation of the Socializer students

5.3.12.7. Survivor students' preferences regarding gamification elements

Table 69 - Shapiro-Wilk test for Survivor students

	w-value	***p-value***	**Result**
Points	*0.82796*	*0.01983*	H_1
Badges	*0.73212*	*0.00175*	H_1
Trophies	*0.81415*	*0.01363*	H_1
Levels	*0.88449*	*0.1001*	H_0
Progress bar	*0.82986*	*0.02089*	H_1
Ranking and leaderboards	*0.68316*	*0.0005829*	H_1
Timeline	*0.87931*	*0.08588*	H_0
History	*0.75834*	*0.00327*	H_1
Avatars	*0.58743*	*8.444e-05*	H_0
Feedback	*0.92139*	*0.2976*	H_0

Table 70 - Kolmogorov-smirnov test for Survivor students

	d-value	***p-value***	**Result**
Points	*0.29421*	*0.005074*	H_1
Badges	*0.35343*	*0.0001883*	H_1
Trophies	*0.20995*	*0.1523*	H_0
Levels	*0.20207*	*0.1926*	H_0
Progress bar	*0.2341*	*0.06824*	H_0
Ranking and leaderboards	*0.30889*	*0.002399*	H_1
Timeline	*0.21313*	*0.1383*	H_0
History	*0.35766*	*0.0001448*	H_1
Avatars	*0.44146*	*3.678e-07*	H_0
Feedback	*0.23722*	*0.06074*	H_0

Table 71 - Skewness and Kurtosis test for Survivor students

	Skewness	***Kurtosis***	**Result**
Points	*-0.853182*	*2.823823*	H_0
Badges	*-0.7585646*	*1.902618*	H_0
Trophies	*-1.246732*	*3.907232*	H_1
Levels	*-0.5064644*	*2.017063*	H_0
Progress bar	*-0.6074052*	*1.917827*	H_0
Ranking and leaderboards	*-1.6114*	*4.310592*	H_1
Timeline	*-1.039016*	*3.401957*	H_1
History	*-0.7346445*	*1.98314*	H_0
Avatars	*-1.709126*	*4.438017*	H_1

Feedback	*-0.6179172*	*2.447087*	H_0

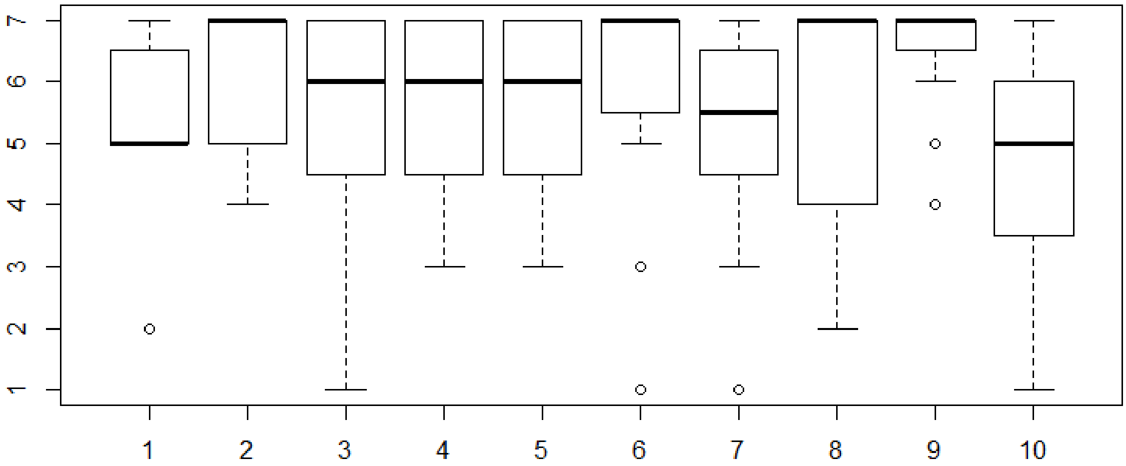


Figure 129 - Boxplots analyses for Survivor students

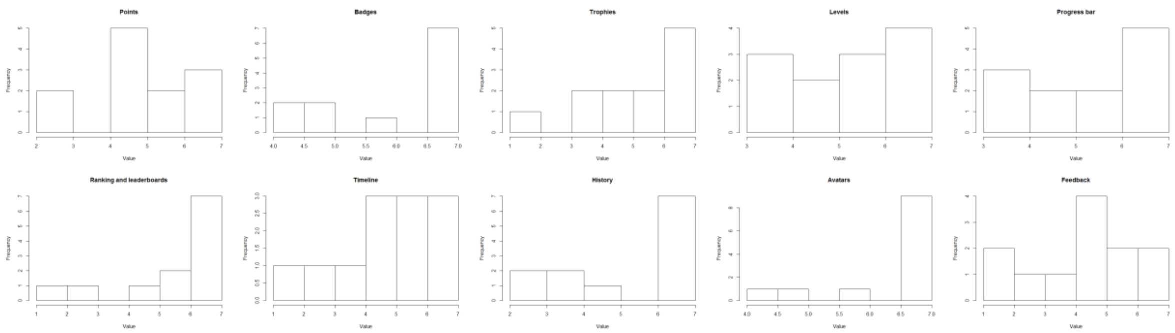


Figure 130 - Histogram analyses for Survivor students

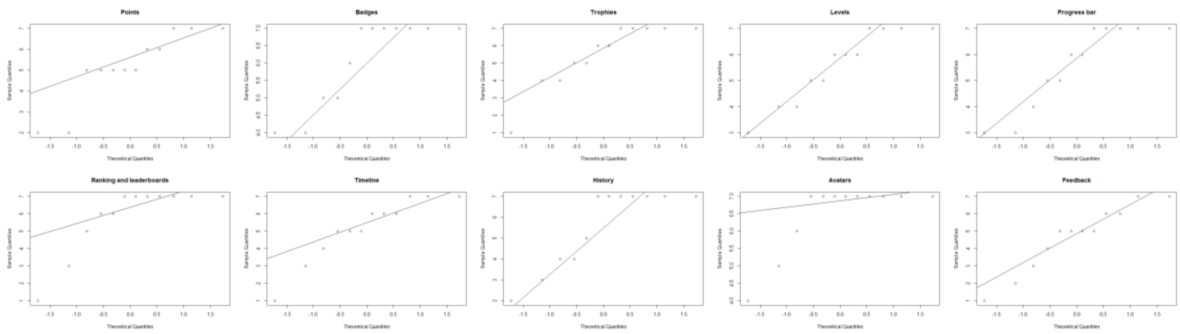


Figure 131 - QQ plots analyses for Survivor students

The normality tests allowed the understanding that most of the data presented a normal statistical distribution. Only in some cases the tests showed the ocurrence of unusual data. However, the indications of unusual data were insufficient to prove that this was a common occurrence, making it possible for us to consider that the data had a normal distribution.

Survivors showed a deep enjoyment for two gamification elements: avatars and badges. However, they also presented an interest in other gamification elements, such as, ranking, trophies, levels and progress bar. This result indicates similarity with recent results in this domain, emphasizing that survivors are more interested in following and showing their performance to other people and sharing their achievements (Orji *et al*. 2014). Table **72** presents the general structure of the data and Figure **132** synthesize the preferences of Daredevil students in terms of gamification elements. The ANOVA tests don't indicate high index variation (0.335) for Seeker students in terms of gamification elements preference.

Table 72 - Gamification elements preferences of the Survivor students

Gamification elements	M	$\tilde{x}$	**Mod**	*var*(*X*)	σ_X
Points	*5.17*	*5.00*	*5.00*	*2.878788*	*1.696699*
Badges	*6.08*	*7.00*	*7.00*	*1.537879*	*1.240112*
Trophies	*5.50*	*7.00*	*6.00*	*3.363636*	*1.834022*
Levels	*5.58*	*7.00*	*6.00*	*1.901515*	*1.378954*
Progress bar	*5.58*	*7.00*	*6.00*	*2.44697*	*1.564279*
Ranking	*5.83*	*7.00*	*7.00*	*3.787879*	*1.946247*
Timeline	*5.17*	*7.00*	*5.50*	*3.242424*	*1.800673*
History	*5.58*	*7.00*	*7.00*	*3.537879*	*1.880925*
Avatars	*6.50*	*7.00*	*7.00*	*1*	*1*
Feedback	*4.67*	*5.00*	*5.00*	*3.515152*	*1.874874*

Index: μ = Mean, $\tilde{x}$ = Median, Mod: modulo, σ_X= standard deviation, *var*(*X*)= Variance extracted

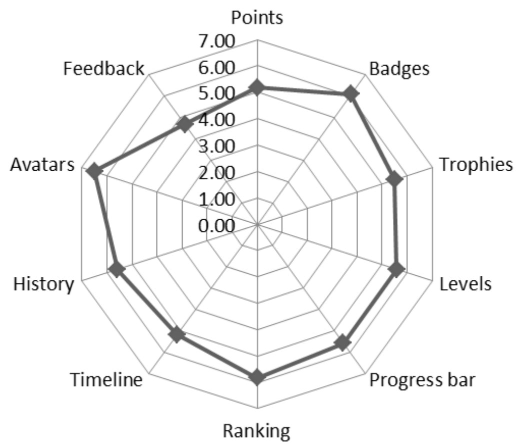


Figure 132 - Gamification elements preferences of the Survivor students

Table 73 - Gamification elements variation correlation of the Survivor students

	A	B	F	G	H	L	M	P	R	T
A	-	-	-	-	-	-	-	-	-	-
B	0.9998060	-	-	-	-	-	-	-	-	-
F	0.1779068	0.5290563	-	-	-	-	-	-	-	-
G	0.9362080	0.9991450	0.9362080	-	-	-	-	-	-	-
H	0.9362080	0.9991450	0.9362080	1.0000000	-	-	-	-	-	-
L	0.9362080	0.9991450	0.9362080	1.0000000	1.0000000	-	-	-	-	-
M	0.6147801	0.9362080	0.9991450	0.9998060	0.9998060	0.9998060	-	-	-	-
P	0.6147801	0.9362080	0.9991450	0.9998060	0.9998060	0.9998060	1.0000000	-	-	-
R	0.9922957	0.9999975	0.7746340	0.9999975	0.9999975	0.9999975	0.9922957	0.9922957	-	-
T	0.8953422	0.9971495	0.9645376	1.0000000	1.0000000	1.0000000	0.9999703	0.9999703	0.9999703	-

A = Avatars, B = Badges, F = Feedback, G = Progress bar, H = History, L = Levels, M = Timeline, P = Points, R = Ranking, T = Trophies

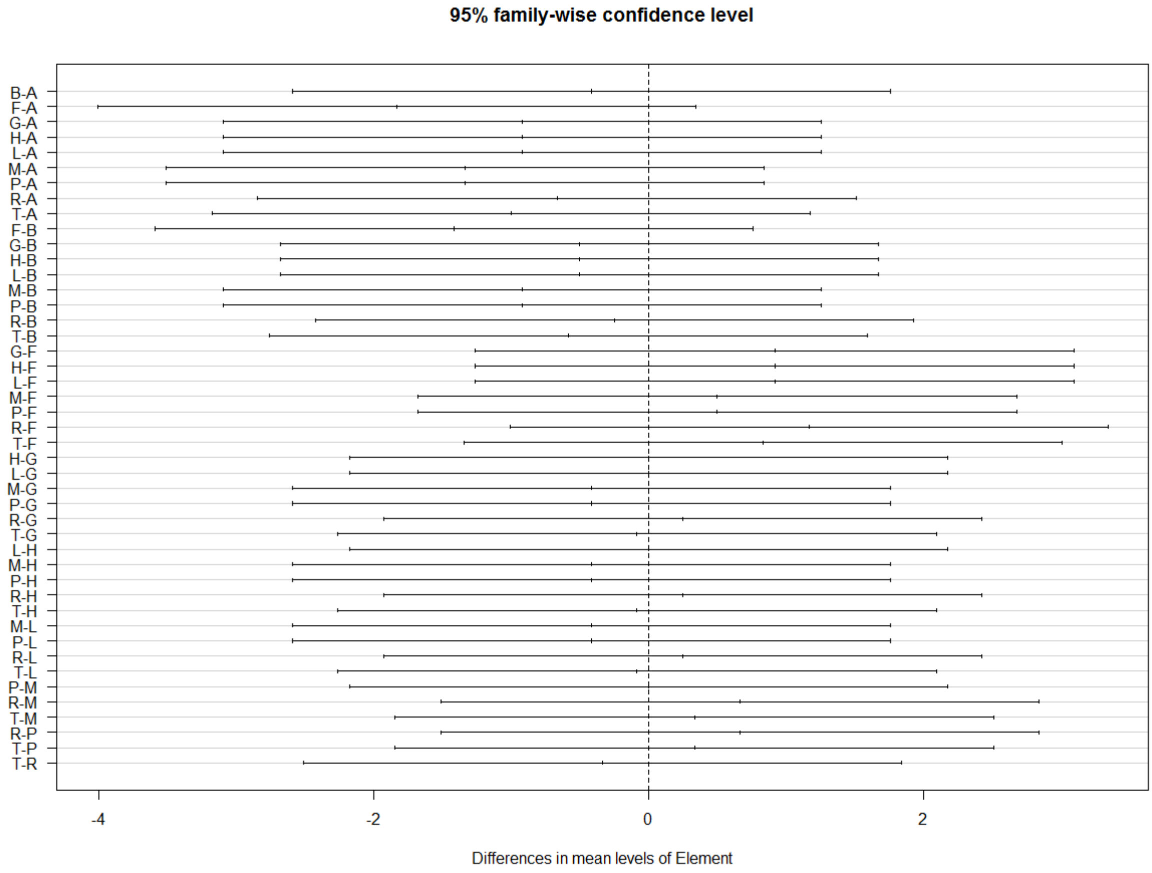


Figure 133 - Plot of gamification elements variation correlation of Survivor students

5.3.13. Instrumentation

To conduct this experiment, different instruments were used. We present these instruments as it follows:

- *BrainHex* questionnaire (used to identify the student's gamer type);
- Gamification elements questionnaire (used to identify the student's preferences about the gamification elements);
- RStudio (used to organize the data, perform statistical tests, and generate graphics).

5.3.14. Statistical Analysis of Data

We conducted in this experiment a comparative analysis about gamification elements preferences, to identify the preferences of *BrainHex* gamer types in terms of gamification elements. The study was conducted with Brazilian elementary schools and our general findings indicated some similarities with recent studies in this field. However, it added new findings for the literature. In this sense, we intended to answer two different research questions: (*i*) Do the students have different preferences about the gamification elements according to their gamer type? And, (*ii*) what are the best gamification elements to motivate each student gamer type?

Regarding the first research question, our findings indicated that there is a statistical difference in terms of gamification elements in most of the gamer types. Only one specific gamer type (Seeker) do not presented a significative difference in terms of gamification elements preferences. The results confirmed the outcome of some recent studies in this field, emphasizing that this gamer type is motivated by the opportunity of choosing his prizes (Orji *et al*. 2014). The other gamer types analyzed in this study presented different perceptions regarding the gamification elements.

Regarding the gamification elements, our study confirmed that most of the gamer types have different individual preferences. In the case of the Achiever students, our results recommend the use of five different gamification elements: points, progress bar, trophies, avatars, and badges. These elements belong to the group of elements used to stimulate players to compete, win challenges and collect their achievements. Other elements, such as history, ranking, and levels, can be used in the system. However, they will not motivate the students. On the other hand, if the system uses the elements feedback and timeline, it can be harmful to the students.

About the Conquerors, our findings indicated that the systems can use six different gamification elements to motivate these students: points, badges, levels, progress bar, ranking, and avatars. These elements are used specially to motivate the students to compete and follow their progress in the system. The elements trophies and history also can be used. However, they could not bring benefits to students in terms of motivation. Like with the achievers, the use of feedback and timeline must be avoided in the system.

To tailor the systems for the Daredevil students, according to our results, five different elements should be used: levels, trophies, avatars, badges, and ranking. These elements also represent a way to motivate students to compete and follow their progress in the system. Points and feedback can also be used; however, they could not bring benefits to the students. Three gamification elements (timeline, history and progress bar) should be avoided to tailor gamified VLEs for this gamer type. At the same time, our results can also confirm a recent study (Orji *et al*. 2014), as it also showed that the Seekers seem to like all the elements, beng motivated for the opportunity of choosing their prizes.

Our results indicated that the Socializers are motivated for the gamification elements points, ranking, avatars, badges and levels, elements especially used to help students to create an identity within the system, increasing their level in it. The elements feedback, progress bar, and history can also be used to help the students to create a social identity within the system. On the other hand, the elements timeline and trophies should be avoided in systems tailored to the Socializer students.

In our study, the findings indicated that for the Survivor students, the gamification elements avatars, badges, and ranking should be used to motivate these students. The elements levels, progress bar, history, and trophies, can also be used; however, they are insignificant for the potential motivation of the survivors. The elements points and timeline should be avoided in tailored systems for the survivors. Table 74, Table 75, and Table 76 present the best, neutral and worst elements to each gamer type. To make the systems more specific, it's recomendable to use only the best gamification elements to each gamer type.

Table 74 - The best gamification elements to each gamer type

Best elements						
Achiever	Points	Progress bar	Trophies	Avatars	Badges	-
Conqueror	Points	Badges	Levels	Progress bar	Ranking	Avatars
Daredevil	Levels	Trophies	Avatars	Badges	Ranking	-
Seeker	Avatars	Badges	Trophies	Points	-	-
Mastermind	-					
Socializer	Points	Ranking	Avatars	Badges	Levels	-
Survivor	Avatars	Badges	Ranking	-	-	-

Table 75 - The neutral gamification elements to each gamer type

Neutral elements						
Achiever	History	Ranking	Levels	-	-	-
Conqueror	History	-	-	-	-	-
Daredevil	Points	Feedback	-	-	-	-
Seeker	Progress bar	History	Levels	Feedback	Ranking	-
Mastermind	-					
Socializer	Feedback	Progress bar	History	-	-	-
Survivor	Levels	Progress bar	History	Trophies	-	-

Table 76 - The worst gamification elements to each gamer type

Worst elements						
Achiever	Feedback	Timeline	-	-	-	-
Conqueror	Feedback	Timeline	-	-	-	-
Daredevil	Timeline	History	Progress bar	-	-	-
Seeker	Timeline	-	-	-	-	-
Mastermind	-					
Socializer	Timeline	Trophies	-	-	-	-
Survivor	Points	Timeline	-	-	-	-

5.3.15. Threats to Validity

This section describes concerns that must be adressed in future publications of this study and other aspects that must be considered to maximize the results of the evaluation performed in this section. In general, the evaluation design had the purpose of minimize the threats discussed in this section. To organize this section, the validity threats were classified using the Internal, External, Construct and Conclusion categories (Wohlin *et al*., 2012).

Internal: As the experiment has the active participation of humans, it was also prone to a number of internal threats, such as: (*i*) history – it is possible that the moment in which the experiment was conducted may have affected the results; however, this threat was minimized by letting the participants took part in the experiment without interference of the other students and teachers; (*ii*) maturation – since the participants analyzed many different gamification elements to answer the questionnaire, and the students answered the survey more than one time during the experiment, it is possible that they were bored or tired while answering the survey; and (*iii*) positive bias – as this experiment is not a comparative one (*i.e*., subjects only analyze one treatment (*e.g*., version 1)), it is likely that the participants did not have a basis for comparison with other results. To minimize this threat, all of the students analyzed both gamification elements.

External: The participants of the experiment are representative only in an academic context. As previously described, participants were elementary school students from one research group. For this reason, we might not be able to maximize the results of this experiment in other contexts. The subjects of this evaluation should be expanded to other academic settings to obtain more generic results.

Construct: The threats of this category are mainly related to two aspects of our experiments. This experiment measures many different items from different aspects, and some constructs may not be measured by the questions. To minimize these threats, we selected methodologies and instruments empirically validated and commonly used in the scientific empirical studies from technological and educational communities. Some gamification elements designs can motivate students to a specific response, independent of the gamification element. To minimize this threat, the gamification elements were designed by a professional with expertise in this field.

Conclusion: The sample size of this experiment was 111 students; however, the experiment was a blocking factorial experiment, and some groups may have a small sample, with insignificant statistical power. The elementary students that took part in the experiment could be anxious when they answered the questionnaire, doing it without paying the proper attention. To mitigate this, we inserted “out of the curve” questions in the questionnaire.

6. General Discussions

From the actual discussions regarding the need to improve the education quality in different aspects, one of the main recent challenges is to identify the student's individual features, needs and preferences, to provide an adapted education to each group of students. Based on theses challenges and the growing use of gamification elements in the educational systems, identifying the better gamification elements to motivate each group of students and providing a tailored system based on the students' gamer type are also two important recent challenges of the Technological and Educational communities.

Recent studies have provided proposes to solve and address these problems, bringing important initial outcomes. However, beside these recent studies, many of the concerns related to the problems remain without solutions, like, for instance, identifying the best gamification elements to each gamer type and providing solutions to implementing tailored educational systems.

To solve these problems, we conducted two different studies, with one having the goal to identify the best gamification elements to motivate each *BrainHex* gamer types, and the other to provide an architectural design and process to tailor gamified VLEs based on the students' gamer types. The two studies were conducted through many different statistical processes with a group of Brazilian elementary students.

Regarding the conducted study, to provide a way for the gamification designers to tailor gamified VLEs based on the students' gamer types, our results found different results for each gamer type. Most of the gamer types had a significant difference in terms of concentration and flow experience constructs. For some gamer types, in most of the flow experience constructs, the tailored system was significantly better than the counter-tailored system, confirming our hypothesis. However, beside these results, surprisingly, for some gamer types, the counter-tailored version (with all of the ten gamification elements) was significant better to the students in terms of concentration and the other flow experience constucts.

In the second study, conducted to identify the best gamification elements to motivate each student's gamer type, our results indentified significative differences in all of the gamer types, confirming the results of the recent studies in this field, which indicated that the different students' gamer types have specific preferences for some gamification elements, and the gamification elements have different influences in terms of the students' perceptions. Our results also confirmed the recent results in most of the specific gamification elements.

The results obtained in this master thesis can help the gamification designers and code programers to design and implement gamified VLEs tailored based on the students' gamer types. The two guidelines provided can help the professionals to identify the students' gamer types in the system, select the best gamification element to each gamer type and tailor a new system or a existent system based on the students' game types.

7. Concluding Remarks

One of the main challenges of the educational systems is to provide good environments to the students, in order to keep them engaged and motivated during their activities and increase their learning process (Paiva *et al*. 2015). With the objective of increasing the students' motivation in this type of system, the gamification tool has been widely used in different perspectives (Hamari *et al*. 2014).

Besides, gamification presented good results in different studies, like, for instance, keeping the students motivated during the activities provided by the system or improving the students' engagement (*e.g*. Paiva *et al*. (2015), Santana *et al*. (2016), Challco *et al*. (2015) and others). On the other hand, other studies showed that gamification can cause the opposite effect (Orji *et al*. 2014). One of the main hypothesis to this situation is that students have different styles (different gamer types) and are motivated for different gamification elements, according to their profile.

In order to investigate this hypothesis, we conducted a study with the objective to provide a process and architectural design to tailor gamified VLEs based on gamer types. We implemented seven different versions of a gamified VLE using the proposed process and conducted a comparative evaluation in terms of flow experience with the students using a tailored and counter-tailored version of the system. We also conducted two SLRs, one about gamer types applied to C&E and other about Flow Theory applied to C&E.

The main results of this study indicate that for some gamer types, the tailored system was more effective in terms of concentration and flow experience in comparison with the counter-tailored system, confirming our expectations and the recent studies in this field. On the other hand, the same study also indicates that for other gamer types, the counter-tailored system was more effective than the tailored system, indicating that new studies need to be conducted to investigate these results.

After conducting this study, based on some astonishing results, we also conducted a second one with the same students in order to investigate their preferences (according to their gamer type) with the ten most used gamification elements. Based on our second study, we also provided a guideline to tailor gamified VLEs based on gamer types, associating the best, neutral and worst gamification elements to each gamer type.

The main results confirmed that the students have different perceptions according to their gamer type, and confirmed most of the recent studies in this fild in terms of which are the best gamification elements for each gamer type. The results also showed some new perspectives in terms of gamification elements preferences of the different students' gamer type. The guideline provided through these results can be used by different professional types to identify the best gamification elements to each gamer type.

We recommend for future studies to associate more gamification elements and game mechanics with each *BrainHex* gamer type, to provide a deeper view regarding the motivational items for each gamer type. We also intent to conduct new evaluations in different versions of the tailored system based on the students' gamer types, including investigating different constructs, such as the students' motivation and engagement, and with different subjects samples (*i.e*. gamification designers).

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APPENDIX A – BEHAVIORAL RESEARCH ETHICS CERTIFICATE OF APPROVAL

UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics

Certificate of Approval

PRINCIPAL INVESTIGATOR	DEPARTMENT	BEH#
Julita Vassileva	Computer Science	16-142

INSTITUTION(S) WHERE RESEARCH WILL BE CONDUCTED
Brazil

STUDENT RESEARCHER(S)
Wilk Oliviera dos Santos

FUNDER(S)
INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC)
COORDINATION FOR THE IMPROVEMENT OF HIGHER EDUCATION PERSONNEL (CAPES)

TITLE
Investigating the Relationship between Gamer Types and Gamification Elements Preferences of Students in a Gamified Learning Environment

ORIGINAL REVIEW DATE	APPROVAL ON	APPROVAL OF:	EXPIRY DATE
25-Apr-2016	13-Jun-2016	Application for Approval of Research Protocol Appendix A: A sample email notification Appendix B: A sample email notification (Translated to Portuguese) Consent Form Consent Form (Translated to Portuguese) Appendix E: A Sample Questionnaire (before tasks) Appendix E: A Sample Questionnaire (before tasks) (Translated to Portuguese) Appendix G Letter of Information (to the parents) Appendix G Letter of Information (to the parents) (Translated to Portuguese)	12-Jun-2017

Full Board Meeting ☐

Delegated Review ☒

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named research project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this research project, and for ensuring that the authorized research is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

Please send all correspondence to:

Research Ethics Office
University of Saskatchewan
Box 5000 RPO University, 223-110 Science Place
Saskatoon SK S7N 5C9
Telephone: (306) 966-2975 Fax: (306) 966-2069

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PRINCIPAL INVESTIGATOR	DEPARTMENT	Beh #
Julita Vassileva	Computer Science	16-142

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month prior to the current expiry date each year the study remains open, and upon study completion. Please refer to the following website for further instructions: *http://research.usask.ca/for-researchers/ethics/index.php*

Vivian Ramsden, Chair
University of Saskatchewan
Behavioural Research Ethics Board

APPENDIX B – BEHAVIORAL RESEARCH ETHICS PROJECT

Behavioural Research Ethics Board (Beh-REB)

Application for Approval of Research Protocol (Programme of Research)
To the Behavioural Research Ethics Board

1. **Name of researcher(s)**
Dr. Julita Vassileva, Department of Computer Science

1a. **Name of researcher(s)**
Dr. Ig Ibert Bittencourt Santana Pinto, Federal University of Alagoas, Brazil

1b. **Name of student(s)**
Wilk Oliveira dos Santos, M.Sc. student, Federal University of Alagoas, Brazil
Diego Dermeval Medeiros da Cunha Matos, Ph.D. student, Federal University of Campina Grande, Brazil

1c. **Anticipated start date of the research study (phase) and the expected completion date of the study (phase)**
28 April 2016 – 28 July 2016

2. **Title of Study**
Investigating the Relationship between Gamer Types and Gamification Elements preferences of students in a Gamified Virtual Learning Environment.

3. **Abstract (100-250 words)**
In the last years, researches have investigated how to provide a personalized learning according to learning style of students and their individual preferences. This study aims to identify the correlation between the Gamer Type of students and their preferences regarding gamification elements in a Gamified Virtual Learning Environment. This study is divided in three steps: (*i*) identify the students' Gamer Type, (*ii*) extract the interaction of students in a Gamified Virtual Learning Environment to identify her gamified activities preferences, and (*iii*) find the correlation between Gamer Type of students and their gamification elements preferences. The first step will be conducted using a Gamer Type topology that includes seven different Gamer Types using a non-invasive questionnaire composed for 28 questions. The second step will be conducted using student's data logs from the *MeuTutor*® system. Finally, the results obtained in the before steps, will be analyzed statistically.

Full document (25 pages): http://migre.me/v9NP3

APPENDIX C – ORIGINAL *BRAINHEX* QUESTIONNAIRE (*IN ENGLISH*)

Year of birth:

Gender:

- Female
- Male

Geographical Territory:

- North America
- Southern or Central America
- Western Europe or UK
- Eastern Europe or Russia
- South Asia (incl. China, India and Japan)
- Africa
- Middle East
- Australasia
- Other (please specify)

I typically play computer or videogames

- Every day
- Every week
- Occasionally
- Rarely
- Never

I would consider myself

- Hardcore gamer
- something between a Hardcore and a Casual gamer
- Casual gamer
- I have no idea!

I work in:

- a non-videogames related industry (or I don't work/am a student)
- videogame development
- videogame publishing
- videogame retail

- videogame press
- videogames in some other context (e.g. research)

I prefer the following way of playing games:

- Single player alone
- Single player with other people helping or pad-passing
- Multiplayer, in the same room
- Multiplayer, over the internet
- Team play or Clan play over the internet
- Virtual worlds or MMORPGs

My attitude to videogame stories is:

- Stories are very important to my enjoyment of videogames
- Stories can help me enjoy a videogame
- Stories are not important to me in videogames
- I prefer videogames without stories
- I don't play videogames

Name three games that exemplify what you enjoy about games (these don't have to be videogames - any game you enjoy counts):

I live with, and/or like living with:

- a cat or cats
- a dog or dogs
- both cats and dogs
- neither

Optional:
If you know your Myers-Briggs Type, please select it here:

-

Case Study Volunteers
We will be conducting case studies to follow up this survey. If you are willing to be considered as a case study, please enter your email address below. We will contact chosen case study volunteers after the first major run data has been collated (this might be as long as year away).

All your survey details will be used only for the purpose of this research, and will not be passed to third parties under any circumstances.

Case Study Volunteers Only:

Email address :

"Exploring to see what you can find."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Frantically escaping from a terrifying foe."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Working out how to crack a challenging puzzle."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"The struggle to defeat a difficult boss."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Playing in a group, online or in the same room."

I love it!

I like it.

It's okay.

- I dislike it.
- I hate it!

"Responding quickly to an exciting situation."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Picking up every single collectible in an area."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Looking around just to enjoy the scenery."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Being in control at high speed."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Devising a promising strategy when deciding what to try next."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Feeling relief when you escape to a safe area."

- I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Taking on a strong opponent when playing against a human player in a versus match."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Talking with other players, online or in the same room."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Finding what you need to complete a collection."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Hanging from a high ledge."

I love it!

I like it.

It's okay.

I dislike it.

I hate it!

"Wondering what's behind a locked door."

I love it!

I like it.

It's okay.

- I dislike it.
- I hate it!

"Feeling scared, terrified or disturbed."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Working out what to do on your own."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Completing a punishing challenge after failing many times."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Co-operating with strangers."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

"Getting 100% (completing *everything* in a game)."

- I love it!
- I like it.
- It's okay.
- I dislike it.
- I hate it!

Please list the seven statements in order of preference, choosing each number only once:

- [---] A moment of jaw-dropping wonder or beauty.
- [---] An experience of primeval terror that blows your mind.
- [---] A moment of breathtaking speed or vertigo.
- [---] The moment when the solution to a difficult puzzle clicks in your mind.
- [---] A moment of hard-fought victory.
- [---] A moment when you feel an intense sense of unity with another player.
- [---] A moment of completeness that you have strived for

APPENDIX D – *BRAINHEX* QUESTIONNAIRE (*IN PORTUGUESE*)

Parte 1: Sobre você

Instruções

Esta é a primeira de quatro páginas.
Esta página vai perguntar sobre suas preferências e hábitos ao jogar vídeo game.

Ano de nascimento:

[--- ▾]

Sexo:

- ○ Feminino
- ○ Masculino

Estado: [Selecione o estado ▾]

Eu jogo vídeo game:

- ○ Todo dia
- ○ Toda semana
- ○ Ocasionalmente
- ○ Raramente
- ○ Nunca

Eu me considero:

- ○ Jogador *hardcore* (sou um jogador muito bom)
- ○ Algo entre *hardcore* e casual (sou um jogador razoável)
- ○ Casual
- ○ Não tenho ideia!

Eu trabalho com:

- ○ Nada relacionado a jogos
- ○ Desenvolvimento de jogos
- ○ Publicação de jogos
- ○ Venda de jogos

- Divulgação de jogos
- Jogos em outro contexto (exemplo: pesquisa)

Eu prefiro jogar da seguinte maneira:

- *Single player* (individualmente) sozinho
- *Single player* (individualmente) com outra pessoa para ajudar ou olhar
- *Multiplayer* (com vários jogadores) em alguma sala
- *Multiplayer* (com vários jogadores) na internet
- Em equipe ou *clan* na internet
- Em mundos virtuais ou MMORPGs

Minha atitude em relação a história dos jogos é:

- Histórias são muito importantes para eu gostar do jogo
- Histórias me ajudam a gostar do jogo
- Histórias não tem importância para mim nos jogos
- Eu prefiro jogos sem histórias
- Eu não jogo vídeo game

Coloque o nome de três jogos que você goste (seus jogos prediletos, podendo ou não ser jogo de vídeo game):

Eu moro com / e / ou:

- Gato(s)
- Cachorro(s)
- Ambos (cachorros e gatos)
- Nenhum

Opcional.
Se você sabe sua clase Myers-Briggs (Myers-Briggs Type), por favor, selecione aqui: ---

Não se preocupe, você não irá receber nenhum *span*
Nós pretendemos conduzir estudos para acompanhar esta pesquisa. Em breve, poderemos entrar em contato com os você caso seja escolhidos após a coleta de dados da pesquisa (isso pode ocorrer em um período de tempo inferior ou superior a um ano). Sua participação é será totalmente voluntária.

Você também receberá uma mensagem automática com seus resultados. Todos os detalhes do seu questionário serão utilizados apenas para efeitos desta pesquisa, e não serão transmitidos a terceiros em nenhuma circunstância.

Por favor, digite um endereço e-mail válido.

E-mail :

Quiz

Instruções

Esta é a segunda de 4 páginas, nela será solicitado que você avalie cada experiência de videogame listada. Escolha entre uma escala entre "eu amo isso!" para as experiências que você aprecia ou "eu odeio isso!" para experiências que você preferiria evitar.

"Explorar o cenário para ver o que você pode achar."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Escapar freneticamente do território inimigo."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Trabalhar para desvendar desafios complexos."

- Eu amo isso!
- Eu gosto disso.

Não tem problema (neutro).
Eu não gosto disso.
Eu odeio isso!

"Lutar para desafiar o chefe."

Eu amo isso!
Eu gosto disso.
Não tem problema (neutro).
Eu não gosto disso.
Eu odeio isso!

"Jogar online, em grupo ou em alguma sala."

Eu amo isso!
Eu gosto disso.
Não tem problema (neutro).
Eu não gosto disso.
Eu odeio isso!

"Responder/resolver rapidamente uma situação emocionante."

Eu amo isso!
Eu gosto disso.
Não tem problema (neutro).
Eu não gosto disso.
Eu odeio isso!

"Pegar cada elemento de uma área do jogo."

Eu amo isso!
Eu gosto disso.
Não tem problema (neutro).
Eu não gosto disso.
Eu odeio isso!

"Ficar apenas olhando em volta do cenário."

Eu amo isso!

- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Entrar no controle do jogo rapidamente."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Imaginar uma estratégia promissora quando decidir a próxima tentativa."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Sentir-se seguro quando escapa de uma área de perigo."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Enfrentar um adversário forte quando joga contra outra pessoa."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Falar com outros jogadores online ou em alguma sala."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Descobrir o que você necessita para completar uma coleção/desafio."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Ficar suspenso em um lugar alto."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Querer saber o que esta por trás de uma porta fechada."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Sentir-se assustado, aterrorizado ou perturbado."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).

- Eu não gosto disso.
- Eu odeio isso!

"Trabalhar para outros jogadores, ao invés de construir seu próprio território."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Completar um desafio ou punição, depois de falhar muitas vezes."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Cooperar com estranhos."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

"Atingir 100% (Completar todo o jogo/ *zerar*):."

- Eu amo isso!
- Eu gosto disso.
- Não tem problema (neutro).
- Eu não gosto disso.
- Eu odeio isso!

Parte 3: Proporção

Instruções

Por favor, liste/ordene cada afirmação a seguir de 1 a 7 na ordem de sua preferencia.
Inicie em 1 (um) para o que você menos gosta e finalize em 7 (sete) com o que você mais gosta (por favor, escolha cada número apenas uma vez).

Por favor, liste as sete afirmações na ordem de sua preferência, escolhendo cada número apenas uma vez:

[▾] Um momento bonito, maravilho "de cair o queixo".

[▾] Uma experiência original de terror que assombra sua mente.

[▾] Um momento de velocidade, de tirar o folego ou dar vertigem.

[▾] Um momento quando a solução para um desafio difícil surge em sua mente.

[▾] Um momento de uma vitória "suada".

[▾] Um momento quando você sente um intenso senso de unidade/cooperação com outro jogador.

[--- ▾] Um momento de plenitude/perfeição que você se esforçou para conseguir.

APPENDIX E – DISPOSITIONAL FLOW SCALE-2

Dispositional Flow Scale-2						
5-point scale						
Item no.	**Content**	**1**	**2**	**3**	**4**	**5**
1	I am challenged, but I believe my skills allow me to meet the challenge.					
2	I make the correct movements without thinking about trying to do so.					
3	I know clearly what I want to do.					
4	It is really clear to me how my performance is going.					
5	My attention is focused entirely on what I am doing.					
6	I have a sense of control over what I am doing.					
7	I am not concerned with what others may be thinking of me.					
8	Time seems to alter (either slows down or speeds up).					
9	I really enjoy the experience.					
10	My abilities match the high challenge of the situation.					
11	Things just seem to happen automatically.					
12	I have a strong sense of what I want to do.					
13	I am aware of how well I am performing.					
14	It is no effort to keep my mind on what is happening.					
15	I feel like I can control what I am doing.					
16	I am not concerned with how others may be evaluating					
17	The way time passes seems to be different from normal.					
18	I love the feeling of the performance and want to capture it again.					
19	I feel I am competent enough to meet the high demands of the situation.					
20	I perform automatically, without thinking too much.					
21	I know what I want to achieve.					
22	I have a good idea while I am performing about how well I am doing.					
23	I have total concentration.					
24	I have a feeling of total control.					
25	I am not concerned with how I am presenting myself.					
26	It feels like time goes by quickly.					
27	The experience leaves me feeling great.					
28	The challenge and my skills are at an equally high level.					
29	I do things spontaneously and automatically without having to think.					
30	My goals are clearly defined.					
31	I can tell by the way I am performing how well I am doing.					
32	I am completely focused on the task at hand.					
33	I feel in total control of my body.					
34	I am not worried about what others may be thinking of me.					
35	I lose my normal awareness of time.					
36	The experience is extremely rewarding.					

APPENDIX F – DISPOSITIONAL FLOW SCALE-2 (IN PORTUGUESE)

Dispositional Flow Scale-2						
5-point scale						
Item no.	**Content**	**1**	**2**	**3**	**4**	**5**
1	Eu me senti desafiado, mas acredito que minhas habilidades me permitiram enfrentar o desafio.					
2	Eu fiz os movimentos corretos, sem precisar pensar como fazê-los.					
3	Eu sabia claramente o que eu queria fazer.					
4	Era realmente claro para mim como estava meu desempenho.					
5	Minha atenção estava focada exclusivamente no que eu estava fazendo.					
6	Eu tive senso de controle sobre o que estava fazendo.					
7	Eu não fiquei preocupado com o que os outros podiam estar pensando de mim.					
8	O tempo pareceu ser alterado (retardado ou acelerado).					
9	Eu realmente aproveitei a experiência.					
10	As minhas habilidades corresponderam aos altos desafio da situação.					
11	As coisas pareceram apenas acontecer automaticamente.					
12	Eu tive um forte sentimento do que eu queria fazer.					
13	Estive ciente do quão bem eu estava realizando as atividades.					
14	Não foi necessário nenhum esforço para manter minha mente no que estava acontecendo.					
15	Eu senti que podia controlar o que estava fazendo.					
16	Não fiquei preocupado com a forma como outros podiam estar me avaliando.					
17	A maneira como o tempo passou, pareceu ser diferente do normal.					
18	Eu amei a sensação de desempenho e quero sentir novamente.					
19	Eu senti que era competente o suficiente para atender às altas exigências da situação.					
20	Eu realizei as atividades automaticamente, sem pensar muito.					
21	Eu sabia o que eu queria alcançar.					
22	Durante as atividades, eu tive noção de quão bem eu estava indo.					
23	Eu tinha concentração total.					
24	Eu tive sensação de controle total.					
25	Eu não me preocupei com a forma como estava "me apresentando".					
26	Parece que o tempo passou depressa.					
27	A experiência me deixou sentindo ótimo.					
28	O desafio e minhas habilidades estavam em um nível igualmente elevados.					
29	Eu fiz as coisas de forma espontânea e automática, sem ter que pensar.					
30	Meus objetivos estavam claramente definidos.					
31	Eu consegui dizer o quão bem eu estava indo de acordo com a forma em que estou desempenhando minhas atividades.					
32	Eu fiquei completamente focado na tarefa que tinha.					
33	Eu me senti no controle total do meu corpo.					
34	Eu não estava preocupado com o que os outros podiam estar pensando de mim.					
35	Eu perdi a consciência de tempo normal.					
36	A experiência foi extremamente recompensadora.					

APPENDIX G – GAMIFICATION ELEMENTS QUESTIONNAIRE (IN PORTUGUESE)

Elementos de Gamificação

Os sistemas gamificados, são sistemas parecidos com jogos, eles oferecem recompensas para você para que você se divirta enquanto usa o sistema.
A seguir, nós vamos mostrar os elementos de jogos disponíveis e avaliar o quanto você gosta de cada um deles:
*Obrigatório

Antes de começar, por favor, insira seu login (caso necessário, peça ajuda ao seu professor para inserir o seu login corretamente) *

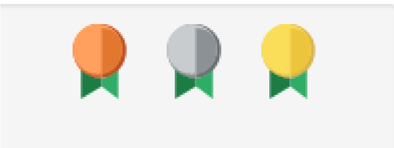
Sua resposta

1- Pontos: Os pontos são dados sempre que você completar uma determinada atividade e representam sua experiência. Veja um exemplo abaixo:

Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (pontos). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

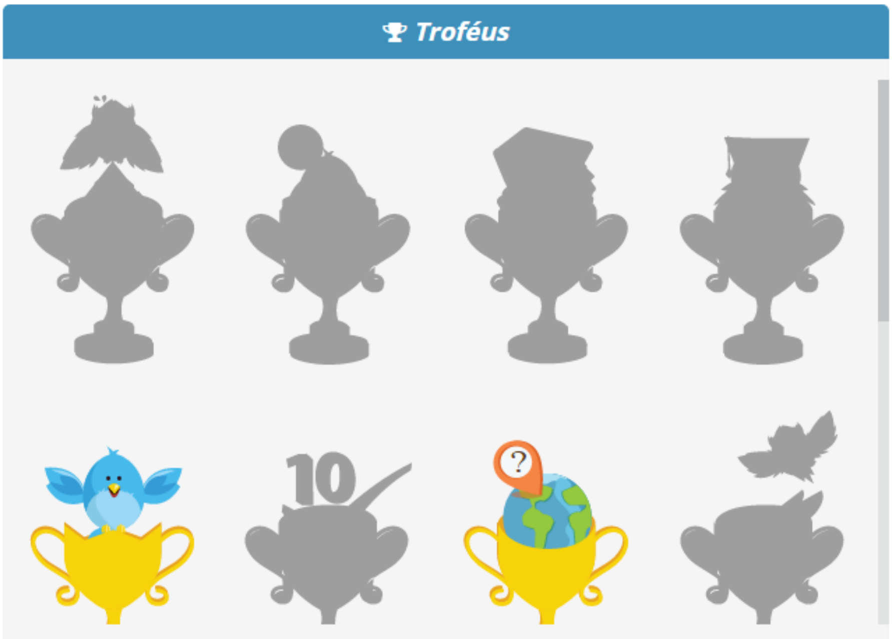
2- Medalhas: As medalhas são dadas sempre que você completa um pequeno grupo de atividades, permitindo que você colecione estas medalhas. Veja um exemplo abaixo:



Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (medalhas). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

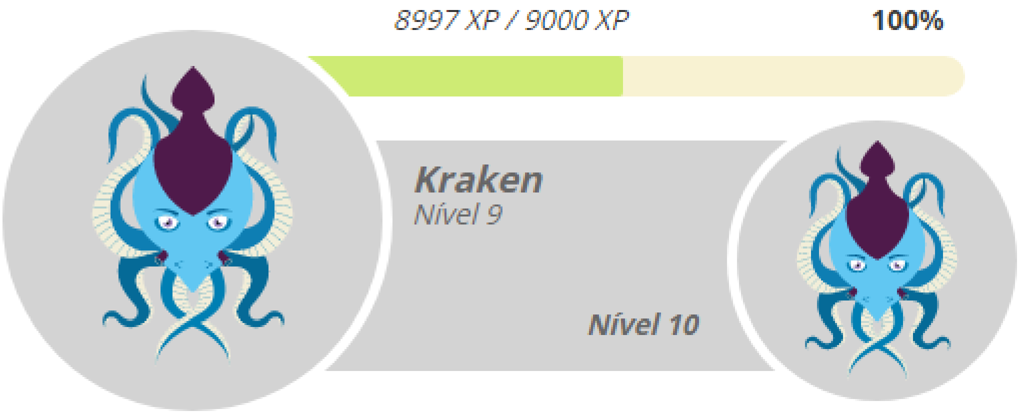
3- Troféus: Os troféus são dados sempre que você completa um grande grupo de atividades, você pode montar uma coleção de troféus. Veja um exemplo abaixo:



Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (troféus). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

4- Níveis: Os níveis são diferentes graus de experiencia que você pode atingir em um jogo. Eles também representam seu nível de experiência no sistema. Veja um exemplo abaixo:



Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (levels/ níveis). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

5- Barra de Progresso: As barras de progresso permitem que você acompanhe o seu desempenho no sistema e quanto falta para você avançar de nível. Veja um exemplo abaixo:

Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (barra de progresso). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

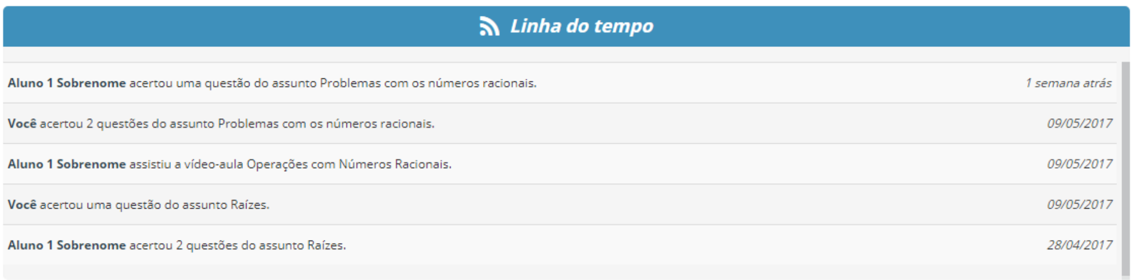
6- Rankings: Os rankings com leaderboards são tabelas que classificam você e seus colegas no jogo, destacando os melhores classificados no ranking, permitindo que seus colegas vejam seu desempenho no sistema e que você veja o desempenho dos seus colegas. Veja um exemplo abaixo:

Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (ranking e leaderboards). *

1 2 3 4 5 6 7

○ ○ ○ ○ ○ ○ ○

7- Linha do tempo: A linha do tempo mostra suas últimas atividades e as dos seus colegas no sistema, permitindo que seus colegas vejam suas últimas atividades e que você veja as últimas atividades do seus colegas. Veja um exemplo abaixo:



Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (timeline/ linha do tempo). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

8- História de Fundo: História apresentada ao logo do jogo, à medida que você vai avançando no jogo, você vai descobrindo novos itens da história. Veja um exemplo abaixo:

Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (História). *

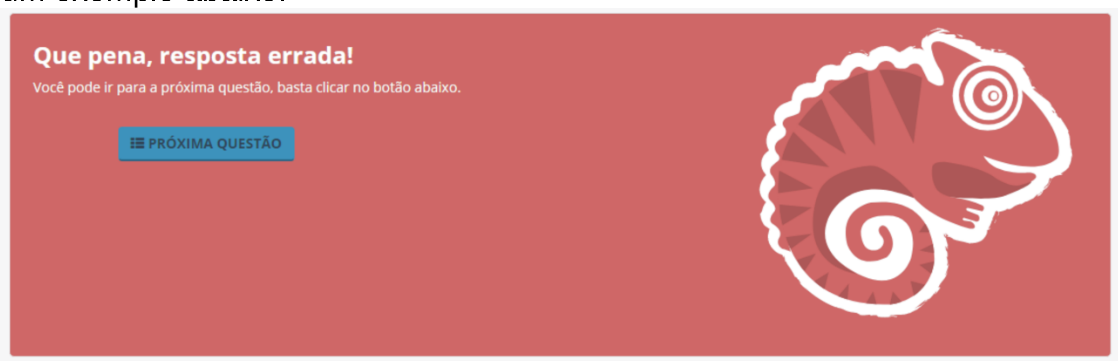
1	2	3	4	5	6	7
○	○	○	○	○	○	○

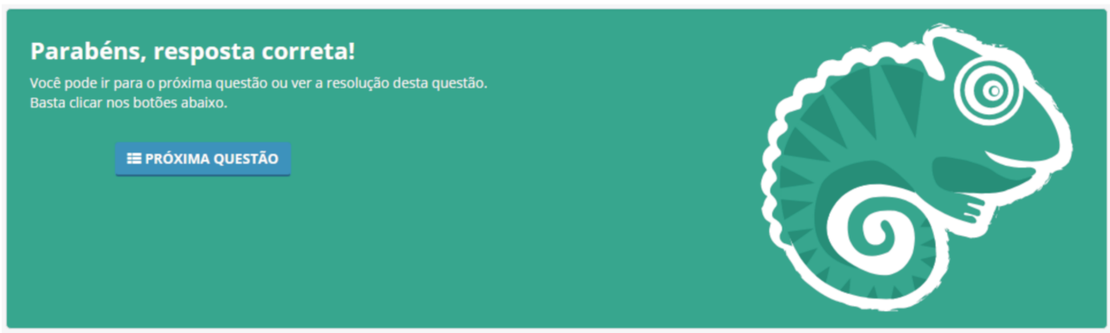
9- Avatar: Os avatares são personagens atrelado a história do jogo, ou apenas um personagem que você escolhe para lhe representar no jogo. Veja um exemplo abaixo:

Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (avatares). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○

10- Feedback: O feedback é uma mensagem que você recebe sempre que fez alguma atividade, dizendo o quão bom ou ruim você se saiu naquela atividade. Veja um exemplo abaixo:





Em uma escala de 1 a 7, onde 1 indica que você odeia e 7 indica que você ama, nos diga o quanto você gosta deste elemento (feedback). *

1	2	3	4	5	6	7
○	○	○	○	○	○	○